



**Ajeenkya DY Patil School of Engineering,  
Lohegaon, Pune, Maharashtra, India**

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(Approved by AICTE, New Delhi, Govt. of Maharashtra & affiliated to Savitribai Phule Pune University)

**International conference on Advancement and  
Innovation in Civil Engineering  
(ICAICE-2024)**

**24<sup>th</sup> May 2024**

**In Association With:**



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## **About the College**

Ajeenkya D Y Patil School of Engineering (ADYPSOE) is one of the most prestigious academic groups in the Pune City and state of Maharashtra which is Approved by AICTE and Affiliated to S.P. Pune University.

ADYPSOE was established in 2010 by the Chairman of Ajeenkya D. Y. Patil Group with excellent infrastructure spread over green campus with spacious buildings.

The college has developed excellent infra-structural facilities with well-equipped laboratories and an enriched library, which are updated regularly. The facilities and in- depth teaching is improvising students to understand the recent trends of Engineering and Technology. The College provides not only technical education to students but also conducts many co-curricular and extra-curricular programs, which ensure multifaceted development of students.

## **Aim & Objective of the Conference- ICAICE-2024**

The conference is aimed to bring together innovative academics and industrial experts in the field of Engineering and Technology to a common forum. The conference aspires to exhibit the technical excellence of budding technocrats, research scholars, representatives from the academia industry.

The conference is also a space for creating collaborative links between academics and professional practitioners and their workplaces, aiming at long-term sharing of knowledge and discussions of highly current issues.

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## MESSAGE FROM PRESIDENT



It gives me immense pleasure that the Ajeenkya DY Patil School of Engineering has organized National Conference on International conference on Advancement and Innovation in Civil Engineering (ICAICE-2024). Ever since the inception of our institute, we have been striving for excellence in various departments of Engineering and at the very same time marching forward with the mission of professional as well as technical development.

I believe in promoting events to be organized in Ajeenkya DY Patil School of Engineering which opens research and innovation avenues for students. This International conference on Advancement and Innovation in Civil Engineering (ICAICE-2024) is one such step towards motivating students and researchers. The conference greatly encourages graduate and Post- graduate students, research scholars and faculty to present innovative ideas and latest discoveries in the field of engineering and Technology. I would like to extend my gratitude towards Research and development cell and all staff who had done excellent job for the success of this conference. I take this opportunity to extend my best wishes to all the participants of this conference for their future endeavors and also aspire that more and more people opt for research and bring laurels to themselves and to the field of education.

**Dr. Ajeenkya D.Y. Patil**

**President, ADYPSOE**



## **MESSAGE FROM TRUSTEE & ADVISOR**



At the outset, I extend my appreciation and congratulations to Ajeenkya DY Patil School of Engineering for successfully organizing International conference on Advancement and Innovation in Civil Engineering (ICAICE-2024) on 24<sup>th</sup> May 2024. Education in general and technical education in particular, must be relevant to rapidly changing needs of the society, industry and business houses. The educational environment must be dynamic and quickly adaptable, so that professionals are capable of shouldering all-encompassing global responsibilities.

I express my sincere thanks to all well-wishers for their valuable guidance and unstinted support, who have been directly or indirectly involved in organizing this conference. May you all always be in pursuit of Excellence.

**Dr. Sushant V. Patil,**

**Trustee & Advisor, ADYPSOE**

## **MESSAGE FROM DIRECTOR**



It gives me great pleasure to be part of the International conference on Advancement and Innovation in Civil Engineering (ICAICE-2024) in Ajeenkya D Y Patil School of Engineering campus. The conference proceedings are a collection of research-based articles and papers presented by graduate and post graduate students and research scholars from all over India. These articles not only handle various issues in the field of Technology but also touch an array of topics right from Civil, Mechanical, Electronics branches. Conducting a conference of this magnitude is always encouraging and I would appreciate the efforts of the Ajeenkya D Y Patil School of Engineering in this endeavor.

I hope that the conference will provide a platform for various personnel to introduce innovative ideas and thoughts and exhibit their research skills in the area of all Technologies for sustainable development.

**Dr. Kamaljeet Kaur**

**Director, ADYPSOE**

## MESSAGE FROM PRINCIPAL



Education is an instrument to enhance the capabilities of human beings to become knowledgeable, creative and good citizens which resulted in my urge to develop excellent educational facility. I am extremely happy as principal of Ajeenkya D Y Patil School of Engineering, hosting International conference on Advancement and Innovation in Civil Engineering (ICAICE-2024).

It is a justified gesture to provide a platform for graduate students and researchers to present their work and seek experts' evaluation that provides insight in the work undertaken. I hope that the presentations, discussions, appreciations and suggestions will help in improving their research work. I extend my heartfelt wishes to all the participants who have contributed to making this conference a great success. It gives me pleasure to write for the proceeding of International conference on Advancement and Innovation in Civil Engineering (ICAICE-2024) an important event. Conferences of this magnitude help the graduate students and researchers to interact amongst themselves as well as experts in various areas. I feel that, with presentations and interactions with experts; students are exposed to the emerging trends in respective domains and the research work being carried out.

I would like to congratulate participants for contributing to this conference. I appreciate conference conveners, faculty coordinators, staff members of Ajeenkya D Y Patil School of Engineering for organizing the International conference on Advancement and Innovation in Civil Engineering (ICAICE-2024).

**Dr. Farook Sayyad**

**Principal, ADYPSOE**

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# Pushover Analysis by considering Soil Structure Interaction a Review Paper

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**ABSTRACT:** Earthquake engineering is a sector of civil engineering that deals with the mitigation of earthquake-induced damage on structures and the minimization of loss of life. In recent years, ample amount of study is going on in this sector due to the rapid developments of computers and computing, the improved experimental facilities, and the development of new methods of seismic design and assessment of structures. Easy and most used method to evaluate performance of structure is non-linear static analysis widely known as pushover analysis. It is not only simple but also a design method for structural systems to achieve the desirable and predictable performance of structure. As name implies, it's a process of pushing structure horizontally, with a prescribed loading pattern incrementally, i.e "pushing" structure & plotting total applied shear force & associated lateral displacement at each increment, until structure reaches a limit state or collapse condition. Pushover analysis provides better understanding of seismic performance of buildings & also give identification of progression of damage and subsequently failure of building's structural element. Generally, structures are analysed for its structural behaviour assuming base condition as a fixed base. However, it is observed that due to assumption of fixity at base condition, the results obtained are very much different from actual condition. In view of the above, while evaluating seismic structural behaviour, the effect of soil structure interaction is of paramount importance.

**KEYWORDS:** Pushover analysis, non-linear static analysis, soil structure interaction, earthquake analysis.

## I. INTRODUCTION

The use of the nonlinear static analysis came in to practice in 1970's but the potential of the pushover analysis has been recognized in last 10-15 years. Under a Strong seismic event a structure are subjected to forces beyond its elastic limit, generally loads on the structures are only gravity loads and result in elastic structural behaviour, this behaviour leads to damage of structures when they are subjected to earthquakes or repeated loads. In some cases, the entire structure will not collapse but member failure take place. The finest challenges for structural engineers are to evaluate the seismic resistance of structure and to take decision according to failure in members.

Pushover analysis provides information regarding its weakness and early failure in terms of plot between base shear and roof top displacement of a structure. In this method, either force or displacement is applied on the structure gradually up to its limit state. When the force or displacement is applied the formation of hinges, degradation of stiffness in the structure can be identified. This procedure is mainly used to estimate the strength and drift capacity of existing structure and the seismic demand for this structure subjected to selected earthquake.

The effectiveness of pushover analysis and its computational simplicity brought this procedure in to several seismic guidelines (ATC 40 and FEMA 356) and design codes (Eurocode 8 and PCM 3274) in last few years.

## II. NON-LINEAR STATIC ANALYSIS

As the name suggests this procedure is essentially a static analysis, in which the static loads are applied in an incremental fashion until the ultimate state of the structure is attained. The non-linear designation comes from the fact that the various components/elements are modelled using a non-linear mathematical model.

Non-Linear Static Analysis or pushover analysis is a useful tool for assessing inelastic strength and deformation demands in the structure, and for exposing design weaknesses. Its foremost advantage is that it facilitates the design engineer to recognize important seismic response quantities and to use engineering judgement to alter suitably the force and deformation demands and capacities that control the seismic response close to failure. The main output of the pushover analysis is in the form of a force-displacement curve, called pushover curve. It is a plot of the base shear Vs the lateral displacement at some point at the roof level, including all the stages of lateral load/displacement increments.

### III. BUILDING PERFORMANCE LEVEL

The seismic performance of structure is measured by the state of damage occurred under a certain level of seismic hazard. The drift of the roof and the displacement of the structure quantify the state of damage. Various building performance levels as per guidelines [FEMA-356, 2000] as shown in Fig.1.

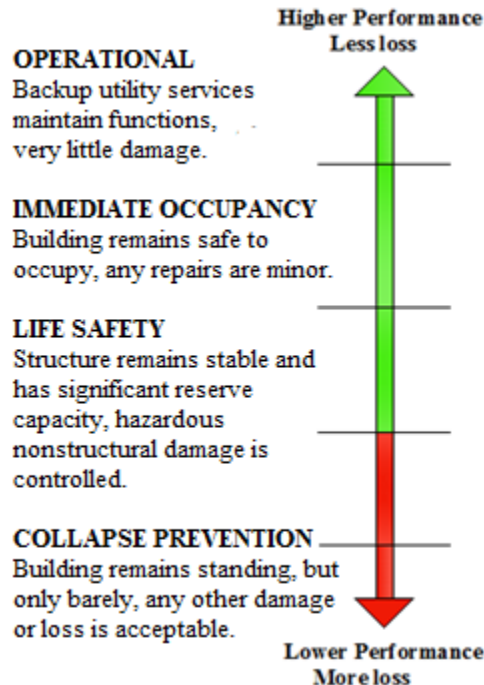


Fig.1 Building performance levels

### IV. SOIL STRUCTURE INTERACTION

Soil structure interaction is defined as a process where the seismic excitation that occurs in the underground soil not only causes the movement of soil but also affects response of the structure above the soil in turn this change in the structure causes changes in the soil movement Soil Structure Interaction analysis is nothing but the interaction between soil and the structure built upon it, it can evaluating the collective response of three linked systems i.e. the structure, the foundation and the soil underlying and surrounding the foundation. Considering Soil Structure Interaction makes a structure more flexible and thus increasing the natural period of the structure compared to corresponding rigidity supported structures.

Approaches for Soil-Structure Interaction analysis-

1. Methods based on the half-space theory
  - a) Direct approach
  - b) Indirect approach
2. Analytical methods
  - a) Winkler approach
  - b) P-y method
  - c) Elastic continuum approach
3. Numerical Methods
  - a) Finite element method
  - b) Finite difference method
  - c) Boundary element method

### V. LITERATURE REVIEW

- Hazmatul Farha Hamzah, Teo Wee (2011) These papers review the recent pushover analysis done on building structures including reinforced concrete structure and steel structure.





- Apurwa Yawale, Mr. P. S. Lande (2014) This paper has presented a general review of seismic vulnerability assessment of bridges using pushover analysis. Unlike the elastic analysis in past, the non-linear pushover analysis has been proposed. Advanced pushover analysis is applicable to bridges is explained in this paper
- Nishant Rana, Siddhant Rana (2015) In this paper various literature reviewed on pushover analysis is presented in this section. A review of literatures is presented in brief summarizing the work done by different scholars and researchers on pushover analysis of building structures.
- . Halkude S.A, Kalyanshetti M.G and Kadlag V. A (2015) Paper shows that the study on various structures are carried out to analysed for fixed base as well as for various flexible base conditions, which are categorized as medium soil and soft soil. For analysis purpose in this study structures are considered from G+5 stories to G+25 stories at an interval of 5 stories.
- Mohammad Tabrez Khan, Prof. Sohail Qureshi et. all (2017) A brief review of several literatures is given in this paper and it proves non-linear static analysis (pushover analysis) to be efficient tool for studying the behavior of the structure in non-linear zone. Paper also enlighten Structures failure modes due to seismic actions become more apparent by performing pushover analysis.
- Ulasala Mahesh, Poornachandra Pandit (2020) This study provides a review on various approaches on pushover analysis for vertical and horizontal irregularity of structures. Pushover analysis and Nonlinear Dynamic analysis were used to evaluate the performance of building. The irregular buildings are subjected to localization of seismic demand where there is uneven distribution of stiffness or reduction in stiffness. This paper shows that the nonlinear static pushover analysis created a great interest amongst researcher since last few years.
- Roshan Patle, Dr. A Bhambulkar et. all (2021) in this paper the selected bridge model is analysed using upper bound pushover analysis. Pushover analysis was performed first in a load control manner to apply all gravity loads on to the structure.
- Nilesh Bharat Vidhate, G. A. Sayyed (2021) In this paper various review of literature are done on, non-linear time history analysis of elevated water tank. It shows that Circular elevated water tank and rectangular elevated water tank with bracings shows good response under earthquake compared to elevated tanks which have no bracings.
- M Sam Horrison, Dr. Selvan V et all (2023) This paper aims to classify and develop a better understanding regarding the improvement of Nonlinear Static pushover analysis. Still now pushover analysis plays a vital role in seismic analysis of the structure due to its versatile and coherent nature. This paper highlighted one of the main drawbacks of using this method is its reliability. This method can be used for checking and analysing the building which is seismically designed using nonlinear Response or time history analysis.
- Prof. Kavish Patwari, Pranav S. Tikar (2023) from this paper it has been seen that many research papers are available to understand the behavior of plan irregular buildings. However, there is little work carried out by researcher related to finding vulnerability of existing RCC plan irregularity building using pushover analysis.
- Bhoopendra Singh, R.K. Grover (2024) this paper shows that pushover analysis helps in finding non-linear structural response which is difficult to find through elastic or dynamic analysis. It shows finding out weak point location in the building by the help of plastic hinges and its location.
- Ashwini L K, M Keshavamurthy, C M Ravikumar (2024) In this paper detailed literature survey of Nonlinear static pushover analysis is carried out from 1970 to 2023. Different researchers use pushover techniques to evaluate both existing and proposed structural behaviour. This paper concludes that that it completely depends on the fundamental knowledge of the Nonlinear analysis and its performance and Pushover is found to be an extraordinary if it is carefully utilized by the users.

## **VI. CONCLUSION**

This study aims to develop a better understanding of Nonlinear Static pushover analysis by considering soil structure interaction. Still now, pushover analysis plays a vital role in seismic analysis of the structure due to its versatile and coherent nature.

This study highlighted effect of soil structure interaction, which shows that assumption of fixity at base condition the results obtained are very much different from actual condition during structural design. In view of the above, while evaluating seismic structural behaviour, the effect of soil structure interaction is of paramount importance.



This method can be used for checking and analysing the building, which is seismically, designed using nonlinear Response.

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# Study on Concrete Using E-Waste as Partial Course Aggregate

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**ABSTRACT:** The Waste materials Utilization of construction industry by-products is a sustainable solution to ecological and environmental problems. Use of such waste materials makes their reutilization in cement-concrete, RCC and other construction materials, and also the cost of cement and concrete manufacturing is reduces. Other indirect benefits of e-waste include reduction in landfill cost, saving energy and reduction in solid waste. E-waste consists of discarded refrigerators, TVs radios, Mobile phones, Air conditioners, computers and several other electronic gadgets that have reached end of life their or become a obsolete. Efforts are being made in the construction industries to use non-biodegradable components of Electronic waste as a partial replacement of the fine or coarse aggregates in concrete. The main aim of this study is to investigate the change in mechanical properties of concrete with the addition of Electronic waste in concrete. It is found that the use of Electronic waste aggregates results in the formation of light weight concrete. In this research article Coarse aggregate is partially replaced by E- waste from 0% to 30% Then in these mix 10%, 20% and 30% of fly ash is also added by partial replacement of cement. It is thereby suggested that utilization of this Electronic waste in concrete will reduce the requirement for conventional coarse and fine aggregates thereby resulting in conservation of natural resources.

## I. INTRODUCTION

Subashree Paramasivan<sup>1</sup>, Raja gopal et.al (2023)Strength studies on concrete using e-plastic waste as coarse aggregate from plastic and recovered e-waste is being tested for feasibility. Testing was done to find out the characteristics of electronic plastic waste when used as coarse aggregate (2%,4%, 6%, & 8%). These characteristics included specific gravity ,water absorption, fineness test, compressive strength, tensile strength and flexural strength of the concrete. Saurav Dixit a, Rishab Arora a, et.al (2022)Replacing E-waste with coarse aggregate in architectural engineering and construction industry. The goal of this article is to investigate the possibilities of substituting certified recycled electronic trash for coarse aggregates in construction. Electronic waste is a general word that refers to electronic items that are no longer valuable to their owners, are no longer functional, or have exceeded their useful life.This study compared the compressive strength of M20 grade concrete for grinded PCB (Printed Circuit Board), plastic, CRT LCD Monitor, and other e-waste to that of conventional concrete by partially replacing coarse aggregates at four levels, namely 7 percent, 12 percent, 17 percent, and 22 percent with a constant interval of 5 percent. The findings of the study conclude that the strength of concrete increase upto the level of 7 percent coarse aggregate is replaced by e-waste. Further till the 12 percent addition it started decreasing but the decline in strength is within the M20 range of compressive strength. This study concludes that the e-waste shall be used and utilized as a replacement of coarse aggregate in the range of 7–10% without impacting the compressive strength of the concrete. faharan ahmed arshad jamal et.al (2021)Performance Evaluation of Plastic Concrete Modified with E-Waste Plastic as a Partial Replacement of Coarse Aggregate Plastic electronic waste (E-waste) is constantly growing around the world owing to the rapid increase in industrialization, urbanization, and population. The current annual production rate of E-waste is 3–4% in the world and is expected to increase to 55 million tons per year by 2025.To reduce the detrimental impact on the environment and save natural resources, one of the best solutions is to incorporate waste plastic in the construction industry to produce green concrete. This study examines the use of manufactured plastic coarse aggregate (PCA) obtained from E-waste as a partial replacement of natural coarse aggregate (NCA) in concrete. Six types of concrete mix with 10%, 20%, 30%, 40%, and 50% substitution of NCA (by volume) with PCA are prepared and tested .N.M. Mary Treasa Shinu , S. Needhidasan et.al (2020) An experimental study of replacing conventional coarse aggregate with E-waste plastic for M40 grade concrete using river sand Electronic waste or E-waste is considered as the most dangerous among the wastes generated in the modern digital world. Due to the unending growth of these electronic wastes the drinking waters are getting polluted and our ecosystem is getting worstly affected all around the world.In this paper, a detailed study is done on the utilization of E-waste plastic as coarse aggregate in M40 grade concrete with a percentage replacement of 12%, 17% and 22%. Shaik Suleman, S. Needhidasan et.al (2020)Utilization of manufactured sand as fine aggregates in electronic plastic waste concrete of M30 mix Electronic waste generation is creating a major problem regarding the environment and human health. As per the Waste Electrical and Electronic Equipment Directive of the European Union, E-waste is the waste material comprising of any wrecked or undesirable electronic apparatus which incorporates PCs, amusement gadgets, cell phones, and other electronic things that have been disposed of by their unique clients.This study focused on replacing natural coarse aggregates with E-plastic waste



in the range of 0–16.5% and full replacement of fine aggregates with M-sand for M30 mix. The obtained results show that the 28 days compressive strength increased by up to 3% after 5.5% replacement of E-waste and then decreases for 11% and 6.5% replacement of E-waste. Arivalagan S et.al (2020) Experimental Study on the Properties of Green Concrete by Replacement of E-Plastic Waste as Aggregate. The electronic wastes are identified as computer peripherals, wires, switches, electronic boards, chips etc., these are affecting the ground water also making contamination of water. In this research work is mainly based on the how to use the e-waste properly to the construction materials without affecting the environment. As per the study it was found that recycle of e-waste from which made the green concrete and to help to the human and global from environment degradation. The research work is mainly based on the recycle of metallic portions in the e-waste and made the green concrete, to increase the mechanical properties of green concrete. The green concrete is made with partial replacement of e-waste 10%, 20% and 30% of coarse aggregate added with a water –cement ratio of 0.45. Santhanam Needhidasan, et al (2020) Experimental study on use of E-waste plastics as coarse aggregate in concrete with manufactured sand E-waste is the fastest growing waste with an annual growth of 3–4% in the world and it is estimated that this will be increasing approximately to 55 million tonnes per annum by 2025. It comprises of different materials and chemicals such as lead, cadmium, mercury, beryllium, and plastics including polychlorinated biphenyls, poly vinyl chloride, and polystyrene, many of which are toxic and are likely to create serious problems for the environment and human health if not handled properly. The present study is focused on replacing conventional coarse aggregate ranging from 0 to 12.5% with e-waste plastic for M 20 grade concrete using manufacturing sand. It has been found that the compressive strength of concrete replacing e-waste is high compared to conventional concrete with 10% of replacement, flexural strength is high compared to conventional concrete with 10% of replacement and the split tensile test is high compared to conventional concrete with 12.5% replacement. N.b.kaniskha1, p.pavithran2 et.al (2019) study on concrete with e-waste as partial replacement of coarse aggregate and m-sand as fine aggregate. Electronic products have become an integral part of daily life which provides more comfort and security. These products have a life period of usually 5-10 years. Disposal of large amounts of E-Waste material can be reused in the concrete industry as E-Waste is an emerging issue posing serious pollution problems to the human and the environment. For solving the disposal of large amount of E-waste material, reuse of E-waste in concrete industry is considered as the most feasible application. The work was conducted on M30 concrete. The replacement of coarse aggregate with E-waste in the range of 0%, 5%, 10%, 15%, 20% and 25%. Finally the mechanical properties of the concrete mix specimens obtained from the addition of these materials are compared with control concrete mix. The test results showed that a significant improvement in compressive strength was achieved in the E-waste concrete compared to conventional concrete and can be used effectively in concrete.

## II. METHODOLOGY

1. REVIEW OF literatures
2. Collection of materials
3. Testing of materials
4. Mix design
5. Mixing and casting
6. Curing
7. Testing of cube
8. Analysis of result

## III. RESULT AND TESTING OF MATERIAL

Teste on Material

Cement

SR NO	DECRIPCTION	TEST NAME	AVRAGE RESULT	OBTAINED RESULT
1	Cement	Fineness of cement	3-8%	3%
2		Specific gravity of cement	3.1 -3.16	3.15



Aggregate

SR NO	DECRIPCTION	TEST NAME	AVRAGE RESULT	OBTAINED RESULT
1	Fine Aggregate	Specific gravity of aggregate	2.60-2.75	2.65
2		Water absorption	0.1-2%	1.0%
		Fineness modulus	2.2-3.1	2.56

Course Aggregate

SR NO	DECRIPCTION	TEST NAME	AVRAGE RESULT	OBTAINED RESULT
1	Fine Aggregate	Specific gravity of aggregate	2.5-2.9	2.70
2		Water absorption	0.5-4%	2.02%
3		Fineness modulus	3.5-8.0	4.60

TEST ON CUBE

Compression strength test

**Table 1** Compressive Strength of M-30 Grade Concrete on 7 days test

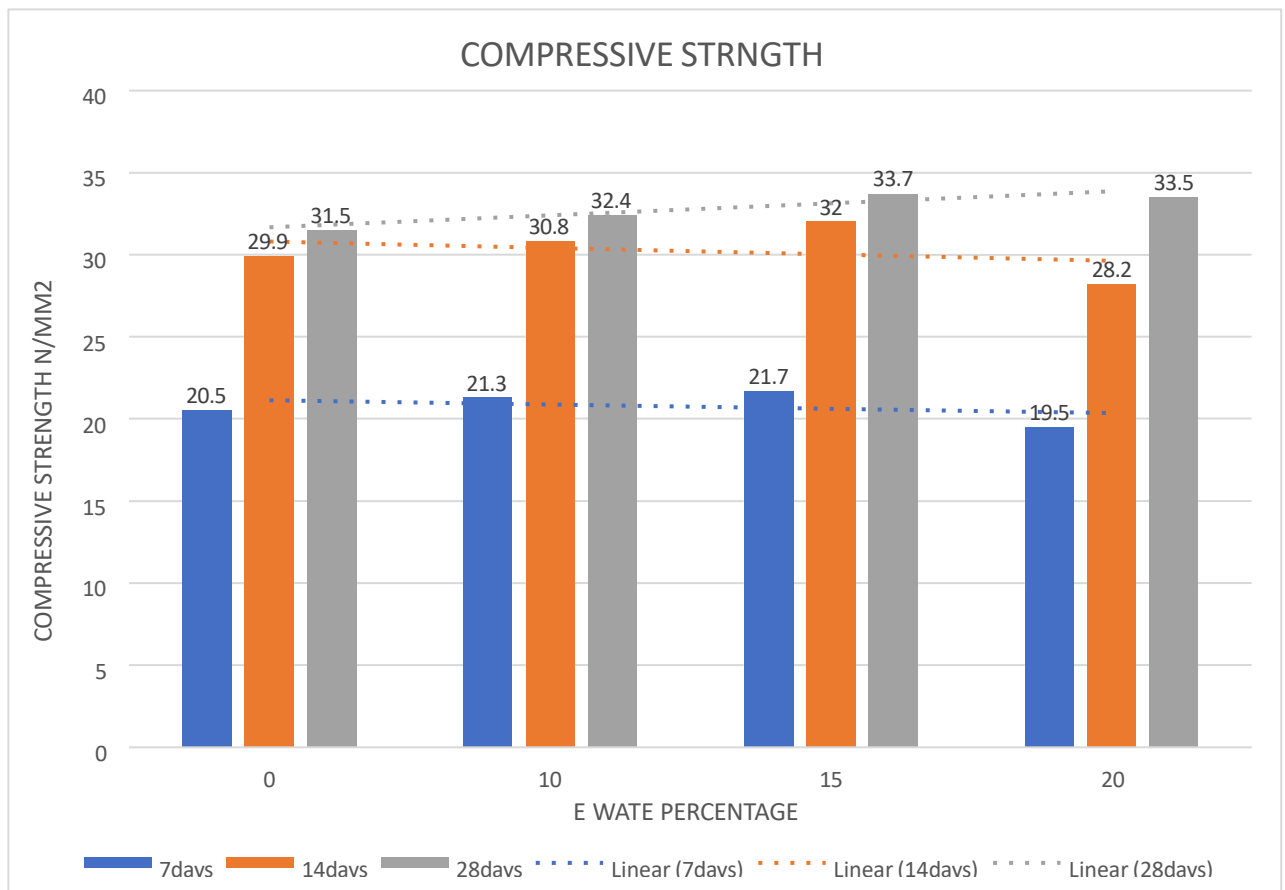
S. NO	% OF COARSE AGGREGATE REPLACED	DATE OF CASTING	DATE OF TESTING	OF ULTIMATE LOAD "P"	COMPRESSIVE STRENGTH "fc= P/A"
	%			KN	MPa
1.	0	22-03-24	29-03-24	460	20.5
2.	7	22-03-24	29-03-24	480	21.3
3.	12	22-03-24	29-03-24	490	21.7

**Table 2** Compressive Strength of M-30 Grade Concrete on 14days test

S. NO	% OF COARSE AGGREGATE REPLACED	DATE OF CASTING	DATE OF TESTING	OF ULTIMATE LOAD "P"	COMPRESSIVE STRENGTH "fc= P/A"
	%			KN	MPa
1.	0	22-03-24	05-04-24	670	29.9
2.	7	22-03-24	05-04-24	690	30.8
3.	12	22-03-24	05-04-24	720	32

**Table 3** Compressive Strength of M-30 Grade Concrete on 28 days test

S. NO	% OF COARSE AGGREGATE REPLACED	DATE OF CASTING	DATE OF TESTING	ULTIMATE LOAD "P"	COMPRESSIVE STRENGTH "fc= P/A"
	%			KN	MPa
1.	0	22-03-24	19-04-24	710	31.5
2.	7	22-03-24	19-04-24	730	32.4
3.	28	22-03-24	19-04-24	760	33.7



**Graph: 1** Compression test on cubes

#### IV. CONCLUSION

E-Waste as a partial replacement of Coarse aggregate in concrete gives good result in both fresh and hardens state. In low volume of replacement gives good strength and workability than high volume of replacement.





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# Designing Efficient Distribution System using Treated STP Water for Flushing at Ajeenkya D. Y. Patil School of Engineering, Lohegaon, Pune

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**ABSTRACT:** This project focuses on designing an efficient distribution system for utilizing treated waste water from Sewage Treatment Plant (STP) for toilet flushing at Ajeenkya D. Y. Patil School of Engineering, Lohegaon, Pune (ADYPSOE). As freshwater resources are insufficient to fulfill the need of daily usage, the reuse of treated wastewater gives a sustainable alternative to potable water supply. The primary objective of the project includes reducing the demand for potable water, environmental impact and promote water conservation by implementing a cost-effective and reliable water distribution network. The study shows that, by the implementation of this treated waste water distribution network, the amount of potable water is 9,270 lit/day (10,000 lit/day) which is currently being used in ADYPSOE can be saved. With the use of Hydro-pneumatic Pump System and Unplasticized Polyvinyl Chloride (UPVC) pipeline network, the maintenance cost is comparatively less than the traditional pump and pipe system.

The treated waste water required is calculated and has fulfilled the criteria for flushing. In reference with the quality of treated waste water, the sample has been tested in the laboratory and the results satisfies the standard specifications given in IS. SP: 35 (1987) (Handbook on water supply and drainage), for using in toilet flushing.

**KEYWORDS:** Sewage Treatment Plant (STP), Potable water, Water conservation, Sustainable, Hydro-pneumatic, Distribution, Unplasticized Polyvinyl Chloride (UPVC), Specification.

## I. INTRODUCTION

Water scarcity is increasingly becoming a global challenge, necessitating approach towards better water resource management and Conservation. In metropolitan cities and urban areas, people are facing crucial crises of potable water supplies due to rapid growth in population, wastage of water and climate change. Cities like Bangalore, Chennai, Delhi, Jaipur are at high risk of facing more crucial conditions due to shortage of potable water. This project is a promising solution and a step towards the conservation of fresh water resources. The substantial portion of potable water is consumed because of toilet flushing that makes up about 24% of overall household water consumption (at average daily volume of 125 lphd or 33.1 gphd). Utilization of treated STP water can significantly satisfy the demand of potable water that is mostly used for toilet flushing around the major part of city's population. In reference with promoting water management and conservation practices, smart cities, housing societies and institutional infrastructures should use the treated waste water for toilet flushing as an alternative to potable water, where STPs are available, however the STPs are now compulsory.

The ADYPSOE have its own sewage treatment plant (STP) having capacity of 3 lakhs lit/day for the treatment of sewage. The daily amount of sewage collected in the STP for treatment is approximately 1.5 lakhs lit/day and the treated waste water given by STP is around 95% i.e. 1.3 to 1.4 lakhs lit/day, which satisfies the requirement of water for toilet flushing and landscaping at ADYPSOE institute.

In some regions use of treated waste water for non-potable purposes like toilet flushing may be mandatory by local regulations or guidelines given by government to promote water conservation and sustainable management practices. Some of the countries like Singapore, Australia (drought prone areas like South Australia and Queensland), California: USA, Spain (in regions of Catalonia and Barcelona), United Arab Emirates (particularly in Dubai and Abu Dhabi), are implementing various regulations to promote the reuse and recycling of waste water. While in India, cities like Chennai, Pune, Bangalore, Hyderabad and Delhi are at the forefront in implementing treated sewage water into their water management systems. These examples show a growing approach towards the mandatory use of treated waste water for non-potable purposes in areas facing water scarcity.



## II. RELATED WORK

The revolutionary efforts in this field work can be assigned to the work done in the 1970s and 1980s, mainly in the regions facing water drought and scarcity conditions. A profound early example is the Water Factory 21 projects in Orange County, California (USA), which began in the 1970s. This project was one of the first to execute advanced waste water treatment processes to produce water that could be reused for non-potable purposes, including toilet flushing.

In India, in the early 2000s, cities like Bangalore and Chennai began to explore the waste water recycling projects to promote treated waste water reuse for non-potable purposes such as toilet flushing, fire protection, landscaping and construction activities, etc. In 2005, the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) was launched for improving water supply & sanitation and promoting waste water practices.

In the year 2014, the launch of Smart Cities Mission and AMRUT (Atal Mission for Rejuvenation and Urban Transformation) by Indian Government further encouraged cities to adapt sustainable practices including reuse of treated waste water. In 2018, the Ministry of Housing and Urban Affairs, launched the National Urban Sanitation Policy, which included regulation and guidelines for waste water reuse, enforcing the municipalities to adopt these sustainable practices more systematically.

## III. METHODOLOGY

This study uses the mixed method approach, combining both the quantitative and qualitative research approach to comprehensively address the design and implementation of efficient distribution system for using treated STP water for the purpose of toilet flushing in the ADYPSOE institute. The main objectives of this study are- (1) Evaluate physical, chemical and biological characteristics of treated waste water to check its suitability for this purpose. (2) Design the efficient distribution system consisting pump and pipe network. The flow diagram of the project work to complete the objectives of this project is as follows-

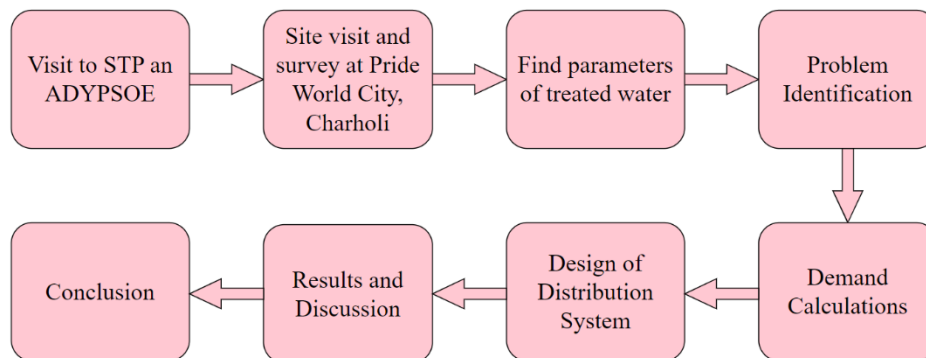


Fig no. 1: Methodology flowchart

- **Visit to ADYPU STP:** The Ajeenkya D. Y. Patil University have its own STP, having a capacity of 3 lakhs lit/day for the treatment of sewage. The daily amount of sewage collected for the treatment is approximately 1.5 lakhs lit/day and it treats the sewage with an 80% efficiency, which satisfies the requirement of water for this system.

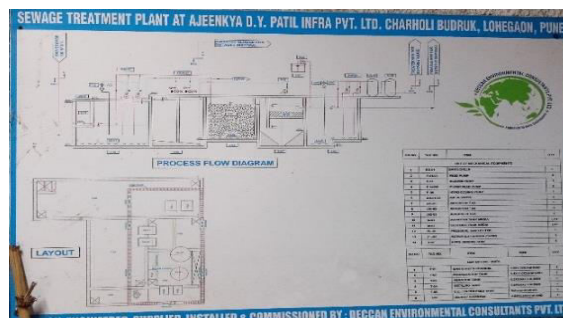


Fig no. 2: Process flow diagram and Layout of STP

Fig no. 2 shows the process flow diagram, layout and specifications of installed units of sewage treatment plant located at ADYPU.

- Site visit and survey at Pride World City, Charholi:** In many housing societies in Pune, this type of flushing system is installed, specially where own STP is available. We conducted a site visit and survey at Pride World City, Charholi and this type of flushing system is installed and it is running successfully without any problems. Here are some of the pictures that are taken during the site visit-

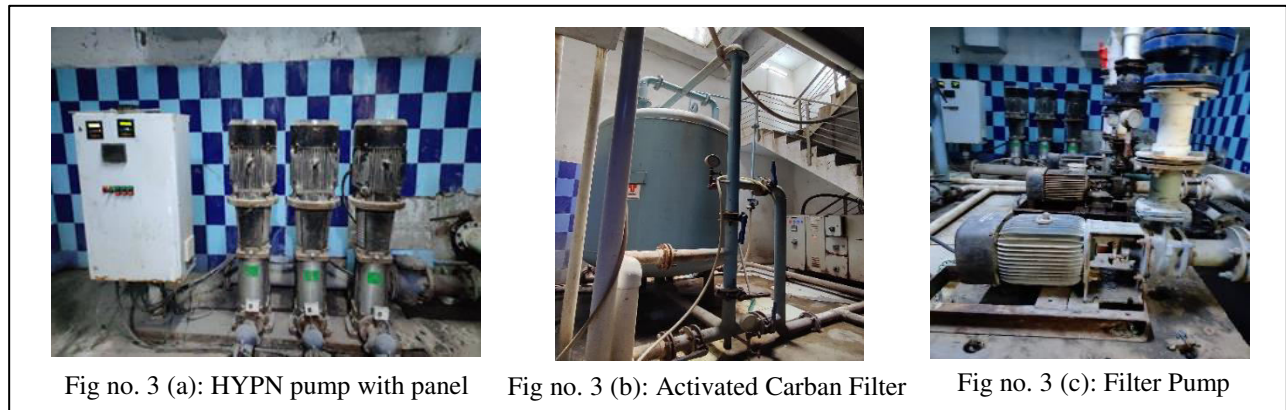


Fig no. 3: Site Visit to Pride World City

- Parameters of treated waste water:** The following parameters of treated waste water has been tested for the purpose of toilet flushing to check its suitability.

Table no. 1: Test results of COD and BOD

Sr. No.	Name of the Test	Results	Limit	Units	Analysis Method
1.	Chemical Oxygen Demand	12.0	<50	mg/lit	IS 3025 (Part 58): 2023
2.	Biochemical Oxygen Demand	4.0	<10	mg/lit	IS 3025 (Part 44): 2023

Table no. 2: Test results of E- coli

Sr. No.	Name of the Test	Result	Unit	Analysis Method
1.	E- coli	<2	MPN/100ml	IS 1622:1981

The original copy of the test results is attached with the given google drive link:  
<https://drive.google.com/file/d/1Z8ieZE0D7dK4srJybJE8VqOk5aRVy78O/view?usp=drivesdk>

Above parameters of BOD and COD are within the limit and safe for the use of flushing water as an replacement of potable water. But there is a presence of E- coli <2, which is possible to treat by providing a additional disinfection method. The method of disinfection selected is chlorination and for the implementation process we have designed a chlorinator unit which is shown in fig no.4 below.

- Problems Identification:** Following are the problems that are identified after taking survey at pride world city,
  - Yellow stains on water closet
  - Odour
  - Bacterial infection (during flushing)

To overcome this problems we need to provide some disinfectent to the treated STP water. A chlorinator unit will be installed in between the outlet of STP and pump for the purpose to overcome these problems.

Figure shows the prototype model of chlorinator unit. A working unit of chlorinator will be installed along with the

hydro-pneumatic pump system during the implimentation of this system in our college premises.

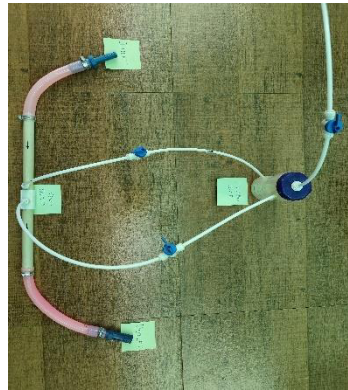


Fig no. 4: Chlorinator unit

• **Demand calculation:**

following data is the distribution of toilets:

- Toilet Distribution :
- a) Wing A / North Wing – 114 Nos. (SOE)
  - b) Wing B / West Wing – 53 Nos. (SOET)
  - c) Wing C / East Wing – 39 Nos. (Management)

**Total Toilets and Urinals = 206 Nos.**

According to the National Building Code (NBC) 2016, the typical water requirement for toilet flushing purpose in institutional building is approximately:

- 1) Water Closet (w/c) – 15 lpcd
- 2) Urinals – 10 lpcd

Hence, **Calculation for water demand:**

- No. of students = 1000 (approx.)
- Water required for flushing = 15 + 10 = 25 lpcd
- Working hours of institute = 10 hrs

Considering water requirement for 10 hours, hence reducing the three times of 24 hours.

Amount of water required for 10 hrs =  $25/3 = 8.33 \dots$  say **8 lpcd**

Volume of Water required daily :

= No. of students\* amount of water (lpcd)  
 = 1000 \* 8

= **8000 lpcd**

Considering 20% additional usage of water for flushing. Heance, total volume of treated waste water required is calculated to be **10,000 lpcd.**

$Q = 10,000 \text{ lpcd}$

For 10 hours –  $10 \text{ m}^3/\text{hr}$

For 1 hour –  $1 \text{ m}^3/\text{hr}$

Therefore, **Discharge of water/hour (Q) =  $1 \text{ m}^3/\text{hr} = 1000 \text{ lit/hr}$**

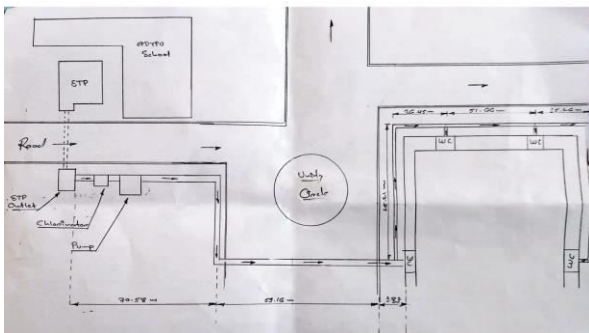


Fig no. 5: Line plan of Network



Fig no. 6: Google earth picture of network



- **Design of Distribution System:** The Design of this distribution system is divided into two parts, they are as follows,

1. **Design of Hydro-pneumatic Pump**
2. **Design of Pipeline Distribution Network**

#### Design of Hydro-pneumatic Pump:

The Design is as follows,

- **Liquid Flow** →

Shape- Circular (full)

Main pipe dia. – 2” (5.08cm)

$$\begin{aligned} \text{Velocity} &= 0.408 * Q / D^2 \\ &= 0.408 * 1 / 0.50^2 && \text{.....(Calculated discharge)} \\ &= 1.632 \text{ m/sec} \end{aligned}$$

Flow Rate = 1000 lit/hr .....(Demand calculated)

- **Total Head** →

Pipe – **UPVC** (Unplasticized Polyvinyl Chloride)

Roughness coefficient (C) – 150

Pipe diameter – 2”

Pipe length – 357.87m ...say **360 m**.

**Friction head loss:** for 1000 m = 1.5 m .....(considering)

$$\begin{aligned} \text{Hence, } H_f \text{ for 360 m} &= 1.5 * \frac{360}{1000} \\ &= 0.54 \text{ m} \end{aligned}$$

**Total head (H)** = Suction head + Delivery head +  $H_f$  + Driving head

$$\begin{aligned} &= 2.0 + 30.00 + 0.54 + 2.0 \\ &= \mathbf{34.54 \text{ m}}. \end{aligned}$$

- **Pump parameter** →

Discharge (Q) = 1000 lit/hr. =  $2.78 * 10^{-4} \text{ m}^3/\text{sec}$

Total head (H) = 34.54 m

Density of fluid ( $\rho$ ) = 1000 kg/m<sup>3</sup>

Efficiency of pump ( $\eta$ ) = 70% = 0.7

Overloading (20%) = 1.2

$$\text{BHP} = \frac{\rho * Q * H}{75 * \eta} = \frac{1000 * 2.78 * 10^{-4} * 34.54 * 1.2}{75 * 0.7}$$

**BHP = 0.434 BHP**

**Note:** With reference to future expansion, Factor of safety and to reduce the working hours of pump instead of 0.5 HP, a **2 HP** hydro-pneumatic pump is taken. Therefore, no. of **Two hydro-pneumatic pumps of BHP = 2 HP** is required (working pump: 1 and on stand-by: 1).

#### 1. Design of Pipeline Distribution Network:

Material selection and pipe sizing:

- a) Pipe Material – UPVC
- b) Main pipe diameter – 2 inches
- c) Riser pipe diameter – 1.5 inches
- d) Intermediate pipe diameter – 1 inch

**Note:** 1) UPVC is an excellent choice for piping because it is resistant to corrosion, chemical damage and weathering. UPVC pipes are available in a variety of sizes and can be cut to fit any application. They are easy to install and require minimal maintenance.

2) As per IS 4985 (2000): Unplasticized PVC pipes for water supply – (CED 50: Plastic piping system), water flow



rate of 2 inch. Diameter pipe is 210 lit/min. while the flow required is 120 lit/min. Hence, considering future expansion above pipe size selection satisfies the requirement.

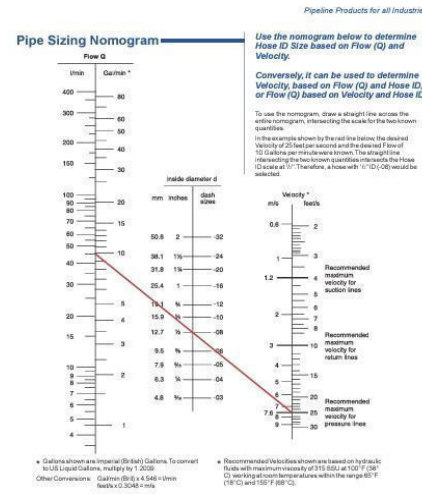


Fig no. 7: Nomogram for Pipe sizing

3) In fig no. 8, the nomogram of pipe sizing is used to determine the desired pipeline diameter. It shows an example to determine diameter size based on flow (Q) and velocity (V) by drawing a straight line intercepting the given values.

#### IV. RESULTS AND DISCUSSION

Table No. 3: Results

Sr. no.	Parameters	Results	Unit	Analysis Method
1)	Waste water testing <ul style="list-style-type: none"> <li>COD</li> <li>BOD</li> <li>E- coli</li> </ul>	12.0 4.0 <2	mg/lit mg/lit MPN/100ml	IS 3025 (Part 58): 2023 IS 3025 (Part 44): 2023 IS 1622: 1981
2)	Water Demand Calculation	10,000	lpcd	-
3)	Design of Hydro-pneumatic pump	2	HP	HS code: 8413 – Hydraulics and pneumatics system
4)	Design of pipe network <ul style="list-style-type: none"> <li>Main pipe dia.</li> <li>Riser pipe dia.</li> <li>Intermediate pipe dia.</li> </ul>	2 1.5 1	Inch	IS 4985 (2000): UPVC- (CED 50: Plastic piping system) and Nomogram for pipe sizing

The amount of potable water that is being saved daily with the implementation of this project is 10,000 lit/day, (2,78,100 lit/month and 33,83,550 lit/year approximately). The calculated horse power of hydro-pneumatic pump is 2 HP with an efficiency of 70%. The total length of pipe required is 360m and the diameter of main pipeline is calculated to be 2 inches.

The future scope of work based on this project is to connect the chlorinator unit with sensors using wi-fi connectivity. The sensors will be of different types for the collection of different data such as, chlorine level, temperature, pH indicator and water pressure. The data captured by sensors will be transferred to the supporting application which will be developed based on previously collected data by experimentation.

#### V. CONCLUSION

This study successfully represents the potential advantages of treated waste water reuse system, as a sustainable solution to urban water management and conservation practices. By approaching technical, economic, environmental and social aspects, the research provides a detailed information for designing and implementing efficient treated waste



water distribution system for the non-potable purpose of toilet flushing at ADYPSOE. The results and discussion support for a team-based approach involving engineers to achieve a adaptable and sustainable waste water infrastructure.

The successful implementation and scaling of such system can significantly contribute to sustainable waste water management and conservation practices, environmental protection and preservation of fresh water resources. Government should develop and enforce the regulations and guidelines that promote the reuse of treated waste water, ensuring consistency with environmental and public health standards. Continuous public engagement and education are important factors to maintain high levels of acceptance and participation and these efforts should focus on addressing the safety, benefits and necessity of using treated waste water for non-potable purposes.

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# Design and Implementation of Sustainable Urban Storm Water

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**ABSTRACT:** Stormwater operation means to manage face runoff Stormwater operation can reduce the runoff of rainwater. It includes controlling flooding and reducing erosion to meliorate water quality. This Strategy used in our ADYPSOE Lot to help the impacts of Stormwater. We know that, in stormy season the water is flux over the ground face. This strome rainwater does not have any append solid, it collects in drainage which flux by the force of staidness and also it discharges near lake or sluice. Urbanization Reducing the infiltration rate of land can contribute to increase instances of flooding.it occurs digging and I soddening problem. So, it's It is essential to pinpoint the areas experiencing issues and recommend Best Management Practices (BMPs) accordingly. Stylish operation Practices) ways.

**KEYWORDS:** Epa Swmm, Google Earth Pro, Autocad, Junctions, Urban Flood

## I. INTRODUCTION

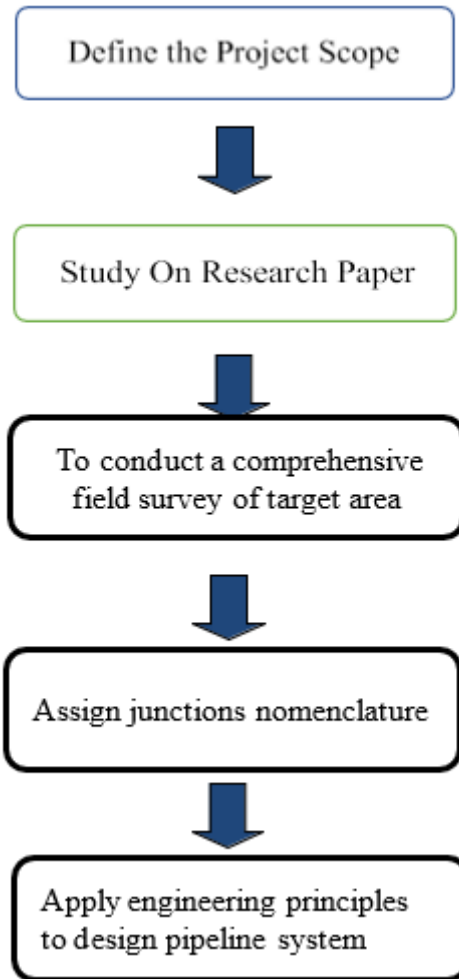
Due to urbanization of municipality the infiltration of when land is diminished, it leads to reduced infiltration of rainwater into the ground. This, in turn, increases the occurrence of stormwater runoff during rainfall events. Falls over the infiltration land analogous as expressway, walk way, parking lots, rooftop and other face that help the infiltration of stormwater. This runoff volume increase and flooding problems are generated in Lot. The runoff is exited in the drain in near lake. The sedimentation, nitrogen, bacteria, phosphorus, oil painting oil, grease, trash, pesticides, substance and other matter present in the terrain also pollute the Increased stormwater in communal areas often necessitates additional capacity in sewer lines to accommodate the higher volume. The sewage water it's further contaminate, after rainspouts in lake or swash the other artificial wastewater pollutes the stormwater. The Stormwater operation practice is used to help the pollution and to reserve in tanks is the wisdom of stormwater runoff operation. To avoid adverse impacts on the terrain. The main thing is to manage water volume and analysis of problems associated with of stormwater impact, and give logical result to it.

## II. LITERATURE REVIEW

The concept of image in painting was first introduced by Bergamo et al. The method was inspired by the real in painting process of artists. The image smoothness information interpolated by the image Palladian is propagated along the isopods directions, which are estimated by the gradient of image rotated by 90 degrees. Exemplar Based method proposed by Crisis et al. [2] used a best exemplar patch to propagate target patch including missing pixels. This technique uses an approach which combine structure propagation with texture synthesis and hence produced very good results. In [3], the authors decompose the image into sum of two functions and then reconstruct each function separately with structure and texture filling-in algorithms. Morphological technique is used to extract text from the images presented in [4]. In [5], the in painting technique is combined with the techniques of finding text in images and a simple algorithm that links them. The technique is insensitive to noise, skew and text orientation. The authors in [6] have applied the CCL (connected component labelling) to detect the text and fast marching algorithm is used for in painting.

The work in this paper is divided in two stages. 1) Text- Detection 2) In painting. Text detection is done by applying morphological open-close and close-open filters and combines the images. Thereafter, gradient is applied to detect the edges followed by thresholding and morphological dilation, erosion operation. Then, connected component labelling is performed to label each object separately. Finally, the set of selection criteria is applied to filter out non text regions. After text detection, text in painting is accomplished by using exemplar based in painting algorithm.

### III. METHODOLOGY



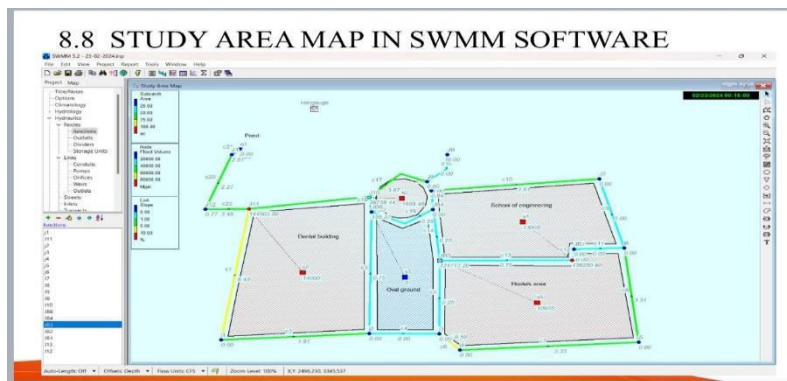
### IV. EXPERIMENTAL RESULTS

SWMM is used in academic research and as an educational tool to teach students about urban hydrology and stormwater management .Reduced Flooding: Implementation of systems like permeable pavements, green roofs, or rain gardens can help absorb and slow stormwater runoff, reducing the risk of flooding in urban areas. Improved Water Quality: By filtering and treating stormwater through natural processes in constructed wetlands or bio-retention basins, the quality of water entering local water bodies can be improved, reducing pollutants and sedimentation



FIG 1 Study Area Map In Google Earth Pro





1.1 Study Area Map In Swmm Software

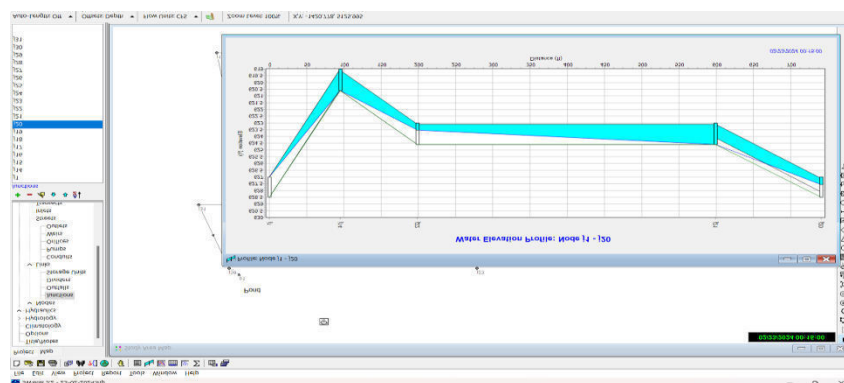


FIG 1.2 Graph Result

## V. CONCLUSION

1. The literature review study shows that there is a compass for studying and assaying to identify the problem in given study area and give swish operation practices to help the impact of stormwater.
2. After studying we came across different problems analogous as the stormwater line is not handed in our study area so furnishing stormwater line at low belt.

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# Anti Collision Warning System at Katraj Ghat

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**ABSTRACT:** In this paper we have proposed the time-based system for alerting the driver against other vehicle at hair pin bends to avoid accidents causing loss of human life. This system is designed to provide safe journey to the local residents and tourists by alerting them against blind spot curves and also reduced the possibility of accident at blind curves. This paper is focused on the designing of automated system with the advent of new technology and up gradation. The proposed automated system would remarkably reduce the human efforts by utilizing the PLCs. Automated system is taking place of human due to increased efficiency and quality output. Thus, the proposed system adopts the latest automated technology including PLC to develop driver alert system which has application on the hair pin bends of hilly roads.

## I. INTRODUCTION

India ranks high when it comes to number of accidents on the road. However, in the recent years, improvement has been seen in this area. With the rapid increase in the number of vehicles on the road, the traffic conditions are under a lot of pressure. Therefore, road safety is one of the most serious public health issues in our country. It has an impact on everyone, whether one drives a vehicle, walks or rides a cycle. Road safety refers to the measures which must be adopted by everyone while using roads. These safety methods are meant for reducing the risk of accidents and injuries or casualties on the road. These rules must be followed by all users of roads including pedestrians, cyclists, motorists, and bus and truck drivers. Safety methods also relate to the construction, layout of roads as well as traffic regulation systems.

Safety is an essential component of transportation engineering. The safety of road transportation involves many factors including driver skills, roadway characteristics, vehicle conditions, and weather. In addition to crash causation, the identification of hazards that may increase severity in the event of a crash is important. Among all contributing elements, speed is considered to be one of the most critical. Statistics show that speed is a factor in one-third of all motor vehicle fatalities (NHTSA, 2018). One mechanism of addressing roadway safety is the implementation of road safety audits. This chapter presents the road safety audit concept, its origin, and expansion. This section provides the background information regarding this concept and strategies used or implementation for an existing roadway focusing on speed issues. Perhaps the most common attempt to control driving speed is imposing speed limits. In the second part of this chapter, the speed topic is reviewed. The review includes speed-related statistics and an examination of the relationship between speed and crash risk as well as a discussion about speed limits based on the 85th percentile speed. All types of sensors and collision detection modules require testing and research to determine and verify the design process and later, also a production process, their characteristic parameters and to ensure their quality and reliability.

In the literature below, characteristics of the methods and test equipment used in these studies are given. In case of testing, the sensors are subjected to test stimulation with different waveforms (characteristics shape as a function of time), the values and durations, for example have sine waveform, half-sine waveform, square waveform, triangle waveform (saw-shaped). Some devices can generate (display) specific test waveforms, for example the ones recorded during crash tests.

Testing often consists of iteratively repeated attempts, where artificially generated waveforms changing from test to test both with the amplitudes and duration time are used. When testing the activation border of sensors, the amplitude of a collision signal is changing, while keeping constant duration of the accident, until the moment of reaching assumed  $\hat{V}$ . Then, tests are carried out again for other values in scope of stimulation's duration, in order to conduct full characteristics of the sensor. In tests concerning performance of the SRS system trigger sensors (in the case of tests with pulses greater than the border values), the sensor response time (the release time) is tested.

In case of collision sensors' tests, devices with different technical capabilities and with varying degrees of sophistication are used. All systems should be equipped with reference measurement systems necessary to evaluate the response of a tested device. The devices can operate in manual, semi-automatic or automatic mode. The most commonly used are:

- pendulum – the tested module is attached to a pendulum and striking in the bumper with it provides a rapid stop at



the lowest point of trajectory of the pendulum. The amplitude of impact is adjusted for the pendulum release angle, and the characteristics of the pulse depend on the properties of the material used for making the bumper. It is a simple device that does not provide high precision.

- pneumatic devices – are powered by compressed air energy. Impact signal amplitude depends on the speed before the collision with the bumper, and a collision signal is shaped by selection of the appropriate material of the bumper.
- devices powered by electric actuators – used in practice, in mass production. They consist of an electrically controlled platform that is moving horizontally. The amplitude and shape of the generated waveforms are controlled by the electric actuators control system, which are powering the platform during the experiment.

### Objectives

- The system would aim to reduce the risk of accidents, particularly collisions caused by driver error, poor visibility, or adverse weather conditions.
- The system would aim to prevent collisions by providing timely warnings to drivers about potential hazards such as sharp curves, approaching vehicles, or obstacles on the road. This could involve using sensors, cameras, or other technologies to detect these hazards and alert drivers in real-time.
- Another objective could be to improve traffic flow and reduce congestion by providing drivers with information about traffic conditions ahead, allowing them to adjust their speed or route accordingly.
- The system could also play a role in facilitating emergency response by quickly alerting authorities to any accidents or incidents that occur within the ghat section. This could help reduce response times and improve the effectiveness of rescue operations in case of emergencies.

## II. LITERATURE REVIEW

### 2.1 Arun S Bagietal. Road Safety Audit (IOSRJMCE) ISSN:2278 -1684

This study had identified accident prone areas on the road from FIR, it studied the effect of roadway geometrics and traffic conditions on the road stretch and development of statistical relationship between accident rates and numerous factors causing accidents. The scope of the study was to reduce accidents on road network, reducing severity of accidents and the need for costly remedial work is reduced. The road selected for the study is Bannerghatta road (12 km). The accident analysis was done from four years data. The V.F.Babkov's analysis is done by collecting geometric features of the road. Pedestrian safety analysis was also done. Accident prone locations are identified by the all analysis. 8 hours volume count was conducted at 2 locations of the stretch on a weekday covering both peak and off-peak hours of a day. Floating car method survey was conducted to find the speed at every kilometer of the stretch.

### 2.2 ZarulazamEusofe et al. Assessment of Road Safety Management at Institutional Level in Malaysia, IATSS

**Research** This paper had examined the current institutional arrangements for the management of road safety in Malaysia in a systematic manner. It focused on road safety funding and seemed to provide an insight into how funding factors may affect both the effectiveness and the efficiency of road safety management. The study followed an exploratory approach based on semi- structured interviews targeting key stakeholders in road safety management such as policy makers from various government agencies, private sector representatives and academia. The analysis revealed that the efficiency and effectiveness of the road safety management system in Malaysia may be sustainably improved by addressing the current dependence of funding solely on government sources, the fragmentation of the decision-making process of this de facto multi-disciplinary area, the road safety legislative framework, public awareness, local needs and institutional capacity. An institutional model based on 2<sup>nd</sup> generation road funds is tentatively suggested to this effect.

### 2.3 Francis John Gichaga et al. Road Safety and Road Safety Audit in India: A Review. ISSN: 2347 – 4718

This paper had reviewed the concept of the road safety audit and its stages. Objective of the RSA is to evaluate ventures for potential mishaps and lessening on the premise of road client learning, characteristics and aptitudes, day/night, wet/dry road conditions. It suggested on outline and before planning of agreement archives, to evaluate itemized intersection design, markings, signs, signals, lighting points of interest, Detail Design of junctions, Design of geometrics, Cross-fall Marking and Signs, Side drains, Embankment slopes, Presence of clear zone, Traffic Signals Lighting.

### 2.4 YuhaHuvarinenetal. Road Safety Audit, “Organization and Traffic Safety Management in Large Cities”, Spbotsic- 2019, 28-30 September 2019, St. Petersburg, Russia.

The article showed that observance of automobile roads design and construction standards does not guarantee safety of traffic. It studied the experience of the leading countries in the field of the traffic safety audit integration into technological processes of roads lifecycle. It had given the key features of the traffic safety audit methods and the model of its application in terms of the Russia/Finland project for the development of a longrun special purpose program for enhancing traffic safety in the Leningrad Oblast by the experts. In the Russian practice, the cause for an

accident which occurred for the combined factor “person – road environment” in an accident card is usually specified as “the driver failed to control the car”.

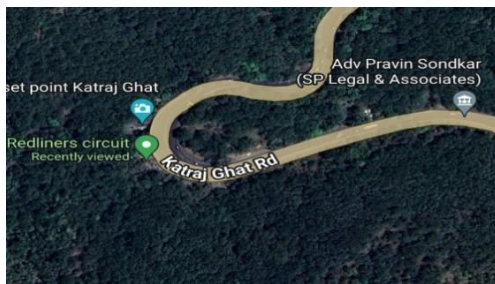
Thus, the blame for an accident is fully laid on a road user who consciously or unconsciously violated the rules or committed an error while driving. The practice shows that accidents of such kind occur also on the sections of roads built in compliance to the design, construction, and operation standards. It means that the application of standards is the reasonable and fundamental condition but not absolute for the safety of road network and its users. As the motorization level grows, the share of unprofessional drivers not protected with the industry work and rest codes and often not informed of potential road risks increases.

### III. METHODOLOGY

#### 3.1 Site selection:

Selecting the route or site for roads involves several considerations to ensure optimal functionality, safety, environmental impact, and cost-effectiveness. We have selected Katraj ghat area due to the following factors:

- **Preliminary Surveys and Studies:** Conduct preliminary studies to understand the need for the road, traffic patterns, population growth projections, and economic development plans in the area.
- **Identify Potential Routes:** Evaluate multiple potential routes based on the collected data and analysis. Consider factors such as topography, land use, existing infrastructure, and environmental impact.
- **Geotechnical Engineering and Consideration:** Conduct geotechnical investigations to understand soil conditions, stability, and potential challenges during construction. Analyze engineering aspects such as slope stability, drainage requirements, and construction feasibility for each proposed route.
- **Cost Benefit analysis:** Evaluate the costs associated with construction, land acquisition, maintenance, and operation of each potential route.



3.1.1 Topographic View



3.1.2 Ghat Section

#### 3.2 Traffic Survey of Roads:

Traffic surveys are essential for understanding traffic patterns, volume, and characteristics on roads. They provide valuable data used in planning, designing, and improving road infrastructure. Here are various methods and considerations involved in conducting traffic surveys:

- **Traffic Count:**

**Manual Traffic Count:** Trained personnel manually count and record vehicle movements at specific locations using tally counters or by visual observation. This method is labor-intensive but provides accurate data for smaller areas.

**Automated Traffic Count:** These devices, such as pneumatic tubes, infrared sensors, radar, or cameras, automatically record traffic volume, speed, vehicle classification, and other relevant data. They are efficient for continuous data collection over longer periods.

- **Origin Destination Surveys:** Conduct surveys to determine where vehicles originate and where they are headed. This information aids in understanding traffic flow patterns and helps in planning for route improvements or alternative routes.
- **Speed Studies:** Measure vehicle speeds using radar guns, laser devices, or automated speed detection systems. This data is crucial for assessing compliance with speed limits, identifying potential safety hazards, and planning speed management strategies.
- **Data Analysis and Interpretation:** Analyze collected data using statistical methods and traffic engineering principles to derive meaningful insights. This analysis helps in identifying trends, patterns, congestion points, and areas needing improvement.
- **Utilizing Technologies:** Implementing advanced technologies such as GPS-based traffic monitoring, mobile apps, and big data analytics can enhance the accuracy and efficiency of traffic surveys.





### 3.2.1 Weekday count i.e. Wednesday 10/04/2024 Table Towards Katraj Ghat

Types of Vehicle	Time : 9:30 am – 10:30 am	Time : 2:00 pm – 3:00 pm	Time : 5:00 pm - 6:30 pm
2 Wheelers	836	571	1051
4 Wheelers	1157	973	1489
Light Motor Vehicles	486	372	584
Heavy Duty Vehicles	217	185	449

### 3.2.2 Weekday count i.e. Sunday 07/04/2024 Table Towards Katraj Ghat

Types of Vehicle	Time : 9:30 am – 10:30 am	Time : 2:00 pm – 3:00 pm	Time : 5:00 pm – 6:30 pm
2 Wheelers	743	503	941
4 Wheelers	989	841	1376
Light Motor Vehicles	393	341	517
Heavy Duty Vehicles	215	198	258

### 3.3 Study of Road Accidents:

- **Local Law Enforcement and Traffic Police:** Contact the local police department or traffic authorities in the area you're interested in. They often maintain records and statistics related to road accidents.
- **Government Websites and Reports:** Many government agencies publish annual or periodic reports on road accidents, including statistics, causes, and trends. Check the transportation department or road safety agency of the specific region for such data.
- **News Outlets and Local Media:** Local newspapers, news websites, or television stations might cover major accidents or provide general statistics about road accidents in their coverage area.
- **Online Databases and Statistics:** Some regions have online databases or portals that compile road accident data. These platforms might offer statistics, accident locations, causes, and trends.

### 3.4 Data Analysis & Risk Management:

- **Data Collection and Analysis:** Collecting diverse data sets related to road incidents, traffic flow, road conditions, vehicle types, weather, and demographics is crucial. Analyzing this data using statistical methods, machine learning, and data visualization tools helps identify trends, hotspots, and contributing factors to road accidents.
- **Risk Assessment and Identification:** Conducting risk assessments involves evaluating the likelihood and severity of road safety hazards and accidents. Identifying high-risk areas, intersections, road segments, or specific conditions (e.g., poor visibility, high-speed zones) helps prioritize interventions.
- **Predictive Modeling:** Using historical data, predictive modeling techniques can forecast potential accident-prone areas or times. This enables proactive measures to be taken to prevent accidents.
- **Safety Performance Indicators (SPIs):** Establishing and monitoring Safety Performance Indicators helps track progress in reducing accidents, injuries, and fatalities over time.
- **Technological Solutions:** Leverage advancements in technology, such as intelligent transportation systems, vehicle safety features, and real-time data analytics, to enhance road safety measures and response capabilities.
- **Regulatory Compliance and Investigation:** Ensure compliance with safety standards, regulations, and policies governing road design, vehicle safety, and traffic management to minimize risks and enhance overall safety.

### 3.5 Material Collection:

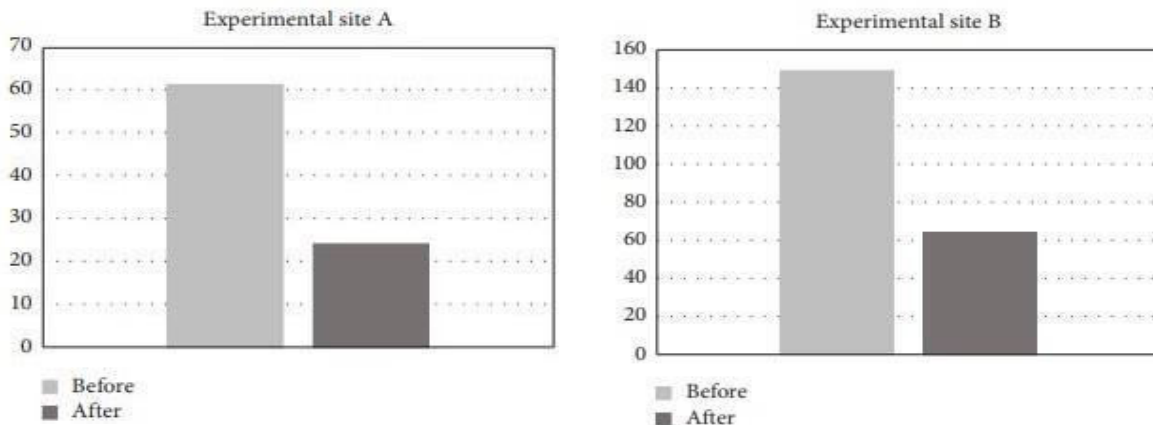
- **Miniature Circuit Board:** It automatically operates and interrupts current during fault condition. It has current rating of 6A of voltage of 220-250V.
- **Switch Mode Power Supply:** A Switch Mode Power Supply is used for the change in input AC Power (220V) into DC Power (24V). It has been utilized for switching regulator to convert electrical power efficiently.
- **Programmable Logic Controller:** A PROGRAMMABLE LOGIC CONTROLLER (PLC) is a small computer which is used in automation industries which continuously scan/watches the state of input devices and gives output based upon a program that is saved in its non-volatile memory and control the state of output devices.
- **Inductive Proximity Sensor:** It is the device which uses the principle of electromagnetic to measure or detect the objects. It is basically a metal detector. We use it for sensing the upcoming vehicles. It detects the vehicle and sends the signal to the PLC. Its sensing range varies from few 'mm to meters'. We mainly use the 8mm inductive proximity sensor for our prototype .
- **Light Emitting Diode :** It is basically a semiconductor device which emits light when the current is passing through it.

#### IV. RESULT AND DISCUSSION

From the similar case study explain below we can reduce accidents about 40 – 50% .

We collected data on risk and normal situations from the sensors implemented on the university campus in Seoul City. We have tested the model’s performance under two different weather conditions, clear and rainy, and two lighting conditions, day and night. For example, photos of one application site under clear and rainy weather are shown in Figure 10. The data collection period for clear weather was from July 8, 2022, to July 11, 2022, for forty-eight hours. The same amount of time data was collected on rainy weather from August 1, 2022, to August 2, 2022. The sample numbers including both risk and no-risk situations were 162 and 135 for the clear and rainy weather periods, respectively, and the sample numbers for day and night conditions are 235 and 62, respectively. Table 2 presents the system verification results for weather and lighting conditions. Under clear weather, accuracy, TPR, and FPR were found to be 80.9%, 76.1%, and 15.4%, whereas, under rainy weather, they were 80.0%, 77.4%, and 18.3%, respectively.

Below figure Indicates Conflicts in before-and-after periods:



4.1.1 Experimental and control sites A

4.1.2 Experimental and control sites B

#### V. CONCLUSION

In this study, we present a novel proactive two-step approach for traffic safety on local roads, comprised of detection and warning. First, using video surveillance and radars to eliminate blind spots, the system detects objects and predicts their trajectories and reachable areas; the system then uses time-to-collision to identify potential risk scenarios based on the overlap of predicted reachable areas. Second, the system provides LED-VMS-based warnings that enable road users, such as drivers and respond to effectively in specific circumstances.

The Finding from this research are encouraging, and further work needs to be carried out to improve safety on local roads. we are aware that our research may have some limitations. Local roads are difficult to standardize like highways or higher road hierarchies than local roads and implementing the proposed system on various local road sites requires a high amount of budget. Instead, we focus on two sites in the context of a case study to derive practical insights from statistically proven site-specific data analysis results. Currently, this research consortium is planning to extend the number of testing sites in the next few years to improve the generality of the proposed system’s potential benefits. In the future, we will, therefore, be able to collect and examine a higher number of samples from newly exploited sites to conduct a meta-analysis for an objective measurement of the integrated quantitative evidence. Second, warning information from LED-VMS alone may not be sufficient for pedestrians using smartphones while walking. Audible alerts would be more suitable for such in stances. Thus, we will install multiple heterogeneous warning systems that will be used to provide road users with risk in formation. In addition, we are planning to further optimize the accuracy and effectiveness of the system by considering conflict severity assessment, to give different levels of warnings (for instance, when the risk is low, only LED-VMS is used, whereas when the risk is high, both LED-VMS and an audible warning are sent).

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# Design of Elevated Roundabout in Pune City

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**ABSTRACT:** Urban transportation infrastructure plays a pivotal role in the economic and social development of a city. As urban centres like Pune experience rapid population growth and increased vehicular traffic, the need for innovative and efficient traffic management solutions becomes paramount. This project aims to address this challenge by proposing the design and cost estimation of an elevated roundabout in Pune City. The proposed elevated roundabout serves as a novel solution to alleviate traffic congestion and enhance traffic flow efficiency at a key intersection in Pune (Vishrantwadi Chowk). The elevated design not only maximizes the utilization of available space but also provides an aesthetically pleasing urban landmark. The project encompasses comprehensive planning, design phases to ensure a holistic approach to urban transportation infrastructure development. The outcomes of this project are expected to contribute significantly to urban planning and transportation management strategies in Pune City. By providing a detailed design and cost estimation for an elevated roundabout, the project aims to offer a blueprint for similar infrastructure projects in other urban centres facing similar traffic challenges. The findings may also serve as a reference for policymakers, urban planners, and engineers seeking innovative solutions to enhance urban mobility and quality of life in rapidly growing cities.

**KEYWORDS:** Elevated Roundabouts, Urban Transportation, Traffic Flow Efficiency, Infrastructure Development, Green Landscaping.

## I. INTRODUCTION

The growth rate of vehicles is increasing in most metropolitan areas, and as a result, traffic congestion is also increasing, particularly at intersections. Traffic congestion is one of the major problems faced by most of the developing countries despite the measures taken to mitigate and reduce it. In order to overcome traffic congestion, especially in four-way intersections with increasing growth rate of vehicles, roundabout design is a popular traffic management solution in urban areas. In most countries, roundabouts have been widely adopted as an alternative to signalized intersections due to their ease of operation with fewer conflict points.

The city of Pune, India, has been experiencing rapid urbanization and increased traffic congestion in recent years at multiple junctions. To address these issues and improve traffic flow, this project aims to design an elevated roundabout at a strategically important locations in Pune (Vishrantwadi Chowk). The proposed sites for this project already had a normal roundabout in past however since it wasn't enough to tackle traffic congestion problem due to which traffic signals were introduced at these junctions. However it was seen that traffic signals were also not enough for proper and efficient flow of traffic, hence we aim to implement an elevated roundabout at this junction along with traffic signals to deploy collaborative efforts to ensure nonstop flow of traffic to ease the traffic congestion problem.

Types of Roundabouts: Single-Lane Roundabouts, Multi-Lane Roundabouts, Turbo Roundabouts, Signalized Roundabouts, Elevated Roundabouts  
Roundabout used for this project : Elevated Roundabout.

## II. LITERATURE REVIEW

**Victoria fromme, (2010)** stated, Roundabouts are useful tools to solve numerous traffic problems in contrasting types of intersections. Roundabouts often increase accessibility, connection, and safety. For instance, Roundabouts reduce vehicle speeds and increase driver attentiveness further she states Roundabouts are a growing trend, especially in Europe and "substantial reduction in injury accidents has been the primary reason for the great success of modern roundabouts in France and in Germany.





**N. Haqe, N. R. Khan et al, (2016)** stated, Roundabouts must be designed to meet the needs of all users—drivers, pedestrians, pedestrians with disabilities and bicyclists. While designing roundabouts, special considerations must be given to the needs of pedestrians with visual disabilities who are unable to judge adequate gaps in traffic at roundabouts. Proper location selection and pedestrian channelization are essential to make roundabouts accessible to all users. In order to propose an effective design for constructing roundabout current condition of field is to be observed, Roundabout has several features i.e. number of lanes, size of the Central Island, design vehicle, turning path characteristic, splitter island size, etc

**Kavyasree S, Binitha Benny et al, (2022)** stated A roundabout is a special type of at-grade intersection. Introducing a roundabout at junction, will eliminate direct conflict at the junction. Moreover, a roundabout avoids frequent stopping and starting of vehicles, which is a major disadvantage of the existing traffic signal system for the design of roundabout traffic volume data are needed. Traffic volume study is conducted at the junction for a period of 7days. Roundabout is preferred when right turning traffic is more. The design of roundabout is done as per the guidelines of IRC 65:2017

**Syed Omar Ballari, Shakeel Ayaz (2020)** stated Roundabouts are fairly common in busy areas to reduce the conflict points. This study can be carried out to evaluate the performance of existing roundabouts to cater the present traffic and suggest improvements for the future traffic. Due to rapid urbanization they may not work efficiently. In no-lane based heterogeneous traffic conditions performance is based on control delay and degree of saturation (V/C ratio). The main objective of this paper is to evaluate the performance of roundabout by assessing the Level of Service (LOS) using empirical models based on capacity and control delay and to make necessary improvements if required.

**Er. Abdul Rashid, Dr. Rakesh Gupta (2017)** stated Modern roundabout, first installed in England in the early 1960s, are becoming popular substitute for signalized intersections in India. These facilities were originally introduced in order to solve the problems of the existing traffic circles. This thesis presents a formulation for evaluate the capacity, delay, and level of service of multilane signalized roundabout. Besides circulating and exiting flows, number of lanes and lateral position of the vehicles, as they approach and cross the roundabout, showed significant influence on roundabout entry capacity.

**Marinela Ință, Lucian Blaga (2017)** stated Streamlining of urban traffic influence nowadays almost everything about our modern life. The main effect, which we all feel as the daily traffic participants, either as pedestrians or vehicles drivers, is travel time to work and back. Roundabouts intersections have a number of advantages over intersections with traffic lights, they reduce the severity of accidents, traffic speeds to provide an "calmer" road environment. So, operating performance of roundabouts are complicated, influenced by the confluence operations.

**Hemavathy M and Ganapati Malarvizhi, (2003)** enlightened us about, traffic volume calculation using the video graphic method by counting the different types of vehicles approaching the intersection from all four approaches and then multiplying the values by the common factor called Passenger Car Unit (PCU). It also provided important geometric parameters such as determining Shape of the roundabouts, Design Speed, Radius of curvature etc.

**Dipak Kumar Dash et al, (2021)** stated, The traffic jam is initiated and triggered at micro and drove it to macro level. The research should be conducted by dividing it in two major cases which are roundabout performance evaluation and quantifying congestion on selected road segments. SIDRA, RODEL, and VISSIM were the choice software packages used to estimate performance like capacity, queue, delay, and length, linked with the collected field data. The above three soft wares overvalues in case of multi-lane roundabouts capacity pre-calibration. Under default parameters, the SIDRA or VISSIM packages undervalue delays and queue lengths when under congestion in multi-lane roundabouts.

**Rahul Sharma, (2020)** Stated , e volume during peak hours is much higher than the capacity of the roundabout. Since the roundabout situated in an urban area, the provision of providing the signals would be a good option for avoiding congestion. Roundabouts intersections have a number of advantages over intersections with traffic lights, they reduce the severity of accidents, traffic speeds to provide an "calmer" road environment. So, operating performance of roundabouts are complicated, influenced by the confluence operations.

### III. METHODOLOGY

#### Site Selection

Task at hand was to Identify a suitable location within Pune where a roundabout would be most beneficial, considering facts such as traffic volume, safety, and accessibility. Various junctions of Pune City were inspected and surveyed, based on final results Vishrantwadi Chowk was finalized.

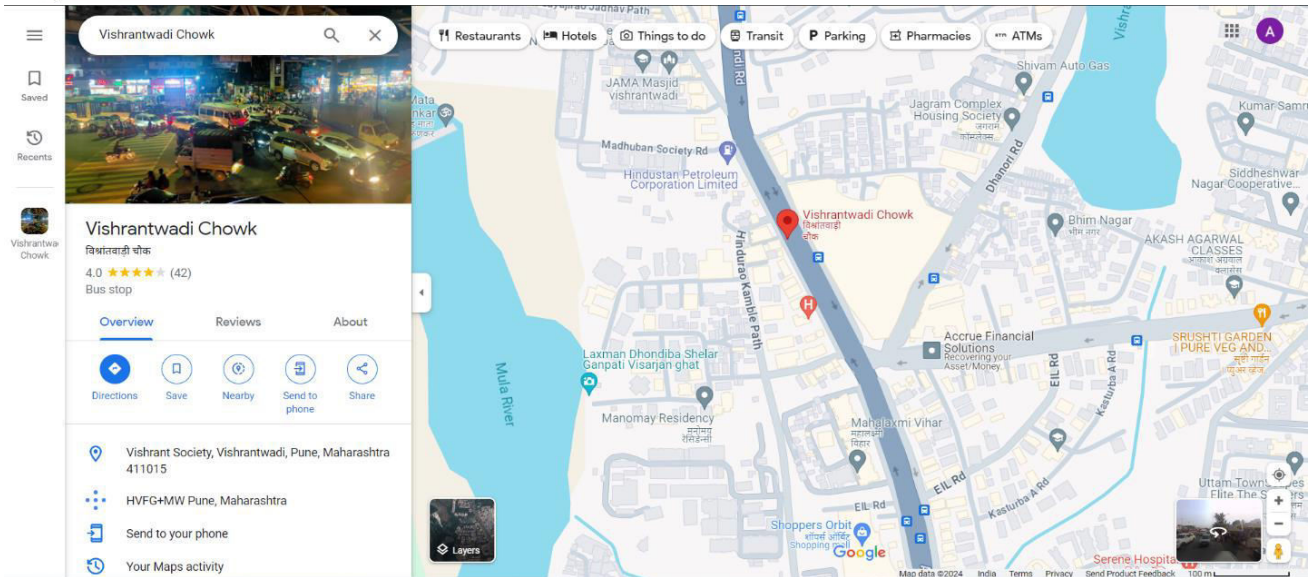


Fig 1. Map View Of Vishrantwadi Junction.

### Traffic Analysis at Selected Junction

Conduct a comprehensive traffic survey to determine the current traffic flow, peak hours, and vehicle types. Guidelines and specifications to carry out all required surveys are provided in IRC:65-2017

In this step an hourly traffic volume survey is to be done for different types of vehicles passing through different directions of the junction at peak hours. Once these values are found out they are to be converted into passenger car unit values. The provision of conversion of normal traffic volume to passenger car units for roundabout is done in IRC: 65-2017.

Vishrantwadi Chowk is intersection of 4 junction which are:

1. Mental Corner Road
2. Dighi – Alandi Road
3. Tingre Nagar Road
4. Lohegoan – Dhanori Road

A survey was carried out at night time when traffic activities were minimal to workout dimensions of all roads connecting to Vishrantwadi junction. Area and road inspection was carried out as well to check to any wanted structures or structures that might be a hindrance during design and construction of elevated roundabout.

Here is the relevant data relating to survey.

Total Area available for construction of elevated roundabout = 91.3 m (approx)

Width of Mental Corner Road = 47.2m

Width of Dighi – Alandi Road = 36.9m

Width of Tingre Nagar Road = 30m

Width of Lohegoan-Dhanori Road = 24.6m

Traffic volume survey for every junction was carried out between peak time of 5 pm to 7 pm by traffic counting method for working out traffic volume in PCU/HR.

Table 1 Passenger Car Units for Roundabout

Table 5.2 Passenger Car Units for Roundabout

Diameter, D (m)	Cycle	Motorized Two Wheeler	Motorized Three Wheeler	Small Car	Big Car	Light Commercial Vehicle	Heavy Vehicle	Cycle Rickshaw	Hand Cart	Buffalo Cart	Horse Cart
20<D≤30	0.18	0.32	0.83	1.00	1.40	1.88	3.65	1.12	2	4	3
30<D≤40	0.21					1.65	3.45	1.31			
40<D≤50	0.25					1.53	3.20	1.56			
50<D≤70	0.28					1.46	3.05	1.74			

[Source: CRRI (2017) "Indian Highway Capacity Manual (INDO-HCM)"]

Table 2 PCU/HR for Mental Corner Road

Vehicle	5-6 pm	PCU	6-7 pm	PCU
Car/Jeep	365	$365 \times 1.4 = 511$	311	$311 \times 1.4 = 435.4$
<u>2 Wheeler</u>	443	$443 \times 0.32 = 141.76$	<b>419</b>	$419 \times 0.32 = 134.08$
<u>3 Wheeler</u>	48	$48 \times 0.83 = 39.84$	62	$62 \times 0.83 = 51.46$
Bus	31	$31 \times 3.05 = 94.55$	34	$34 \times 3.05 = 103.7$
LCV	18	$18 \times 1.46 = \underline{26.28}$	37	$37 \times 1.46 = 54.02$
Cycle	23	$23 \times 0.18 = 4.14$	17	$17 \times 0.18 = 3.06$
<b>Total</b>		<b>817.57</b>		<b>781.72</b>

Table 3 PCU/HR for Dighi Alandi Road

Vehicle	5-6 pm	PCU	6-7 pm	PCU
Car/Jeep	248	$248 \times 1.4 = 347.2$	302	$302 \times 1.4 = 422.8$
<u>2 Wheeler</u>	336	$336 \times 0.32 = 107.52$	389	$389 \times 0.32 = 124.48$
<u>3 Wheeler</u>	107	$107 \times 0.83 = 88.81$	141	$141 \times 0.83 = 117.03$
Bus	56	$56 \times 3.05 = 170.8$	74	$74 \times 3.05 = 225.7$
LCV	63	$63 \times 1.46 = \underline{91.98}$	81	$81 \times 1.46 = 118.26$
Cycle	66	$66 \times 0.18 = 11.88$	52	$52 \times 0.18 = 9.36$
<b>Total</b>		<b>818.19</b>		<b>1017.63</b>

Table 4 PCU/HR for Tingre Nagar Road

Vehicle	5-6 pm	PCU	6-7 pm	PCU
Car/Jeep	360	$360 \times 1.4 = 504$	<b>354</b>	$354 \times 1.4 = 495.6$
<u>2 Wheeler</u>	511	$511 \times 0.32 = 163.52$	496	$496 \times 0.32 = 158.72$
<u>3 Wheeler</u>	137	$137 \times 0.83 = 113.17$	125	$125 \times 0.83 = 103.75$
Bus	33	$33 \times 3.05 = 48.18$	31	$31 \times 3.05 = 94.55$
LCV	22	$22 \times 1.46 = \underline{32.12}$	29	$29 \times 1.46 = 47.56$
Cycle	26	$26 \times 0.18 = 4.68$	24	$24 \times 0.18 = 4.32$
<b>Total</b>		<b>865.65</b>		<b>904.5</b>

### Design Of Elevated Roundabout

Select the appropriate type of roundabout (e.g., single-lane, multi-lane) based on traffic analysis.

Determine the roundabout's dimensions, including the central island, entry and exit radii, and lane widths.

Design 2D & 3D Plan using software. Design will be followed as per IRC : 65 Guidelines.

## IV. EXPERIMENTAL RESULTS

Based on analysis of traffic volume done by Traffic counting method to find out maximum PCU/HR of respective roads. Following results were found:

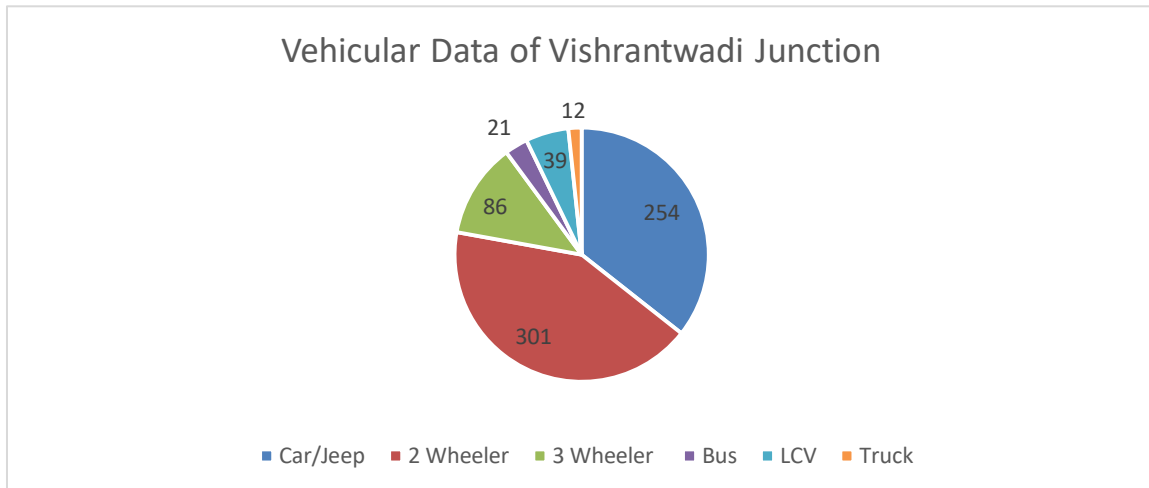


Fig 2 Pie Chart of Vehicle differentiation at Vishrantwadi Junction

Table 5 Result of traffic volume study

Name of Road	Maximum PCU/HR
Mental Corner Road	1017.63
Dighi – Alandi Road	817.57
Tingre Nagar Road	904.5
Lohegoan – Dhanori Road	662.4

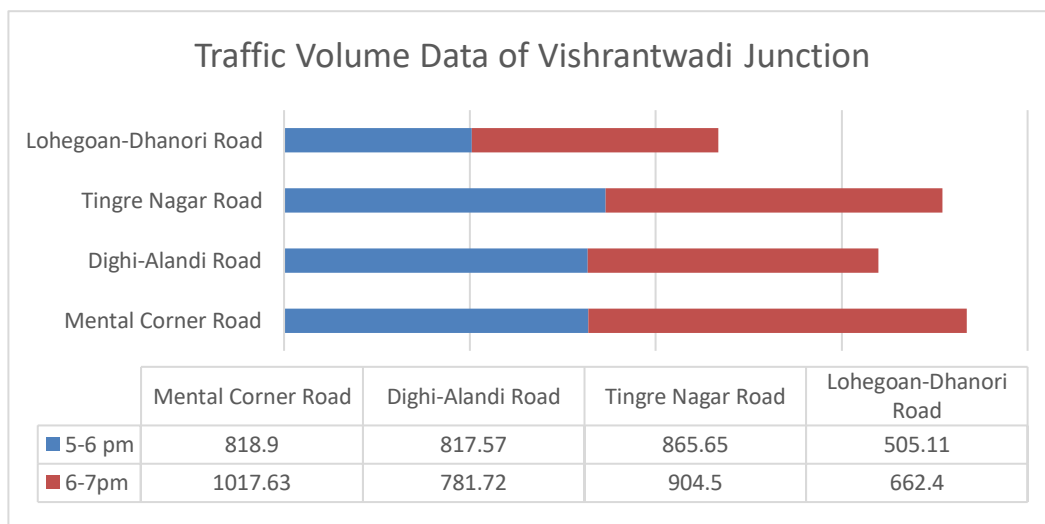


Fig 3. Graphical Data Of PCU/HR at Vishrantwadi Junction

Therefore total volume of traffic (in PCU/HR) was calculated to be:

$$\text{Total PCU/hr} = 662.4 + 904.5 + 817.57 + 1017.63 = 3402.1 \text{ PCU/hr}$$

Vishrantwadi Junction is one the busiest and traffic heavy intersection of Pune city, therefore it was necessary to check if the roads have sufficient capacity for construction of elevated roundabout. It was a challenging task to design an elevated roundabout that would fit in the area that we had as well as designing it with proper geometric dimensions and data and check if it actually can be constructed at the junction or not through 2D & 3D design.



Based on our findings and results

As per IRC 65: 2017 3600 PCU/hr is required for construction of Roundabout at arterial road. Based on our traffic analysis the maximum PCU/hr was 3402.1 PCU/hr. This implies that normal roundabout is suitable for Vishrantwadi Chowk. Since we will be diverting traffic flow from ground floor road and elevated roundabout the conditions are met.  $PCU/HR = 3403.1/2 = 1701.05 PCU/hr$ .

Hence we get the result that Vishrantwadi Junction is suitable for construction of elevated roundabout.

#### **Geometric Design Result of Elevated Roundabout** (All design carried through guidelines given by IRC 65 : 2017)

Design speed: 30 kmph

Total area available at site is suitable for: 40 m ICD

Width of Circulatory Carriageway: 16m

No. of lanes: 2 (Both Lanes 8 m each)

Central Island Diameter: 24 m

Positioning of Central Island: Ideally the Central Island should be located in such a way that center lines of approach road passes through the center of Inscribed Circle.

Entry width: 4 m

Exit Width: 7 m

Radius Of Entry Curve: 35 m

Radius of exit curve: 40 m

Entry Angle: 60 Degree

Exit Angle: 30 Degree

Camber: A camber of 0.5%-1% can be provided to drain the surface runoff away from central island. A camber of 0.5% adopted.

#### **V. CONCLUSION**

As discussed earlier Vishrantwadi Junction is intersection of 4 roads.

Mental corner road having PCU/HR of 1017.63 was observed to be the busiest road with maximum traffic flow. Total Calculated width of Mental corner road measured was 47.2 m.

Tingre Nagar road having PCU/HR of 904.5 was observed to be the second busiest road after Mental corner road with heavy traffic flow. Total Calculated width of Tingre Nagar road measured was 36.9 m

Dighi-Alandi road having PCU/HR of 817.57 was observed to be the considerably small road dimension wise compared to Mental corner and Tingre Nagar road with moderate traffic flow however due to smaller width problems of congestions and traffic delay occurred. Total Calculated width of Dighi-Alandi road measured was 30 m

Lohegoan-Dhanori Road having PCU/HR of 662.4 was the smallest road among all 4 roads having width 24.6 m . Major traffic congestion problem is observed on this road and Lohegoan road accounts for major traffic delays.

Based on our geometric design the maximum widths of your roads connecting to roundabout are 2 laned with each lane of 8m therefore total width is 16m which fits all our roads without causing any trouble as well as demolition of any existing structure on road is not required.

It is to be noted that Dhanori road having 24.6 m which can fit 16 m width of our roundabout but do to already existing severe traffic congestion on that road it was decided to not carry construction on that road as major issues will be faced.

Hence our elevated roundabout will be 3 way roundabout which will be constructed on Mental corner road, Dighi Road and Tingre Nagar road and Dhanori road will be excluded and corresponding traffic from Dhanori road will still be eased as it will be passed from signalized junction below elevated roundabout.

Vishrantwadi Junction also has a Pass over bridge for pedestrian road crossing. This cross over bridge is a challenge for construction of roundabout which has two solutions.

1. Either increase the elevation of roundabout so the roundabout passes above the bridge however this will increase the cost of project and is not feasible solution.



2. Demolish the bridge to elevated roundabout can be constructed at suitable height without increase in cost.

After through geometric designing suitable lengths, measurements and angles relating to entry exit lanes, widths, curves and camber a suitable elevated roundabout that could be constructed at the junction was worked out. Based on this we can conclude that:

The design prepared by us do fit in with the existing road infrastructure

Hence Roundabout Construction is feasible (Only design aspect, Financial aspect is other concern) Continuous flow of traffic achievable Reduction in traffic delays due to diversion of traffic is possible.

2D & 3D Plans are shown below.

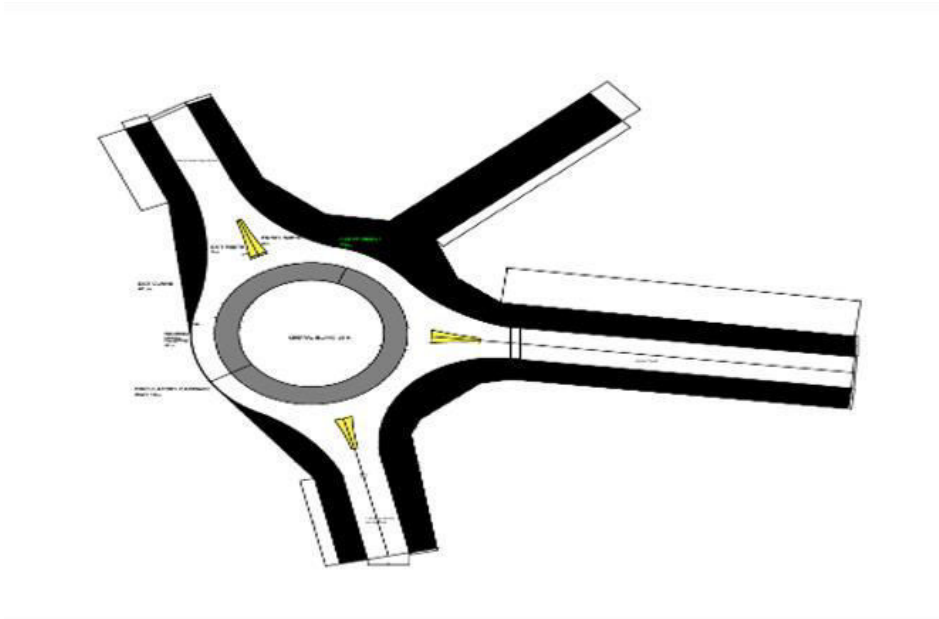


Fig 4 2D Plan of Elevated Roundabout

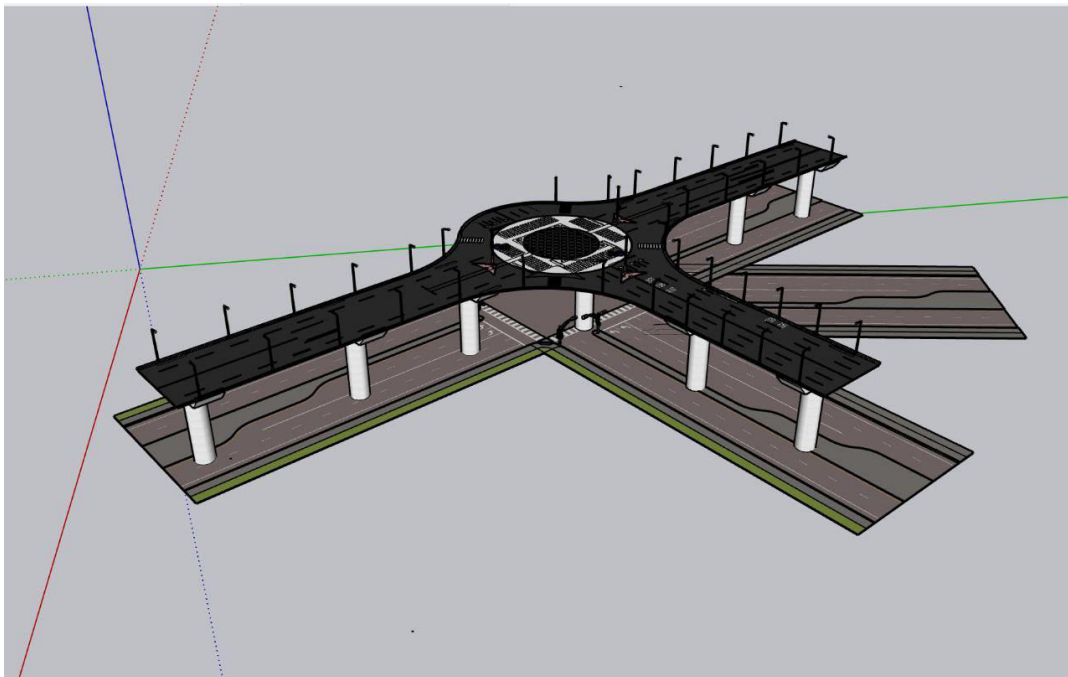


FIG 5 3D PLAN OF ELEVATED ROUNDABOUT



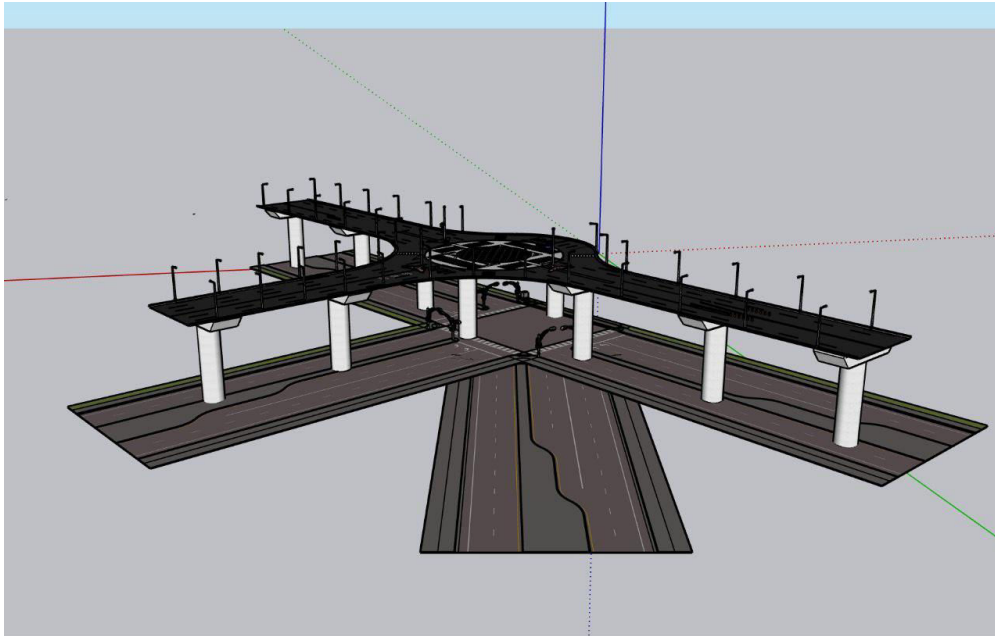


FIG 6 3D PLAN OF ELEVATED ROUNDABOUT TOP VIEW

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# Manufacturing and Performance Fly Ash Plasto Tiles

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**ABSTRACT:** Plastic generation in India is per year is 3.4 million tonnes .as we knows plastic disposal is the verymuch time consuming as well as very expensive method ,plastic takes years and years for it's disposal .And the waste generated from thermal power plants is also difficult to dispose it off .Which mAs increased rate of population is contributing to the polution as well as generation of waste materials .This consistently increase in polution is contineously threatening the human health .the plastic eans the disposal of fly ash is also a long lasting process.This study is carried out for the utilization of both the waste generated from both the sources.The utilization of plastic and flyash for manufacturing of tiles is the good practice for the pollution free environent.The tiles have it's different impact in the construction industry to complete the work or to give the good aesthetics tiles plays an imoportant role

**KEYWORDS:** plastic flyash sustainability, waste management,plastic-fly ash tiles ,reuse and recycle

## I. INTRODUCTION

These are the tiles made of plastic waste generated from plastic bottles and the waste generated from power plant waste which means fly ash. As we know plastic is very important substance or material and which plays an vital role in our day to day life but equally it is very hazardous after it's usage due to its non-biodegradable nature.Nowadays researchers as well as scientists are taking much interest in plastic because it has wide scope in different fields.Plastic has it's own unique properties and can mix with any materials which we want this is the composition of synthetic and semi-synthetic organic compounds.In construction field different tiles are used like clay tiles,ceramic tiles etc.In this study we are going to manufacture the tiles made from flyash and plastic.these tiles are cheaper than other tiles and peoples can easily afford these tiles.the main ingredient of plastic waste is plastic water bottles.

## II. LITERATURE REVIEW

1| Anaaths Kon in 5 February 2011

Topic: Use of plastic waste as a binding material in the manufacture of tiles: case of wastes with a basis of polypropylene

He studied on the possibility of using plastic waste as a binding material instead of cement in manufacturing of roofing tiles. The measurements of physical and mechanical properties show that plastic waste tiles whose proportion in plastic is 40%, give better results than micro-concrete tiles.

2| Asif Abdul Razak Momin, Siddarooda Talavara. Augest 2014

Topic: Plastic floor tiles

They have studied on floor tiles mechanical, physical properties, polymer, waste plastic.

Conclusion: The waste plastic with proportion of 10% & 20% by weight of sand were found to be insufficient to prepare tile.

3| Archit Hardikar ,Omkar Borhade,Swapneel Wagholikar ,Abhishek Shivdeo, Rohit Bhikule  
February,2019.

Topic: Comparative Analysis of Tiles Made From Recyclable LDPE Waste.

They have studied on the properties and generation of LDPE plastic and different test on tiles made from LDPE plastic.

Conclusion :A completely recycled product was manufactured at a very cheap price. The material is unbreakable as against ceramic tiles

4| Author: Athanas Konin

Title: Use of plastic wastes as a binding material in the manufacture of tiles: case of wastes with a basis of polypropylene

Accepted: 28 Jan 2011

Published: 5 Feb 2011

The main aim of Athanas Konin's study on the use of plastic wastes in tile manufacturing is to investigate the feasibility of replacing cement with plastic waste as a binding material for roofing tiles. The study focuses on polypropylene-based plastics and examines the physical and mechanical properties of tiles with varying proportions of plastic waste. The conclusion highlights that tiles containing 40% plastic waste exhibit superior qualities compared to micro-concrete tiles, with low porosity and high impermeability even after impact tests.

### III. METHODOLOGY

#### 1) COLLECTION OF WASTE

This process include the collection of waste materials such as plastic bottles which are thrown after it's use and the flysh from thermal power plant. About 95 million tonnes of flyash is being produced from various power plants.



#### 2) MANUAL SORTING

The different plastic types were seperated from each other and the unwanted materials were removed from waste like the plastic bottles are attached with plastic on it's skin and the plastic caps etc. The seperated bottles were copped into smaller pieces and the chopped pieced were washed thoroughly to remove the glue,plastic labels,dirt etc.



#### 3) MELTING OF PLASTIC MATERIALS

The chopped pieces are collected in a container and melted at it's melting point of ( 150-170 degree centigrade)





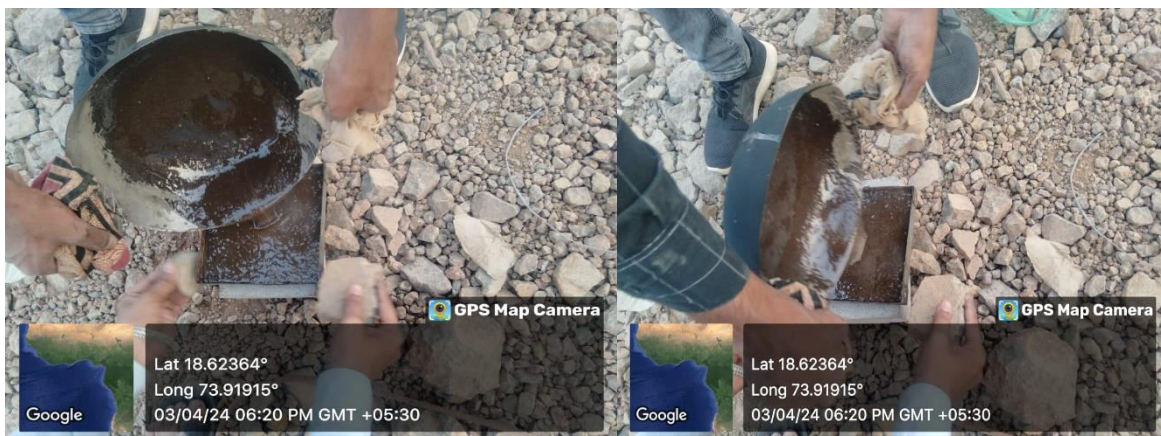
#### 4) MIXING OF MATERIALS

The flyash is added to the same container the mixture is stirred properly, the flyash is added little by little in quantity. The care shall be taken that the mixture does not catch the fire.



#### 5) PLACING OF RESIN (PLASTIC+FLYASH) INTO MOULD

Once the homogeneous mix is obtained it is fed into the mould of size 30cm\*30cm\*2.5cm then the mould is oiled properly before pouring the mix. The mould is prepared b



#### 6) DEMOULDING

Once the mould is completely prepared and cooled then it is allowed to cure either by air cooling or by water curing. And then it is removed from mould and the floor tile is now ready to use with the smooth surface finish..



#### IV. ADVANTAGES

##### 1) ENVIRONMENTALLY FRIENDLY

These tiles utilize flyash which is the byproduct of coal combustion and which reduce the amount of material sent to landfills.

##### 2) LIGHTWEIGHT

These tiles have light weight when compared with traditional tiles, which makes it easier to handle during transportation, installation and maintenance.

##### 3) COST-EFFECTIVE

As these tiles utilize flyash which is inexpensive when compared with other traditional raw materials, that's why these tiles are cost effective.

##### 4) INSULATION PROPERTIES

Flyash plastic tiles have excellent insulation properties, helping to regulate indoor temperatures and reduce energy consumption required for heating and cooling.

#### V. DISADVANTAGES

##### 1) DURABILITY CONCERNS

Flyash plastic tiles are not that much durable when compared with traditional raw materials like clay tiles or concrete tiles. They could be prone to breaking and cracking when exposed to heavy loads.

##### 2) LIMITED AESTHETIC OPTION

The tiles made from flyash and plastic may have limited aesthetic options or may not have a variety of appearances.

##### 3) COST CONSIDERATIONS

Depending on the locality and materials available, the tiles may not always be cost effective.

##### 4) MAINTENANCE REQUIREMENT

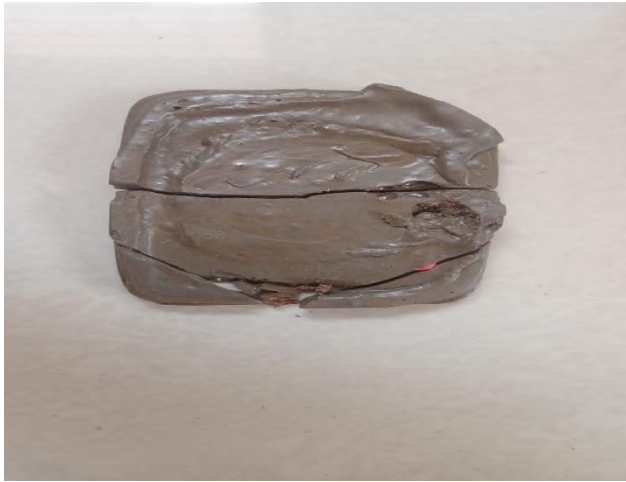
The flyash plastic tiles might require more frequent maintenance compared to other roofing materials to ensure longevity and performance.

#### VI. SCOPE OF WORK

- 1) To reduce the generation of plastic waste and waste generated from power plants i.e. flyash.
- 2) To reduce the inconvenience for disposal of materials.
- 3) Tiles for roofing
- 4) Utilization of waste plastic in construction industry.



## VII. TRIAL AND ERROR SAMPLES



**SAMPLE 1**  
FLYASH + PLASTIC



**SAMPLE 2**  
CEMENT + FLY ASH + PLASTIC

### TRIAL AND ERROR SAMPLES



**SAMPLE 3**  
GLASS FIBRE + FIBRE + PLASTIC



**SAMPLE 4**  
CEMENT + FLY ASH + PLASTIC



**SAMPLE 5**  
AGGREGATE + FLY ASH + PLASTIC



**SAMPLE 6**  
FLY ASH + PLASTIC (1:2)



### TRIAL AND ERROR SAMPLES



**SAMPLE 7**  
FLY ASH + POND ASH + PLASTIC  
(1:2.2:5)



**SAMPLE 8**  
FLYASH + FINE AGGREGATE +  
PLASTIC (1:1.5:2)



**SAMPLE 9**  
FLY ASH + PLASTIC (1:2.3)

### VIII. RESULTS

SAMPLE NO	REASON OF FAILURE	DATE
SAMPLE NO 1	SAMPLE ISBRITTLE	11/02/2024
SAMPLE NO 2	SAMPLEIS BRITTLE	22/02/2024
SAMPLE NO 3	NOT GAINED STRENGTH	22/02/2024
SAMPLE NO 4	SAMPLE IS VERY BRITTLE	06/03/2024
SAMPLE NO 5	SAMPLE IS BRITTLE	31/03/2024
SAMPLE NO 6	GAINED GOOD STRENGTH BUT CRACKS FORMED	04/04/2024
SAMPLE NO 7	CRACKS DEVELOPED INSTENTLY AFTER DEMOULDING	04/04/2024
SAMPLE NO 8	SAMPLE IS BRITTLE	14/04/2024
SAMPLE NO 9	GAINED STRENGTH BUT CRACKS FORMED	21/01/2024

TABLE NO. 1



## **IX. CONCLUSION**

While the idea of creating tiles from fly ash and plastic showed promise the outcome fell short of expectations due to lack of durability. Further research and development are needed to address the issues before the concept can be viable for practical applications.

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# Physicochemical Characterization and Assessment of Ground Water Source for Construction

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**ABSTRACT:** In the present study has done to assess the groundwater quality in the Lohegaon. Groundwater collected from different sampling location cover uniform entire study area city and analyse for various physicochemical parameter to assess the groundwater quality. The physicochemical parameter such as pH, TDS, Alkalinity, Turbidity, Total Hardness and Chloride. Where analyse result show that the various parameter were within permissible limit of IS CODE 456:2000. The value of different physicochemical parameter were found. The quality of water directly impact on the construction work. Construction activities heavily rely on the water sources for various purposes including mixing concrete, dust control, and general site maintenance. This research project aims to comprehensively investigate the physicochemical properties of water sources commonly used on construction sites.

**KEY WORDS:** Water, Concrete, Construction, physical Parameter, Assessment, characterization.

## I. INTRODUCTION

Water is a fundamental resource in construction activities, essential for various purposes such as concrete mixing, curing, cleaning. With increasing awareness of sustainable building practices, there is a growing need to assess the quality of water source commonly used in the construction water source to commonly used in construction and implement strategies to mitigate adverse impacts. Potable tap water is generally used in making concrete. Water governs the hydration of cement, strength, workability and overall durability of concrete. The water used for mixing and curing should be clean and free from Water is a fundamental resource in construction activities, essential for various purposes such as concrete mixing, curing, cleaning. With increasing awareness of sustainable building practices, there is a growing need to assess the quality of water source commonly used in the construction water source to commonly used in construction and implement strategies to mitigate adverse impacts. Potable tap water is generally used in making concrete. Water governs the hydration of cement, strength, workability and overall durability of concrete. The water used for mixing and curing should be clean and free from injurious quantities of alkalis, acid, oils, salt, sugar, organic materials and other substances that may be deleterious to bricks, stone, concrete or steel. Potable water is generally considered satisfactory for mixing. Construction sites often source water from various locations such as groundwater, surface water, and municipal supplies, each with distinct physicochemical characteristics. The quality and composition of these water sources can vary widely depending on geographical location and environmental factors. Therefore, it is essential to carry out a comprehensive physicochemical characterization of water sources at construction sites to ensure they meet acceptable standards.

## II. TESTS ON WATER

Acidity, Alkalinity, Chloride, pH Value, Sulphate as So<sub>3</sub>, Total Hardness, Turbidity, Total Dissolved Solid, Volatile (Organic Residue), Fixed Residue (Inorganic Residue).

## III. RECOMMENDED LIMITS FOR CONSTRUCTION WATER AS PER IS CODE

Water quality standards for construction sites are guided by several standards published by the Bureau of Indian Standards. The most relevant standard for water quality in construction is IS 456:2000. Additionally, IS 3025 Methods of Sampling and Test (Physical and Chemical) for Water provides methods for testing water quality.

**Acidity:** Additionally, IS 3025, Methods of Sampling and Test (Physical and Chemical) for Water and Waste water, provides methods for testing water quality.



**Alkalinity:** To neutralize 100ml sample of water, using mixed indicator, it should not require more than 25ml of 0.02 normal H<sub>2</sub>SO<sub>4</sub>. The details of tests shall be as given in IS 3025 (Para 23) 3. pH: The water should not be less than 6.

**Total Dissolved Solids (TDS):** The maximum limit for total dissolved solids should not exceed 2000 mg/liter.

**Chloride Content:** For reinforced concrete, the maximum allowable chloride content should not exceed 500 mg/liter.

**Sulfate Content:** The maximum sulfate content in water should not exceed 400 mg/liter.

**Suspended Matter:** Water should be clear and free from suspended matter.

**Inorganic Impurities:** Water should be free from harmful impurities such as sulfides and heavy metals.

**Organic Impurities:** The organic matter in water should be limited; harmful substances such as sugar, oil, or other organic compounds that could negatively affect the concrete properties should be absent.

**Nitrates:** The maximum limit for nitrates should not exceed 45 mg/liter.

## IV. METHOD

### 1. Study Area Selection:

Selecting Lohegaon as study area for analyzing water physical parameter involve in the groundwater which is used for construction purpose.

Geographic Location of Lohegaon is situated in the eastern part of Pune, Maharashtra, India, approximately at coordinates 18.5793° N, 73.9251° E.

### 2. Physicochemical Characterization

Measure physical parameters of the water samples such as pH, temperature, turbidity. Use standard laboratory equipment and IS code methods to ensure accurate and precise measurements.

### 3. Chemical Analysis

Determine chemical constituents in the water such as dissolved solids, chlorides, sulfates, alkalinity, hardness, and organic matter. Utilize appropriate analytical techniques such as titration for alkalinity and hardness, and colorimetric methods for other chemicals.

### 4. Evaluation

Compare the results of the physicochemical and contaminant analysis with relevant standards and guidelines such as those outlined in IS 456:2000. Identify any exceedances of the permissible limits and note any deviations from the recommended values.

## RESULT:

Table No 1: Reading of Physiochemical Parameter

Sr No	Test Particulars	Sample 1 (mg/l)	Sample 2 (mg/l)	Sample 3 (mg/l)	Sample 4 (mg/l)	Sample 5 (mg/l)	Specified Limits (As per 456-2000)
1	pH Value	7.56	7.59	7.58	7.56	7.54	> 6
2	Acidity	3.8	3	4.18	3.42	3.80	0.02N NaOH , 100 ml < 5 ml
3	Alkalinity	86	62.10	63.45	63	62.55	0.02H <sub>2</sub> SO <sub>4</sub> , 100ml < 25ml
4	Chloride	179.23	183.77	179.23	188.31	186.04	500 mg/l=RCC
5	Total Hardness	442.96	427.28	50.80	435.12	431.20	NA
6	Sulphate as So <sub>3</sub>	267.47	288.05	279.82	296.28	292.16	400 mg/l
7	Total Suspended Solid	40	35	46	42	38	NA
8	Total Dissolved Solid	1400	130	1410	1380	1390	<2000mg/l
9	Volatile Residue (Organic)	190	180	190	210	180	200 mg/l
10	Fixed Residue (Inorganic Residue)	1270	1260	1280	1230	1250	3000 mg/l



## V. DISCUSSION

### Sample1: Borewell Water At Dhanori 1

Compare the test results of each parameter with the limits specified in the IS 456:2000 code. Suitable Parameter for construction use is pH , acidity, chloride , total hardness , Sulphate as So<sub>3</sub> ,total suspended solid ,Total Dissolved solid, Volatile (Organic Residue) & Fixed Residue (Inorganic Residue) etc. parameter limit suitable for the construction use. Remaining parameter such as Alkalinity , Sulphate as So<sub>3</sub> .These parameter test results exceed the limits specified in the IS code, take appropriate corrective actions to bring the water quality within acceptable limits.

### Sample 2: Borewell Water at Dhanori 2

Compare the test results of each parameter with the limits specified in the IS 456:2000 code. Suitable Parameter for construction use is pH , acidity, chloride , total hardness , Sulphate as So<sub>3</sub>,total suspended solid ,Total Dissolved solid, Volatile (Organic Residue) & Fixed Residue (Inorganic Residue) etc. parameter limit suitable for the construction use. Remaining parameter such as Alkalinity , Sulphate as So<sub>3</sub>.These parameter test results exceed the limits specified in the IS code, take appropriate corrective actions to bring the water quality within acceptable limits.

### Sample 3 : Borewell Water at Dhanori 3

Compare the test results of each parameter with the limits specified in the IS 456:2000 code. Suitable Parameter for construction use is pH , acidity, chloride , total hardness , Sulphate as So<sub>3</sub> ,total suspended solid ,Total Dissolved solid, Volatile (Organic Residue) & Fixed Residue (Inorganic Residue) etc. parameter limit suitable for the construction use. Remaining parameter such as Alkalinity , Sulphate as So<sub>3</sub> .These parameter test results exceed the limits specified in the IS code, take appropriate corrective actions to bring the water quality within acceptable limits.

### Sample 4 : Borewell Water at Lohegaon 1

Compare the test results of each parameter with the limits specified in the IS 456:2000 code. Suitable Parameter for construction use is pH , acidity, chloride , total hardness , Sulphate as So<sub>3</sub> ,total suspended solid ,Total Dissolved solid, Fixed Residue (Inorganic Residue) etc. parameter limit suitable for the construction use. Remaining parameter such as Alkalinity , Sulphate as So<sub>3</sub> , Volatile (Organic Residue).These parameter test results exceed the limits specified in the IS code, take appropriate corrective actions to bring the water quality within acceptable limits.

### Sample 5: Borewell Water at Lohegaon 2

Compare the test results of each parameter with the limits specified in the IS 456:2000 code. Suitable Parameter for construction use is pH , acidity, chloride , total hardness , Sulphate as So<sub>3</sub> ,total suspended solid ,Total Dissolved solid, Volatile (Organic Residue) & Fixed Residue (Inorganic Residue) etc. parameter limit suitable for the construction use. Remaining parameter such as Alkalinity , Sulphate as So<sub>3</sub> .These parameter test results exceed the limits specified in the IS code, take appropriate corrective actions to bring the water quality within acceptable limit.

## VI. CONCLUSION

The water must be tested before using in construction work because the quality of water used in concrete mixing is directly linked to the strength, durability, and overall performance the concrete structure. Regular testing and monitoring of water sources are essential to maintain consistency and identify potential contamination issues early. Various contaminants such as suspended particles, inorganic salts, oils, and pH variations can adversely affect concrete properties, leading to issues like reduced strength, corrosion, and chemical degradation.

Ensuring the use of potable and treated water contributes to the longevity, safety, and sustainability of concrete structures. By prioritizing the physicochemical characterization and assessment of water sources, construction projects can produce higher quality concrete, leading to more resilient, long-lasting, and environmentally friendly structures.

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# Strengthening of Structure by Using FRP and Ms Plate

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**ABSTRACT:** Steel and FRP composites are the most used material in strengthening process of existing concrete structures. Near surface mounting techniques for strengthening of existing structures will be discussed. The NSM technique has provided a significant increment of the load at serviceability limit state, as well as, the stiffness after concrete cracking. Many of the reinforced concrete structures are being damaged by the frequent earthquakes and they need to be retrofitted using external retrofitting materials. Finite element method (FEM) has become a source for analysing by simulating a model and predicting the physical behaviour of complex engineering models.

During the last few decades, strengthening of concrete structural elements by fibre-reinforced polymer (FRP) has become a widely used technique where high strength is needed for carrying heavy loads or repairing is done due to fatigue cracking, failure modes and or corrosion. This paper reviews various aspects of RC beams strengthened with FRP. This topic has not been covered comprehensively in previous studies, whereas the technology has been modified rapidly in the recent past. It highlights aspects such as surface preparation, adhesive curing, finite element (FE) simulation, fatigue performance as well as the failure modes of RC beams retrofitted with FRP. This technique eliminates and or reduces the crack growth rate, delay initial cracking, decline the stiffness decay with residual deflection and extend the fatigue life of RC beams. The best strengthening option in this case is pre-stressed carbon fiber-reinforced polymer (CFRP).

**KEYWORDS:** Simply supported beam, Retrofitting, MS steel plates, adhesive, fiber reinforced polymer (FRP), failure mode, finite element, RC beam, strengthening.

## I. INTRODUCTION

“Structural strengthening in civil engineering involves the process of reinforcing existing buildings or infrastructure to enhance their stability, load-bearing capacity, and overall durability”. This is often necessary due to factors such as aging, increased loads, or the need to meet updated safety standards. Various methods, including reinforcement with materials like steel or polymers, overlay applications, and foundation modifications, may be employed based on the specific requirements of the structure. Before implementing any strengthening measures, a thorough structural assessment is conducted to identify weaknesses and determine the optimal approach. This meticulous process ensures that the strengthened structures can effectively withstand both anticipated and unforeseen loads, contributing to their longevity and resilience. Structural strengthening is the process of upgrading structures to improve performance under existing loads or to increase the strength of structural members to carry additional loads. The need for structural strengthening is commonly driven by building codes, deterioration, change in use, or deficiencies caused by design and/or construction errors. Structural strengthening is a critical practice in the fields of civil and structural engineering, aimed at fortifying existing buildings, bridges, and infrastructure to endure changing demands and evolving safety standards.

## II. RELATED WORK

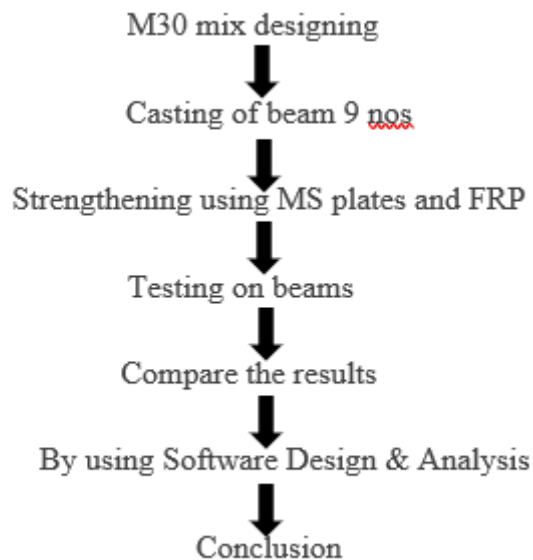
In this comprehensive literature review, we Endeavor to gather information on structural strengthening methodologies while delving into the underlying causes of structural weaknesses, failures, defects, and the consequences of improper maintenance. It is widely acknowledged that structural failure often stems from neglect and aging, necessitating a proactive approach to maintenance. While some may resort to demolition as a solution for aging structures, strengthening presents a viable alternative that can prolong the lifespan and enhance the safety of existing structures. Through an exploration of various strengthening techniques, including the application of Fiber-Reinforced Polymer



(FRP) and the strategic incorporation of Mild Steel (MS) plates, we aim to elucidate the efficacy and potential of these methods in mitigating structural vulnerabilities. Moreover, we Endeavor to highlight the economic and environmental benefits associated with structural strengthening, underscoring its significance in sustainable urban development and infrastructure management.

### III. METHODOLOGY

Conduct a thorough assessment of the existing structure, including visual inspections, historical data review, and identification of weak points. In this project, the focus lies on enhancing the strength and durability of concrete structures using a systematic approach. The choice of using a standard mix of M25 concrete ensures consistency and reliability in the material properties. By casting nine beams and cubes of specified dimensions, the aim is to accurately assess the concrete's strength through cube testing at different curing periods of 7, 28, and 56 days. This comprehensive testing protocol allows for a thorough understanding of the concrete's performance over time, providing valuable insights into its long-term behaviour under varying Conditions.



### IV. EXPERIMENTAL RESULTS

#### Flexural Test Procedure

##### ➤ Step No1: Specimen Preparation:

**size and Shape:** The standard specimen size for the flexural strength test is typically a beam of 150 mm x 150 mm cross-section and a length of 700 mm for a span length of 600 mm. Casting and Curing: Cast the concrete beams using standard procedures. Cure the specimens as specified, generally for 28 days.

##### ➤ Step No 2: Setup of specimen:

Ensure the specimens are in a saturated surface dry condition before testing. Set the support span to 600 mm, ensuring the supports are free to rotate and have rollers to allow for slight movement. Place the beam specimen on the supports, ensuring it is centered and aligned properly. Attach the loading device to the machine. Typically, a single-point loading (three-point bending) or two-point loading (four-point bending) is used.

##### ➤ Step No 3: Testing on specimen:

Zero the force and deflection measurements to account for any initial offsets. Start applying the load at a constant rate. For concrete, a standard rate is to increase the stress at a rate of 0.7 to 1.4 MPa/min. Continuously record the applied force and corresponding deflection until the specimen fractures or the maximum specified deflection is reached.

##### ➤ Step No 4: Post test:

Carefully remove the fractured or tested specimen from the supports. Measure the location and nature of the break. Ensure that the fracture occurs within the middle third of the span length. Use the recorded maximum load to calculate the flexural strength.

The formula is :  $\sigma = P \times L / BD^2$

Where,

P=Maximum load applied

L = Span length of the beam



b = Width of the beam  
d = Depth of the beam

- **Step No 4: Post test:** document all results, including specimen dimensions, span length, maximum load, flexural strength, and observations about the fracture. ensure all procedures and calculations comply with IS 456:1959 standards.

#### Test Result Normal beam:

Table No 4.1 test result on normal beam

Beam Sizes (mm)	Surface area (mm <sup>2</sup> )	Compressive strength Of cube (N/mm <sup>2</sup> )	Crack Form support (mm)	Load (KN)	Flexural Strength (N/mm <sup>2</sup> )
700x600x600	106153	33.56	290	25.01	4.46
700x150x150	105549	31.18	298	24.2	4.30
700x150x150	105000	32.61	295	23.95	4.25

We refer The IS code (IS:456-1959) for conducting this test, firstly Set up the beam on the supports, ensuring it is level and centered between the supports. Connect the load cell to the loading machine to measure the applied load accurately. Continuously record the applied load and corresponding deflections. If strain gauges are used, record strain data as well. After reaching the peak load or failure, gradually unload the beam to its original position.



Fig No 4.1 Flexural test on normal beam

### Test Result beam which is strengthening by MS plate

Table No 4.2 Test result on beam strengthened by MS plate

Beam Sizes (mm)	Surface area (mm <sup>2</sup> )	Compressive strength Of cube (N/mm <sup>2</sup> )	Crack Form support (mm)	Load (KN)	Flexural Test N/mm <sup>2</sup>
700x150x150	106153	33.56	280	28.22	5.01
700x150x150	105549	31.18	297	31.04	5.51
700x150x150	105000	32.61	300	30.95	5.50

We refer The IS code (IS:456-1959) for conducting this test, firstly Set up the beam on the supports, ensuring it is level and centered between the supports. Connect the load cell to the loading machine to measure the applied load accurately. Continuously record the applied load and corresponding deflections. If strain gauges are used, record strain data as well. After reaching the peak load or failure, gradually unload the beam to its original position.

**Calculate Flexural Strength:** The flexural strength ( $\sigma$ ) is calculated using the formula:  $\sigma = P \times L / BD^2$

**Where,**

- P=Maximum load applied
- L = Span length of the beam
- b = Width of the beam
- d = Depth of the beam

### Test Result beam which is strengthening by FRP plate

Table No 4.3 Test result on beam strengthened by FRP sheet

Beam Sizes (mm)	Surface area (mm <sup>2</sup> )	Compressive strength Of cube (N/mm <sup>2</sup> )	Crack Form support (mm)	Load (KN)	Flexural Test
700x600x600	106002	33.56	294	35.65	6.33
700x600x600	105150	31.18	286	32.37	5.75
700x600x600	10570	32.61	298	31.35	5.57

We refer The IS code (IS:456-1959) for conducting this test, firstly Set up the beam on the supports, ensuring it is level and centered between the supports. Connect the load cell to the loading machine to measure the applied load accurately. Continuously record the applied load and corresponding deflections. If strain gauges are used, record strain data as well. After reaching the peak load or failure, gradually unload the beam to its original position.

**Calculate Flexural Strength:** The flexural strength ( $\sigma$ ) is calculated using the formula:  $\sigma = P \times L / BD^2$

**Where,**

- P=Maximum load applied
- L = Span length of the beam
- b = Width of the beam
- d = Depth of the beam



Fig No 4.2 Flexural test on Strengthened beam.

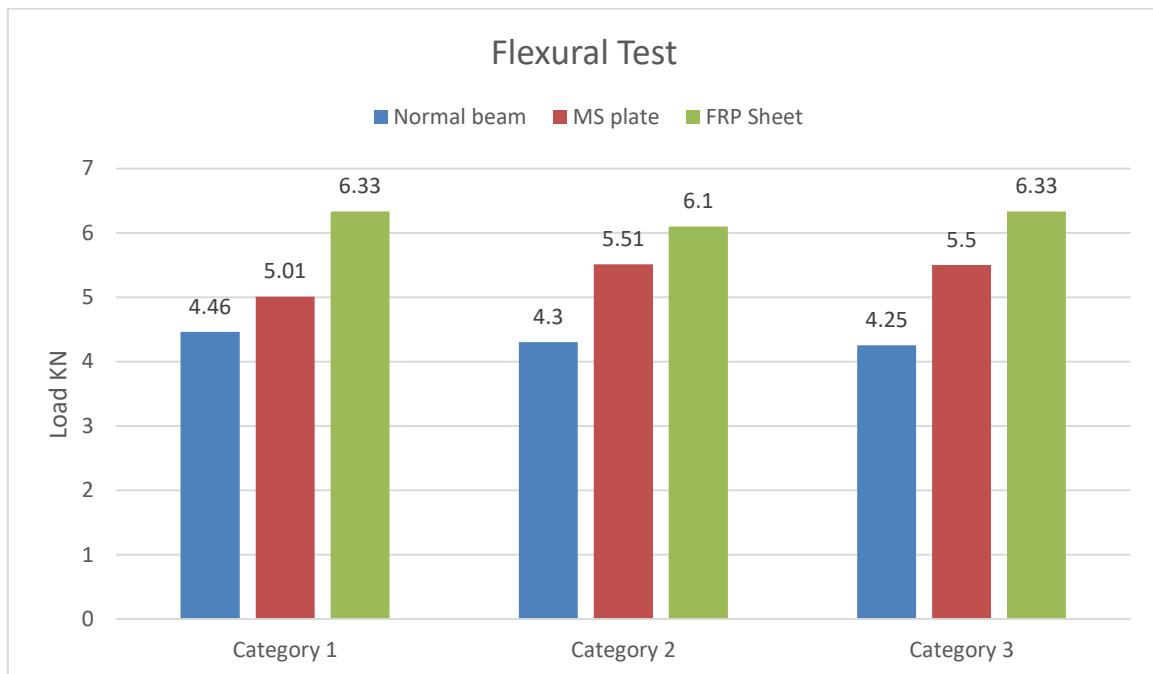


Fig No 4.3 Graph of comparison between test value

illustrates the comparison of test values obtained from the flexural tests conducted on three different beams. The graph highlights the variations in flexural strength among the beams, providing a clear visual representation of their performance under load. Each beam's response to the applied force is depicted, allowing for an easy comparison of their structural integrity and resilience. This comparison is crucial for understanding the material properties and the



effectiveness of different reinforcement techniques used in the beams. The results shown in the graph underscore the importance of selecting appropriate materials and construction methods to enhance the flexural capacity of structural elements.

## V. CONCLUSION

- In conclusion, the utilization of Fiber Reinforced Polymer (FRP) and Mild Steel (MS) plates for strengthening structures has shown promising results in enhancing structural performance and durability.
- When the strengthening done by FRP sheet the strength is increase by 26%
- When the strengthening done by FRP sheet the strength is increase by 21%
- Our investigation revealed that FRP and MS plates offer significant benefits in terms of cost-effectiveness, as they provide a viable alternative to traditional strengthening methods while also offering increased durability against environmental factors such as corrosion and moisture.

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# Analysis and Design of Bay Spacing of Steel Foot Over Bridge using Staad Pro

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**ABSTRACT:** The main goal of this study was to analyze and design the bay spacing of a steel foot over bridge using the STAAD Pro software. To ensure that the bridge is structurally sound and meets all necessary design requirements. To achieve this, first created a detailed model of the bridge in STAAD Pro, taking into account the properties of the steel material and the different loads that the bridge would experience. Then conducted a thorough analysis to evaluate the structural behavior and performance of the bridge under various loading conditions. During the design process, consider the factors such as safety, aesthetics, and functionality.

To optimise the bay spacing to ensure that the bridge can resist the applied loads while maintaining an efficient and cost-effective design. The key findings of the study highlighted the importance of properly spacing the bays in the foot over bridge. Optimal bay spacing resulted in improved structural integrity, reduced stress concentrations, and enhanced overall performance of the bridge

**KEYWORDS:** Bay Spacing, Steel Foot Over Bridge, Staad Pro Software, Cost Effective

## I. INTRODUCTION

Bridge is a structure that offers passage over limitations or obstacles which includes valley, tough terrain or river or bodies of water via spanning such obstacles with herbal or manmade substances/material. They first all started be used in ancient instances when first contemporary civilizations started out growing within the Mesopotamia. From that factor on, information, engineering, and manufacture of new bridge constructing substances unfold beyond their borders, permitting slow but regular/steady adoption of bridges all internationally. A foot over bridge is a bridge designed only for pedestrian. While the principle which means for a bridge is a structure which links “two distinct points at a peak above the earth”. The smooth kind of a bridge is steppingstones, so this may were one of the premature sorts of a foot bridge. Neolithic people also construct a shape of a boardwalk to the other facet of swamp, of which the sweet track, and the post track are examples from England, which are about 6000 years antique (Limaje et al,2019). Doubtless past peoples might also have used Timber Bridge that drop naturally. Different kinds of design foot over bridges consist of timber foot over bridges, steel foot over bridges and concrete foot over bridges. Steel truss is normally used round the world for the development of foot over bridges of different length. Steel is a useful material that provides provable solution. Steel has long been diagnosed as the financial/economical option for a number of foot over bridges. After literature survey it is observed that, includes design and analysis of Foot over Bridge Using STAAD-PRO software, study mainly includes static and dynamic seismic analysis, specifically seismic coefficient method and response spectrum method is used (Gupta et al, 2017). But, yet bay spacing for economical design of steel foot over bridge has not been studied. So, in the present dissertation work, it is proposed to carry out bay spacing for the optimize/economical design of steel foot over bridge.

## II. RELATED WORK

From the literature survey, it is observed that consists design and analysis of foot over bridge using STAAD- PRO software, study mainly includes static and dynamic seismic analysis, specifically seismic coefficient method and response spectrum method is used. But, yet bay spacing for economical/optimize design of steel foot over bridge has not been studied. So, in the present dissertation work, it is proposed to carry out bay spacing for economical/optimize design of steel foot over bridge.



### III. METHODOLOGY

The first step is to create a 3D model of the bridge in STAAD Pro. This can be done by importing a DXF file of the bridge or by creating the model from scratch. Once the model is created, the next step is to define the loads that will be acting on the bridge. These loads are dead loads, live loads, wind loads, and seismic loads. The next step is to define the material properties of the bridge. These properties are found in the material properties library of STAAD Pro or they can be entered manually. The next step is to define the section properties of the bridge. These properties can be found in the section properties library of STAAD Pro or they can be entered manually. The next step is to define the boundary conditions of the bridge. These conditions can be fixed, pinned, or roller. The next step is to run the analysis. This will calculate the stresses and deflections in the bridge. The next step is to design the bridge. This involves selecting the appropriate sections for the members of the bridge and checking the stresses and deflections to ensure that they are within the allowable limits. The final step is to document the design. This involves creating a report that includes the 3D model of the bridge, the loads that were applied, the material properties, the section properties, the boundary conditions, the results of the analysis, and the design of the bridge.

### IV. EXPERIMENTAL RESULTS

2m Bay Spacing and 6m Span:-

- Maximum Utilization ratio is  $0.505 < 1.0$
- Maximum Deflection is 3.622 mm
- Weight of Structure Before Optimization:- 23.185 KN
- Weight of Structure after Optimization:- 10.510 KN

3m Bay Spacing and 9m Span:-

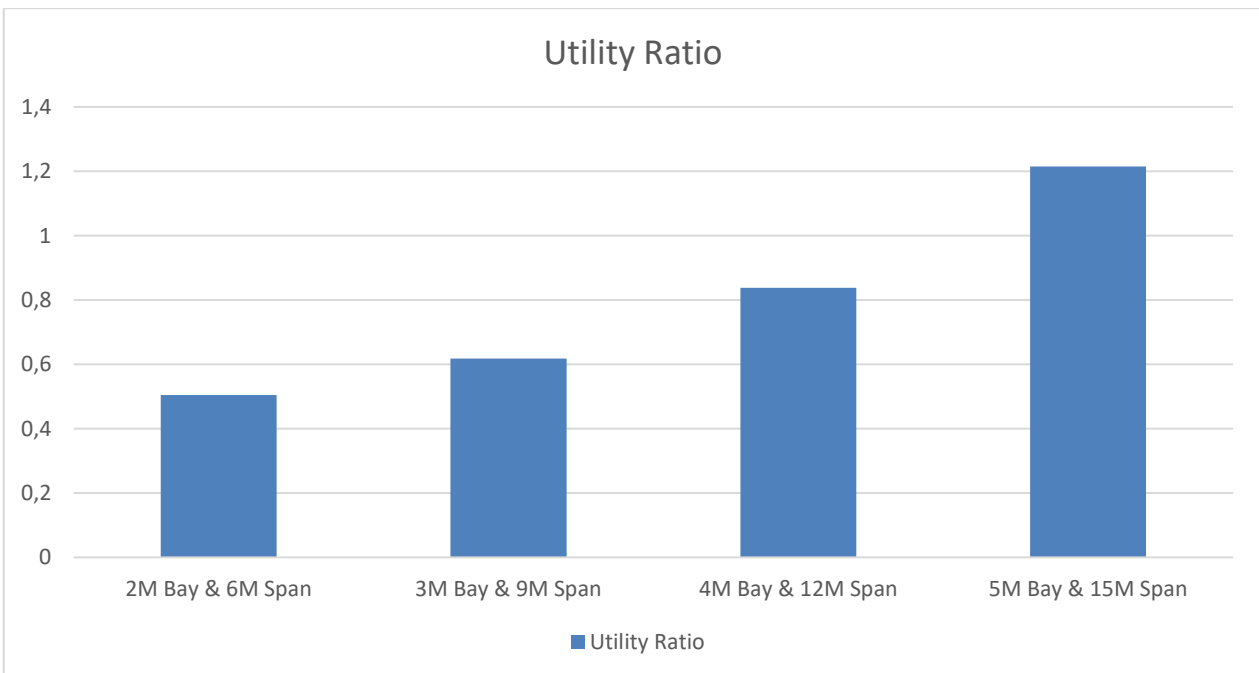
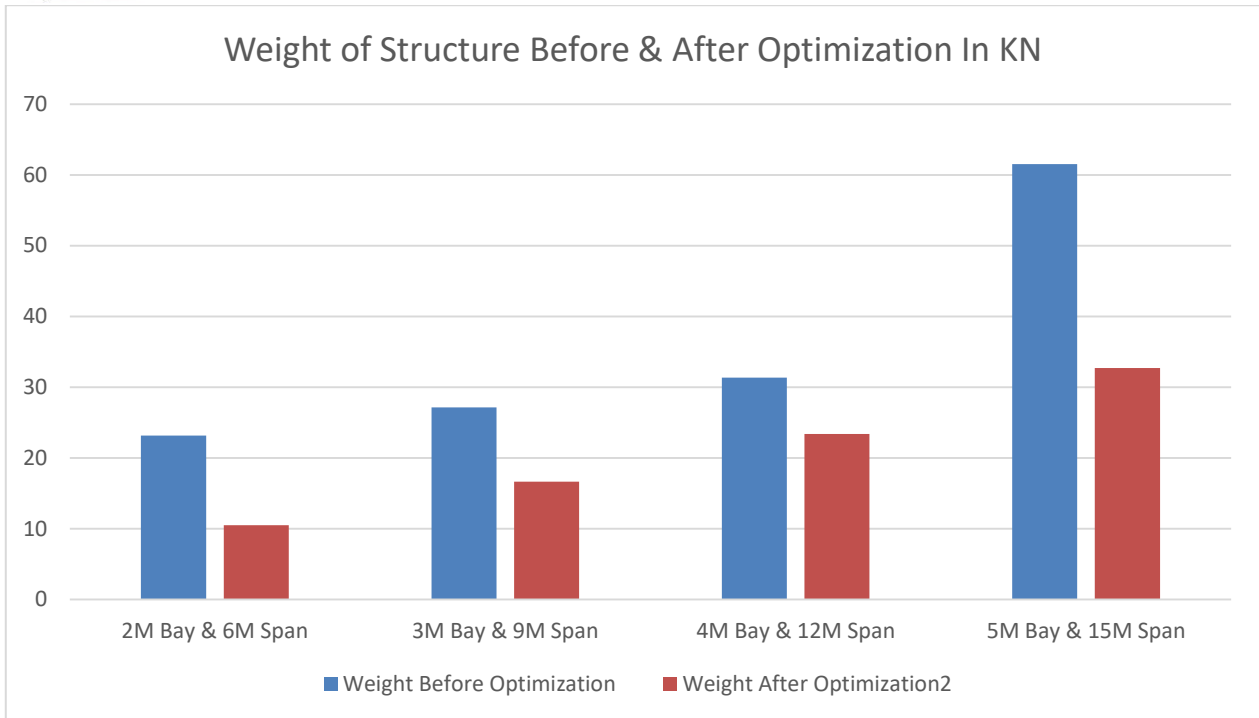
- Maximum Utilization ratio is  $0.618 < 1.0$
- Maximum Deflection is 11.025 mm
- Weight of Structure Before Optimization:- 27.131 KN
- Weight of Structure after Optimization:- 16.644 KN

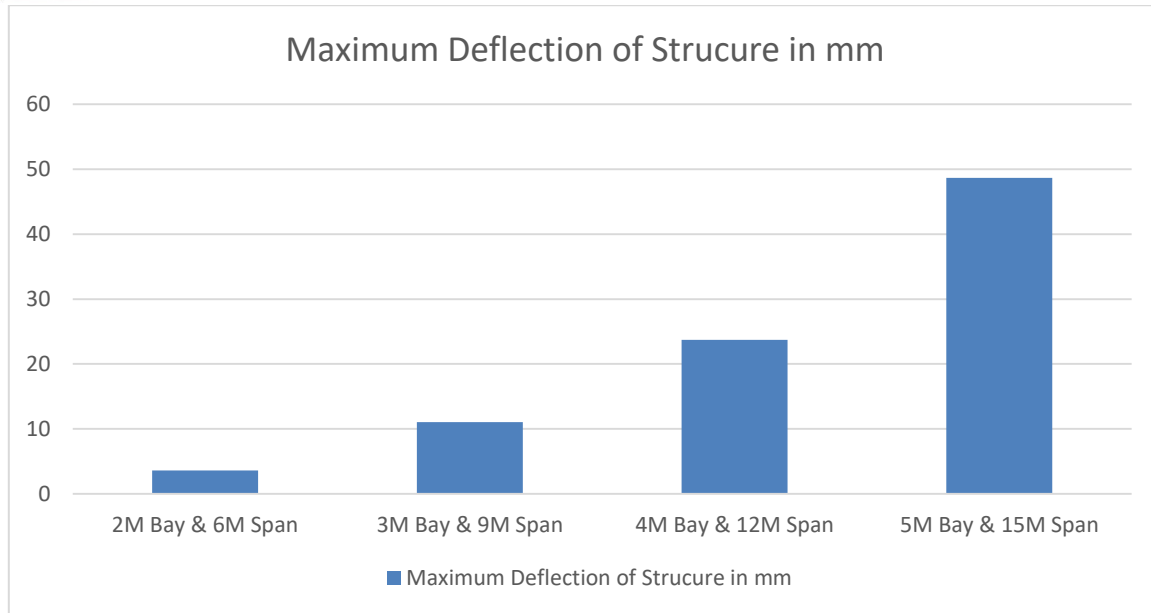
4m Bay Spacing and 12m Span:-

- Maximum Utilization ratio is  $0.838 < 1.0$
- Maximum Deflection is 23.731 mm
- Weight of Structure Before Optimization:- 31.354 KN
- Weight of Structure after Optimization:- 23.388 KN

5m Bay Spacing and 15m Span:-

- Maximum Utilization ratio is  $1.215 > 1.0$
- Maximum Deflection is 48.672 mm
- Weight of Structure Before Optimization:- 61.557 KN
- Weight of Structure after Optimization:- 32.706 KN





## V. CONCLUSION

After Design & Analysis of steel foot over Bridge by using STAAD PRO for different bay spacing and different span. The following points are observed.

- 1] Weight of steel foot over Bridge after optimization is reduced i.e. economical sections are achieved.
- 2] As the bay spacing and span of steel foot over Bridge increase the dependent factors like deflection, utility ratio and weight of steel foot over Bridge also increase and vice versa.
- 3] 2M, 3M, & 4M bay spacing steel foot over Bridge are safe as maximum utility ratio is under 1.
- 4] so we can say that 2M, 3M, & 4M bay spacing can be comfortable with different span length.
- 5] The 5M bay spacing of steel foot over Bridge is not preferable as maximum utility ratio is above 1 hence the steel foot over Bridge is unsafe.
- 6] The economical steel foot over bridge after the analysis and design is 2M bay spacing and 6M span.
- 7] As the span of steel foot over Bridge increase the weight of steel foot over Bridge will also be increases keeping the bay spacing constant.

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# Carbonation Studies for Sustainable Concrete Durability Solutions

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**ABSTRACT:** Concrete is essential in construction worldwide and is used daily. However, it deteriorates over time, primarily due to carbonation, which causes corrosion in reinforced concrete structures. This process involves carbon dioxide (CO<sub>2</sub>) entering the porous concrete, lowering the pH around the reinforcement and starting corrosion. An accelerated carbonation chamber was developed to create an environment for the carbonation process, ensuring a constant flow of carbon dioxide gas for all cubes, cylinders, and beams. M30 grade concrete cubes, cylinders, and beams were prepared and subjected to varying levels of carbonation. This paper examines how carbonation affects concrete properties such as compressive, tensile, flexural, and shear strength, as well as durability. The addition of materials like fly ash, GGBFS, rice husk ash, and metakaolin has been shown to enhance concrete's strength and durability. This improvement has been demonstrated through accelerated carbonation tests, which provide a controlled environment to observe the effects of carbonation on concrete specimens. The study confirms that these supplementary cementitious materials significantly improve the performance and longevity of concrete under carbonation conditions.

**KEY WORDS:** carbonation, corrosion, GGBFS, compressive strength, Durability

## I. INTRODUCTION

Carbonation is a significant factor in the deterioration and weakening of concrete structures. It involves the reaction of hydration products dissolved in pore water, reducing the concrete pore solution's pH from 12.6 to below 9. Carbonation has a substantial impact on various engineering properties of concrete, particularly affecting compressive strength, tensile strength, and flexural strength. The depth of carbonation can be measured by spraying phenolphthalein indicator on the concrete surface; this colorless indicator turns purple when the pH is above 13. This paper investigates the effects of carbonation on the hardened properties of concrete by conducting tests on compressive strength, tensile strength, flexural strength, and shear strength. The study also explores the performance of M30 grade concrete when cement is partially replaced with supplementary cementitious materials such as fly ash, GGBFS, rice husk ash, and metakaolin. To assess the mechanical properties of the concrete, tests for compressive strength, split tensile strength, flexural strength, and shear strength will be performed. Additionally, durability aspects will be evaluated through tests for sulphate attack, acid attack, and carbonation.

## II. LITERATURE REVIEW

The investigation into the weakening of cement's strength may find resolution through an examination of its microstructure and its reaction to aggressive environmental conditions. Despite its adverse effects on reinforced structures, one cannot overlook the benefits of carbonation in enhancing the mechanical properties of unreinforced concrete. Carbonation, a long-term effect, leads to a reduction in surface porosity. The greenhouse gas CO<sub>2</sub> emitted by the majority of concrete-based industries is, to some degree, absorbed by concrete structures, contributing to the mitigation of greenhouse gas effects on the environment. Understanding this phenomenon becomes crucial when considering the balance between carbon dioxide emissions and absorption in a beneficial context[1]. Carbonation, a significant factor contributing to the deterioration of structures, occurs when hydration products dissolved in the pore water of cement react with carbon dioxide present in the air. This interaction alters both the physical and chemical properties of concrete, leading to changes in its composition and structure [2,3]. It is a process wherein Ca(OH)<sub>2</sub> reacts with carbon dioxide to form CaCO<sub>3</sub>[4]. Carbon dioxide in the environment reacts with the calcium content in concrete and water within the pores of cement, forming carbonic acid. This acid further reacts with calcium hydroxide to produce CaCO<sub>3</sub>. However, CO<sub>2</sub> diffuses through the surface of the concrete via its interconnected narrow pores, dissolving as carbonic acid (H<sub>2</sub>CO<sub>3</sub>). This process leads to the formation of HCO<sub>3</sub><sup>-</sup> and CO<sub>3</sub><sup>2-</sup> ions and the dissolution of hydration products of concrete, such as Ca(OH)<sub>2</sub>, resulting in the release of Ca<sup>2+</sup> and hydroxyl ions, and the formation of CaCO<sub>3</sub> [5]. The initial reaction occurs within the pores of the concrete, where carbon dioxide and





water combine to form carbonic acid. Subsequently, the carbonic acid reacts with the calcium compounds present, leading to the formation of calcium carbonate. As calcium hydroxide from the concrete is converted into calcium carbonate, calcium silicate hydrates release calcium oxide, further contributing to the formation of calcium carbonate. The pH value of the pore solution of concrete typically ranges from 12.6 to 13[6]. This outcome stems from the dissolution of  $\text{Ca}(\text{OH})_2$ , which introduces hydroxyl ions into the pore water. The factors that significantly influence the rate of carbonation include the type and quantity of pozzolanic material, the water-to-cement ratio, the porosity of the material, ambient humidity, and the duration of curing[7,8]. Carbon dioxide ( $\text{CO}_2$ ) diffusion within the solid's porosity is one of the most common aggressive ingress mechanisms to assess the amount of carbon dioxide absorbed per gram of concrete. [9,10]. Galan et al. [1] conducted a study using 15 types of concrete to develop concrete mixes with water-to-cement ratios of 0.45 and 0.60. These mixes were exposed to various environmental conditions. The depth of carbonation, its propagation rate, and carbon dioxide absorption for both water-to-cement ratios were determined. It was observed that samples exposed to open air and protected from rain exhibited maximum carbonation depth after one year, appearing uniformly discolored across the tested area. In contrast, those unprotected from rain showed a soft pink hue, indicating a drop in pH to no less than 8 compared to the former case. According to Jose and Cristela, carbonation distribution is lower in surface-protected concrete compared to non-protected concrete[11]. The authors [11] illustrate that the use of epoxy resin has demonstrated superior protection compared to acrylic and siloxane coatings. The carbonation dispersion coefficient increased with the water-to-cement ratios, attributable to the increase in cement porosity. The dispersion coefficient represents the quantity of a substance diffusing from one region to another per unit cross-sectional area per unit time when the volume-concentration gradient is unity. Yongsheng et al. [12] concluded that the influence of carbon dioxide concentration and the duration of carbonation has minimal effect on the length of the semi-carbonation zone, where the pH value ranges from 8.3 to 12.6. In their study, the authors [12] found that for high-strength concrete and under high relative humidity, the semi-carbonation zone is shorter. Conversely, the length of semi-carbonated zones under normal environmental conditions exceeds those under high  $\text{CO}_2$  conditions. The authors [12] attributed this difference to variations in temperature and relative humidity. Neves et al. [13] investigated the effects of age and environmental conditions on the ratio of accelerated and natural carbonation coefficients. They concluded that only natural conditions significantly influence the ratio. Neves et al. [13] suggested that in cases where  $\text{CO}_2$  concentrations deviate slightly from 5% in accelerated carbonation resistance testing, a correction of the acceleration factor (the slope of accelerated and natural carbonation coefficients) using the square root of the accelerated carbon dioxide concentration ratio should be applied. Cheng et al. [14] conducted a study on the depth of carbonation for accelerated carbonated concrete and found that pH values using phenolphthalein indicator are typically 9 and 7.5 for 50% and 100% levels of carbonation, respectively. The durability of concrete structures exposed to aggressive conditions is a significant concern. Various environmental phenomena are known to significantly impact the strength of reinforced concrete structures[15-17]. Carbonation is a central factor contributing to structure deterioration. It occurs when hydration products dissolve in the pore water of concrete, reacting with carbon dioxide from the air. This process reduces the pH of the concrete pore solution from 12.6 to under 9. Additionally, it may lead to the destruction of the passive oxide film on steel, accelerating uniform corrosion[18]. Carbonation-induced corrosion can increase crack propagation and decrease concrete strength[19]. Carbonation reduces the pH value and destroys the passive film around the steel. However, it appears to densify the concrete surface and decrease chloride ion permeability, reducing surface porosity and hence sorptivity in cement[20,21]. Carbonation could have both positive and negative consequences for concrete durability. Glass et al. pointed out that even a small amount of chloride in carbonated concrete enhances the erosion rate resulting from carbonation of cement[22]. The primary factor affecting carbonation is the diffusivity of the solidified concrete paste. The rate of carbonation is limited by the entry of  $\text{CO}_2$  into the solid pore system through diffusion, with a concentration gradient of  $\text{CO}_2$  acting as the driving force. Factors influencing the diffusion rate include the type and quantity of cement, material porosity, curing duration, and type and quantity of pozzolanic additives[17,23]. Additionally, certain mechanical properties of concrete, such as compressive strength, surface hardness, and resistance to aggressive agents, may change due to carbonation[24]. A trial investigation was conducted to assess the solidification properties of M30 and M35 grade concrete using Ordinary Portland cement with water-to-cement ratios of 0.42 for M30 and 0.40 for M35 grade concrete[25]. Carbonation is assessed using a solution of 0.2% phenolphthalein indicator. Ordinary concrete exhibits pink coloration, while no change in color indicates that the concrete is affected by carbonation. The mix design is carried out according to BIS (10262-2009) standards. Compressive strength tests, split tensile tests, and flexural strength tests were conducted to determine the impact of carbonation on the hardened properties of carbonated concrete and ordinary concrete. A similar study was conducted between ordinary concrete and carbonated concrete for third-day, seventh-day, and twenty-eighth-day test samples. The results indicate that carbonated concrete exhibits higher compressive strength compared to non-carbonated specimens. Furthermore, the split tensile strength and flexural strength of carbonated concrete increase compared to non-carbonated concrete in third-day, seventh-day, and twenty-eighth-day tests. Reinforcement corrosion is a significant cause of deterioration in concrete structures. In carbonated environments, carbon dioxide reacts with hydrated concrete, eroding its alkalinity and impacting concrete durability. The transport properties of concrete, such as porosity, capillary suction, permeability, and absorption, have been shown to be significantly affected[26]. Concrete is one of the primary materials extensively used worldwide for construction purposes, particularly in aquatic



environments. Its versatility and durability make it indispensable in various applications in our daily lives[27]. Decay is a common occurrence in most materials, and concrete is no exception, breaking down in three main forms: physical, chemical, and corrosion. Carbonation is widely recognized as a significant cause of corrosion in reinforcing steel within concrete structures. This study primarily investigates the impact of carbonation on concrete properties, such as compressive strength, porosity, and durability. The incorporation of Fly Ash (FA) is known to enhance the durability of reinforced concrete as beneficial cementitious materials. In this research, concrete cubes are prepared with and without partial substitution of cement by Fly Ash and are subjected to an accelerated carbonation chamber to analyze the carbonation of concrete. Specifically, the cubes are prepared for M30 grade with varying proportions of FA ranging from 0% to 30%. This paper also presents the experimental results of the study conducted on carbonated and non-carbonated concrete, including parameters such as compressive strength, porosity, depth of carbonation, and carbonation coefficient[27]. Acid rain poses a significant environmental threat resulting from air pollution. Rainwater becomes weakly acidic because carbon dioxide gas in the atmosphere reacts with water to form carbonic acid. However, sulfur oxide and nitrogen oxide particles, originating from industrial pollution and vehicle emissions, react with rainwater to form strong acids. These compounds combine to cause acid rain. A test study was conducted to investigate the effects of controlled carbonation in concrete to enhance its properties under acid rain exposure. The strength parameters of concrete subjected to acid rain conditions were examined. Artificial acid rain conditions with a pH level of 4.5-5 were created in the laboratory by combining sulfuric, nitric, and carbonic acid solutions. After exposure to simulated acid rain for various durations, compressive strength, flexural strength, split tensile test, scanning electron microscope (SEM), and X-ray diffraction (XRD) analysis were performed on the concrete samples at different stages of damage[28]. Concrete is a construction material composed of cement, fine aggregates (sand), and coarse aggregates mixed with water, which solidifies over time. Portland cement is commonly used in the production of concrete. Concrete degradation can occur through various stages such as fire damage, aggregate expansion, exposure to seawater, and chemical damage (such as from carbonation). Carbon dioxide from the air reacts with calcium hydroxide in concrete to form calcium carbonate, a process known as carbonation. This experimental study aimed to investigate the degradation mechanism of concrete due to carbonation, focusing on parameters such as compressive strength, depth of carbonation using phenolphthalein indicator, and crystalline structure using X-ray diffraction (XRD) analysis. In this study, concrete samples of grade M35 with a water-to-cement ratio of 0.45 were used. The samples will undergo microscopic structural analysis (SEM) to identify the crystalline structure of calcium carbonate[29]. Vatsal N Patel conducted an exploratory examination of M30 grade concrete performance by replacing cement with 4%, 8%, and 12% marble powder. Various tests were conducted to assess mechanical properties such as compressive strength, split tensile strength, and flexural strength. Additionally, tests to evaluate durability aspects including sulfate attack, acid attack, and carbonation were performed. The results indicate that at an 8% substitution level of marble powder, mechanical and strength properties showed improvement compared to both the control sample and other substitution levels of marble powder[30].

### **III.CONCLUSION**

The above study included a brief investigation into the effects of carbonation on concrete. The focus was primarily on studying the impact of admixtures in cement to enhance properties such as mechanical strength. In the pressure, flexural, and split tensile tests, concrete proportioned with admixtures demonstrated optimal values, showing maximum strength. Durability tests yielded favorable results, indicating less reduction in strength and mass during acid attack on bricks with the addition of admixtures. Similarly, the addition of admixtures proved beneficial in resisting sulfate attack, resulting in stable concrete. Although carbonation was not observed in any of the concrete cubes, it can be inferred that admixtures contribute to better resistance against the pinkish discoloration that typically occurs on the surface of concrete. In conclusion, the substitution of cementitious material in concrete with admixtures leads to the production of denser and more impermeable concrete, thereby improving mechanical and durability properties.

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# Flood Detection and Control Using IOT

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**ABSTRACT:** Floods have been recurrent phenomena in India. Causes of floods are due to natural factors such as heavy rainfall, high floods and high tides, etc., and human factors such as blocking of channels or aggravation of drainage channels, improper land use, deforestation. Flood problems in India, regional variability of the problem, present status of the ongoing management measures, their effectiveness and future needs in flood management are covered. Different measures have been adopted to reduce the flood losses and protect the flood plains. Flood control methods are used to reduce or prevent the detrimental effects of flood waters or high-water levels. This also presents a description of an alert generating system for flood detection. In addition, future needs to achieve efficient and successful flood management measures in India are also pointed out the importance of early detection, and the role of IoT in providing real-time monitoring and control. It would likely touch on the system's architecture, including sensors for data collection, communication protocols, and mechanisms for flood prediction and mitigation. The abstract might also mention the benefits of such a system, such as improved response times and reduced damage to infrastructure and property. The system integrates sensor networks to monitor key parameters such as water level, rainfall intensity, and soil moisture in real-time. Data from these sensors are processed and analysed using machine learning algorithms to accurately predict and detect potential flood events. Upon detection, automated control mechanisms such as smart floodgates and drainage systems are activated to mitigate the impact of flooding. Through this IoT-based approach, timely and proactive measures can be taken to minimize damage and enhance disaster resilience in flood-prone areas.

**KEYWORDS:** Flooding Prevention, Internet of Things, Drainage pipe, catastrophic situation, flooding condition, Flow Rate, Water Level

## I.INTRODUCTION

Prevalent urban flooding in urban areas is increasing because of growing population with inappropriate land use planning and climate change-induced rise in extreme rainfall events. Flood risk is the product of a hazard and its consequences. Flood hazard can be quantified in terms of flood depth, duration, velocity, sediment contains and its probability.

To minimize the extent of damages caused by flood, warning systems to inform the people of the disaster should be implemented in high-risk areas. This system will be able to reduce the damages of floods.

Excessive river levels are normally caused by high runoff from upstream and backwater effect of high tides at river mouths.

- To have successful flood control and flood risk management, we should consider not only hydraulic and engineering aspects but also socio-economic and environmental aspects. Prevalent urban flooding in urban areas is increasing because of growing population with inappropriate land use planning and climate change-induced rise in extreme rainfall events.
- Flood risk is the product of a hazard and its consequences. Flood hazard can be quantified in terms of flood depth, duration, velocity, sediment contains and its probability.

A residential flood control system is any way(s) used to systematically reduce the risk of damage to a home or basement due to flooding. This flooding can be from basement cracks, floor drains or floors, through an overwhelmed catch basin, or even worse, up through the connection to the sewer system. Some components may be catching basins, sump pumps, sewer backflow valves, overhead sewers, lift stations, backup sump pumps, battery backup systems for pumps, drain tile systems, French drains, or any number of other methods which are appropriate for a given property. Overland flooding is when water collects around the building and finds entry from without the structure through window wells, basement cracks, or even through doors or windows when the water is that high. Floods are caused by many factors or a combination of any of these generally prolonged heavy rainfall (locally concentrated or throughout a catchment area), highly accelerated snowmelt, severe winds over water, unusual high tides, tsunamis, or failure of dams, levees, retention ponds, or other structures that retained the water. Flooding can be exacerbated by increased amounts of impervious surface or by other natural hazards such as wildfires, which reduce the supply of vegetation that can absorb rainfall.





## II. OBJECTIVES

- To develop a device and simple technique of flood detection and control in different villages for dam supply.
- To Manage time and level by using device of arduino controller software.
- To give openings for dam water and migration of people at critical level

## III. LITRATURE REVIEW

### 3.1 A Study on IOT Based Flood Detection Management System.

**C.K. Gomathy, G.G.Lasya Priya, Hemanth Kumar K.N**

Over the past few years we can see there is an occurrence of floods at different parts of the world almost every year. The technical advancements in recent years have made it easier to get a solution for these natural disasters. One of such technologies which takes us much closer to the internet is the “Internet of Things”. This paper consists of flood detection and avoidance system using the IOT technology. The sensors present in this are used to estimate the water levels, humidity, and temperature and send the real-time data to the cloud and the users can access the data via the mobile app. This model is widely used to alarm the people before a flood occurs and necessary precautions could be taken.

### 3.2 FLOOD DETECTION AND WATER MONITORING SYSTEM USING IOT BASED ON DISASTER MANAGEMENT SYSTEM.

**Mr. Bhushan M. Borhade, Miss. Kajal G. Date, Miss. Pooja U. Kahane, Miss. Rutuja B. Rasal, Miss. Komal S. Aher**

Now in recent years the natural disasters is a very important issue and this issue is occur in many more region like Kerala, Bhopal, and Malian. This issue is occur due to the global warming, Deforestation, Heavy use of unwanted chemicals. To reduce the effect of the disaster, a flood warning and monitoring are needed to give an early warning to the victims at a particular place with high prone to flood. Natural Disasters leads the vast loss of life and property damages in many countries. Hence we decided to implement one system that will help to our society from the losses. So the objectives of this project is to monitor the floods, fire, spark, landslides and send the alert in case of danger in the form of text message and call to take appropriate action. In this proposed system the detection section will consist of microcontroller and different sensors to detect the different situations like fire, floods, sparks, and landslides but firstly focuses on flood alert system. The system deal with monitoring and controlling the conditions with sensors and send the information to the peoples using Message and automated calls.

### 3.3 FLOOD DETECTION AND ALERT SYSTEM BASED ON IOT

**Aishwarya Jadhav, Harshvardhan Jadhav, Snehal Jalkote, Prof. Mr. V.B. Deokamble**

Floods are the most destructive and dangerous natural calamity in this world. On the event of flood, it can demolish the community and can affect many lives in different ways. It is very necessary to design a flood control device as a mechanism to reduce the flood. The application of this proposed structure is to remotely monitor and alert public user about the current flood conditions by continuously measuring the water level, rain fall reading and current temperature and humidity values. To accomplish this task various technologies are used such as messaging, live data feed via remote online platform named as Thing speak, video streaming & audio alerting etc. as we know messaging is most easy and convenient way to deliver messages using this advantage in appropriate possible way. This was fulfilled by using Twilio Messaging Platform instead of GSM Module making it more reliable & cost-effective system. And for the people willing to see live feed of the site YouTube live streaming was used & for alerting rural area user an audio buzzer was used. Using such technologies gave us efficient results for monitoring and alerting purposes making our aim satisfactory. As this proposed system mainly deals with safety of the society & its people so they can take necessary precautions before disaster occurs.

### 3.4 Design of Information Monitoring System Flood Based Internet of Things (IoT)

**1.Dedi Satria, 2. Syaifuddin Yana, 3. Rizal Munadi, 4. Samui Syahreza.**

The purpose of this paper is to develop prototype of the information system of the flood monitoring based internet of things (IoT). This prototype serves to assist users in accessing flood levels through water levels and rainy weather conditions. This paper presents the design of information system of flood monitoring based internet of things (IoT). This prototype study acquires water level and rainfall data using ultrasonic sensors HC-SR04 and rain sensor. Data of flood height and rain levels detected by sensors are processed using Arduino Uno Microcontroller to produce output data in HTML format. Flood altitude information system and rainy weather from the microcontroller are distributed using ethernet module as web server integrated with Wireless N Router TL-MR3020 as a gateway path to the user.



### 3.5 Flood Detection and Water Monitoring System Using IOT

1Minakshi Roy, 2 Parka Pradhan, 3 Jesson George, 4Nikhil Pradhan

we are now currently present in an era of Computing Technology; it is essential for everyone and everything to be connected to the internet. IOT is a technology that brings us more and more close to this goal. Our project comprises of smart water monitoring system which is a small prototype for flood detection and avoidance system. This paper explains the working and the workflow of all the components present inside our project. The sensors sense the environment and sends real-time data to the cloud (firebase cloud) and users can view and access this data via their mobile platform. The model gives a warning after the water level rises to a particular height. Since it is a small scaled prototype for flood detection and avoidance system, the working of this model is good. The data are uploaded and changed in the cloud in precision to the sensor and real-time changes in the mobile application is achieved. This model can be used to greatly reduce the casualties in a devastating event of flood.

### IV. METHODOLOGY

Some of the critical factors during a flood event are such as time, cost & plan.

Studies have been carried out in many possible ways to highlight the factors and effects of flooding towards mankind from time to time.

These factors play an important role for the researchers in development of the hardware and a complete system to assist authorities in monitoring flood prone locations in real time basis.

1. Developing a dam model having a flood level
2. Developing an algorithm for flood detecting device
3. Fixing of device in the dam model (detecting of water level in the dam model).

➤ Time

- Early Detection and Alert
- Respond To Alert
- Rescue Activities



Fig:01: operational chart of flood control

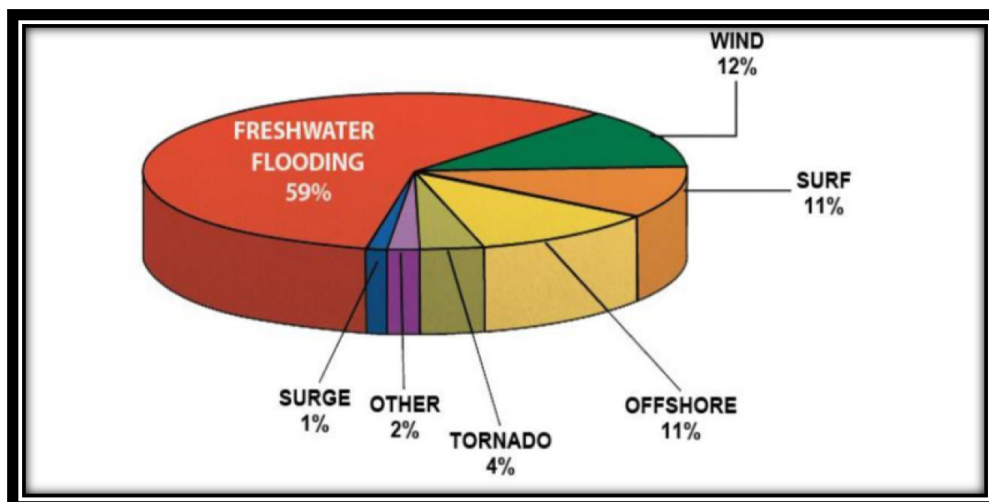


Fig.02: % of factors causing change in water levels



## V. DESIGN OF ARCHITECTURE AND ALGORITHM

In Logical Architecture 1 consider area & rainfall.

### Mathematics

$F = \{f_1, f_2, f_3, \dots\}$  Set of water flow rate measured by ultrasonic flow meter after fixed interval.

$L = \{l_1, l_2, l_3, \dots\}$  Set of water level measured by Water Level Indicator after fixed interval.

$R = \{r_1, r_2, r_3, \dots\}$  set of rain fall rate measured by Rain sensor after fixed interval.

$t$  = Threshold value for catastrophic situation.

$R \propto f$  If rate of rainfall increases the water flow rate also increase due to pressure created by water level on drainage system.

$L \propto f$  if water level increases the water flow rate also increase. If water flow level crosses a threshold and rain fall rate is also increasing or constant then there may be catastrophic situation.

If  $f/l = \text{constant}$  Then there is less chances of catastrophic situation or flooding condition. If  $f/l \geq t$  then there may be catastrophic situation or flooding condition.

$R$  = Rainfall Rate

$A$  = Area

$T$  = Fixed Time Interval

$P$  = Perimeter of Drainage Pipe

Collected Water =  $R * A * T$

Water Dispatched =  $F * P * T$

Remaining Water to Dispatch (RWD) = Collected Water - Water Dispatched

$RWD = \sum_{t=0}^n R_t * A * T - \sum_{t=0}^n F_t * P * T$

Water Level =  $RWD / A$

### Algorithm

Step 1: if rainfall then Step 2: Activate the system, initialize Water Level, Flow Rate, Rain Fall with its default values.

Step 3: do repeatedly

Step 4: calculate New Water Level, New Flow Rate, New Rain Fall Rate.

Step 5: if New Rainfall Rate > Rainfall Rate Then

Step 6: if New Flow Rate = Flow Rate AND New Water Level > Water Level Then

Step 7: check threshold and do the necessary action for catastrophic situation or flooding condition.

Step 8: end if

Step 9: if New Flow Rate > Flow Rate OR New Water Level > Water Level OR New Flow Rate > Flow Rate Then

Step 10: calculate probability of catastrophic situation by doing statistical analysis on available data

In Logical Architecture 2 consider time

(Flood Prediction Algorithm).

1:  $\emptyset$ : past flow

2:  $\theta$ : air temperature

3:  $\rho$ : rainfall

4:  $N$ : # past flow values used

5:  $Q$ : # rainfall values used

6:  $P$ : # air temperature values used

7:  $Y$ : predicted flow

8:  $e$ : prediction error      9:  $T$ : training time window

10:  $T$ : prediction lead time

$L$

11:  $T$ : recalibration time window

$R$

12:  $T_{TL} = T - T_L$

13:  $\triangleright$  Compute initial coefficients and prediction

14:  $\emptyset_N \leftarrow [\emptyset(1:T_{TL}-N), \dots, \emptyset(1+N:T_{TL})]$

15:  $\theta_P \leftarrow [\theta(1:T_{TL}-P), \dots, \theta(1+P:T_{TL})]$

16:  $\rho_Q \leftarrow [\rho(1:T_{TL}-Q), \dots, \rho(1+Q:T_{TL})]$





Fig no :3: Checking Water Levels with Arduino Uno Micro Controller

## VI. RESULT

1. The result of implementing such a system would be early detection of floods, allowing authorities and communities to take proactive measures to minimize damage and ensure public safety. By leveraging IoT technology, data from sensors can be transmitted in real-time, enabling timely alerts and efficient coordination of emergency response efforts.
2. This can potentially reduce the impact of floods on infrastructure, livelihoods, and the environment.
3. The Flood control Following Three Situation Can Occur In Particular Flood Water Level

- A) Under Level.
- B) Moderate Level
- C) Danger Level

## VII. CONCLUSION

- The application of urban flood control management system which is based on Internet of things technology provides comprehensive monitoring and pays more attention to the management of urban drainage and flooding prevention.
- It also provides operational services, conducts the monitoring and realizes the comprehensive supervision management, early warning management, and investigation management, which has not only improved the flood control decision making and drainage, but the city's flood control capacity is significantly improved.
- We described in this report architecture for predictive environmental sensor networks over large geographic areas. These systems are node-limited due to region size and cost constraints.
- They also have significant system requirements due to the real-time need for the data, destructive events, and long operational lifetime.
- Our sensor network solution addresses these requirements, consisting of two communication tiers, four node types, and support for a variety of sensor types. We focused on the event of river flooding.
- The report describes our work on the flood prediction algorithm that will eventually run on the system and the implementation of the sensor network architecture for this application.
- Future work involves adding the flood prediction algorithm to the network and connecting the Dover sensors through the computation nodes to MIT.
- This will provide a sufficient enough test for us comfortably plan a permanent system installation in India, a further test of the practicality and robustness of the system.



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# Analysis of the Liquefaction Potential Using In-Situ and Laboratory Test

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**ABSTRACT:** This project aims to analyze the liquefaction susceptibility of Pune Area. The Pune Area of specific data related to Standard Penetration Tests data are collected for determination of liquefaction susceptibility of these sites by using SPT test from these procedures, shear stresses due to earthquake or settlements of structures are evaluated using SPT test for liquefaction analysis of soils. Liquefaction which can be defined as a loss of strength and stiffness in soils is one of the major causes of damage to buildings and infrastructure during an earthquake. This report provides basic knowledge about the liquefaction of cohesionless soils under seismic loading. Presented also are the most widely accepted methods for evaluating the liquefaction potential of cohesionless soils in level ground, for estimating earthquake-induced settlements. Liquefied soil loses its density and strength and damages the structures. Analysis of soil liquefaction is essential for assessing and mitigating the risks associated with this geotechnical phenomenon, ensuring infrastructure safety, and contributing to earthquake-resistant construction practices. We calculate CSR and CRR from the SPT (Standard Penetration Test) Data. From CSR and CRR we calculate the FOS (Factor of Safety). If the FOS is less than 1 then it has liquefaction Potential.

**KEYWORDS:** Liquefaction, SPT Test, Earthquake, CRR, CSR, FOS.

## I. INTRODUCTION

Soil liquefaction is a major geotechnical hazard that occurs when soil loses its strength and stiffness due to earthquake-induced cyclic loading and behaves like a fluid. Liquefaction can cause severe damage to structures and infrastructures, such as settlement, tilting, cracking, and collapse. Therefore, it is essential to analyze the liquefaction potential of soil before designing and constructing any project in seismic-prone areas. Liquefaction of soil is a phenomenon in which saturated or partially saturated soil temporarily loses its strength and behaves like a liquid during seismic activity or other rapid loading conditions. This occurs when the water pressure within the soil pores increases to the point where it exceeds the soil's ability to support the weight or load on it, causing the soil particles to lose contact and allowing them to move freely, resembling a liquid-like state. Liquefaction can lead to ground instability, settlement, and potential damage to structures built on or in the affected. Analysis of soil liquefaction is essential for assessing and mitigating the risks associated with this geotechnical phenomenon, ensuring infrastructure safety, and contributing to earthquake resistant construction practices. Various methods have been developed to evaluate the liquefaction potential of soil, such as laboratory tests, field tests, and numerical analysis. Some of the commonly used methods are the standard blasting test, ground response analysis, cone penetration test (CPT), and standard penetration test (SPT). These methods are based on different principles and assumptions and have their advantages and limitations. One of the most widely used methods for evaluating the liquefaction potential of soil is based on the data obtained from the standard penetration test (SPT). The SPT is a field test that measures the resistance of soil to penetration by driving a split spoon sampler into the ground using a standard hammer and drop height. The number of blows required to drive the sampler for a certain distance is recorded as the SPT blow count (N). The SPT blow count reflects the relative density and shear strength of the soil and can be used to estimate its liquefaction resistance. However, the SPT data are affected by various factors such as overburden pressure, hammer efficiency, borehole diameter, rod length, and soil type. Therefore, the SPT data need to be corrected and normalized before using them for liquefaction analysis. Moreover, different procedures and criteria have been proposed to calculate the cyclic stress ratio (CSR) and the cyclic resistance ratio (CRR) of the soil based on the SPT data and to compare them with a factor of safety (FOS) against liquefaction. The soil is considered to be liquefiable if the FOS is less than 1.



## II. LITERATURE REVIEW

1. V.K. Dwivedi, R.K. Dubey, S. Thockhom, V. Pancholi, S. Chopra and B.K. Rastogi, “ Assessment of Liquefaction potential of soil in Ahmedabad Region”, Western India, J. Ind. Geophys. Union, V.21, no.2, pp: 116-123, March 2017. The author discusses the importance of estimating liquefaction resistance, known as the Cyclic Resistance Ratio (CRR), in geotechnical earthquake engineering. They focus on assessing the liquefaction potential of soil in the Ahmedabad city area, which primarily comprises sandy to silty sediments and has experienced significant construction activities recently. The first step the researcher is going to conduct the geological investigation on the Ahmedabad region. He collected data from Standard Penetration Tests (SPT) conducted in 23 boreholes. Then the researcher calculated the factor of safety (FS) against liquefaction, with a focus on comparing earthquake-induced loading (characterized by the Cyclic Stress Ratio, CSR) with liquefaction resistance (represented by the Cyclic Resistance Ratio, CRR). Various empirical formulas and correction factors are used to estimate these parameters based on Standard Penetration Test (SPT) data. Results from the liquefaction assessment indicate that the majority of soil samples in the Ahmedabad city area are classified as non-liquefiable, with only a small percentage categorized as marginally liquefiable or liquefiable. He concludes that the different parameters analyzed in the present study indicate high compaction and low water table which give high SPT N-values. Hence it can be concluded that the study area is safe for construction.

2. Jagabandhu Dixit .D. M. Dewaikar R. S. Jangid, “Soil liquefaction studies at Mumbai city”, Natural Hazards and Earth System Sciences,2012.

The study assesses soil liquefaction susceptibility in Mumbai, India, a major economic hub situated along the western coast. The city's reclaimed land predominantly consists of alluvium, sand, and recent conglomerate. Using standard penetration test data, the study quantifies liquefaction susceptibility based on factors such as earthquake-induced cyclic stress and soil resistance. The factor of safety against liquefaction is evaluated at various sites for two peak ground acceleration (PGA) levels, corresponding to different return periods. Contour maps illustrate liquefaction vulnerability across the city for a seismic event of magnitude Mw 6.5. These contour maps show the information vulnerability at different sites of the city. The seismic site classification is based on SPT N values complying with the International Building Code (IBC 2003) and provisions in the National Earthquake Hazards Reduction Program (NEHRP). Raghukanth and Iyengar (2006) for the analyses are 0.18 and 0.30 g corresponding to 10 and 2 % probability of exceedance in 50 years, respectively, for different magnitudes of earthquake.

3. Neelima D. Satyam and Ikuo Towhata, “Site-specific ground response analysis and liquefaction assessment of Vijayawada city (India)”, Springer Science Business Media Dordrecht,(2015).

This study concludes that the city is vulnerable to seismic risks due to its geological and geotechnical characteristics, including the presence of recent alluvium and higher groundwater levels. In this paper, the liquefaction potential of Vijayawada City is estimated using the ONDA program. The tool uses SPT data to determine dynamic soil properties, and then the peak ground acceleration (PGA) at the surface is calculated at each location which is used for the evaluation of the factor of safety against liquefaction. In this site, the thickness of the alluvium in some of the areas is estimated to be of the order of 150 m. Geological Survey of India (GSI) carried out deep drilling at some locations in the city and could not find the bedrock depth up to 140 m below the ground. The geotechnical data show that the study area has four major soil types, namely black cotton (58 %), sandy clay loams (23 %), red loams (17 %), and sandy soils (2 %). Most of the city is covered by alluvium, and sandy clay loams are formed along the river. Vijayawada city is located along the stream of Krishna River and is covered by dominant amounts of alluvium. Ground response analysis will be useful for the prediction of local site effects and for estimating the dynamic behavior of the soil during seismic loading. To assess the peak frequency and amplitude of vibration, microtremor testing was adopted in the area of study. From the study, it is observed that almost all the locations that are near the water bodies are within the risk. Vijayawada could experience a Peak Ground Acceleration (PGA) of up to 0.27 g and a Peak Ground Velocity (PGV) of up to 8 cm/s, indicating a moderate to high seismic hazard. A map with the comparison of the Liquefaction potential index and PGV was generated for further damage estimation.

## III. METHODOLOGY

### 1) Data Collection:

Collect in-situ SPT (Standard Penetration Test) data from Pune area. This data include SPT blow counts at different depths.

### 2) Laboratory Testing:

Standard penetration test: This test measures the resistance of soil to penetration by a standard-sized sampler drop from standard height. The number of blows required to penetrate the soil at a certain 15 m depth is recorded. This test provides information for evaluating liquefaction potential.

Conduct laboratory tests on the soil samples, which may include:

- a) Grain size analysis
- b) Specific gravity tests
- c) Atterberg's tests



Fig.1: Taking Sample Weights



Fig.2: Sieve Analysis

### 3) Data Analysis:

- A. Process and analysis the collected SPT data: Gather all SPT data points from the field. Organize the data into a spreadsheet or database format for easy manipulation. Check for any inconsistencies or errors in the data. Remove any outliers or erroneous readings.
- B. Calculation of corrected blow counts: Apply corrections to the raw SPT blow counts based on factors such as rod length, energy efficiency, and hammer type. Use established correction equations or standards to ensure accuracy. We double-check calculations to minimize errors.
- C. Plotting SPT-N values against depth. Create a depth versus SPT-N value plot using suitable software like, LiqIT EXCEL etc. Label axes appropriately to indicate depth and SPT-N values. Plot each data point accurately to visualize variations with depth.

### 4) Analyze the plotted data to identify distinct soil layers based on changes in SPT-N values:

Use established methods such as visual inspection, clustering algorithms, or statistical analysis to delineate soil boundaries. Characterize each soil layer based on its typical SPT-N range, grain size distribution, moisture content, and other relevant properties.

### 5) Calculation Steps:

#### 5.1 Calculation of cyclic shear stress Ratio (CSR):

$$CSR = 0.65 \left( \frac{\sigma_{vo} a_{max}}{\sigma'_{vo}} \right) r_d$$

Where,

$a_{max}$  = maximum horizontal acceleration at the ground surface

$\sigma_{vo}$  = total vertical stress

$\sigma'_{vo}$  = effective vertical stress at depth

$z$  = depth (m)

$r_d$  = stress reduction coefficient that accounts for the flexibility of the soil column

**3.1.1 Stress reduction coefficient (rd):** is expressed as a function of depth ( $z$ ) and earthquake magnitude ( $M$ ):

$$\ln(r_d) = \alpha(z) + \beta(z)M$$

$$\alpha(z) = -1.012 - 1.126 \sin\left(\frac{z}{11.28} + 5.133\right)$$

$$\beta(z) = 0.106 + 0.118 \sin\left(\frac{z}{11.28} + 5.142\right)$$

where,

$z$  = Depth (m)

$M$  = Magnitude of earthquake

$r_d$  = Stress reduction coefficient

$$MSF = 6.9 \exp\left(\frac{-M}{4}\right) - 0.058$$

where;

$M$  = Magnitude of the earthquake

The MSF should be less than equal to 1.8

The coefficient  $C_\sigma$  is expressed in terms of  $(N_1)_{60}$

$$C_\sigma = \frac{1}{18.9 - 2.55\sqrt{(N_1)_{60}}}$$

where,

$(N_1)_{60}$  is limited to a maximum value of 37 and 211 respectively

(i.e., keeping  $C_\sigma$  less than equal to 0.3)

$$K_\sigma = 1 - C_\sigma \ln\left(\frac{\sigma'_{vo}}{cd}\right) \leq 1.0$$

### 3.2 Calculation of Cyclic Resistance Ratio (CRR):

Boulanger and Idriss (2004) adjusted the equation of CRR to an equivalent clean sand value as follows:

$$CRR = \exp\left(\frac{(N_1)_{60cs}}{14.1}\right) + \left(\frac{(N_1)_{60cs}}{126}\right)^2 - \left(\frac{(N_1)_{60cs}}{23.6}\right)^3 + \left(\frac{(N_1)_{60cs}}{25.4}\right)^4 - 2.8$$

Subsequent expressions describe the way parameters in the above equation are calculated as:

$$\begin{aligned} (N_1)_{60cs} &= (N_1)_{60} + \Delta(N_1)_{60} \\ \Delta(N_1)_{60} &= \exp\left(1.63 + \frac{9.7}{FC} - \left(\frac{15.7}{FC}\right)^2\right) \\ (N_1)_{60} &= C_N(N)_{60} \\ C_N &= \left(\frac{65.76}{\rho'_\alpha}\right)^{\frac{1}{2}} \end{aligned}$$

where,

$(N)_{60}$  - SPT 'N' value after correction to an equivalent 60% hammer efficiency

$C_N$  - Overburden Correction Factor for Penetration resistance

$\rho'_\alpha$  - Effective overburden pressure in KN/m<sup>2</sup>

FC - Fine contents

### 3.3 Calculation of Factor Of Safety (FOS):

If the cyclic stress ratio caused by an earthquake is greater than the Cyclic Resistance Ratio (CRR) of the in-situ soil, then liquefaction could occur during the earthquake and vice-versa. The Factor of Safety against liquefaction is defined as:

$$FS_{Liq} = \frac{CRR}{CSR}$$

Liquefaction is predicted to occur when  $FS \leq 1.0$ , and liquefaction predicted not to occur when  $FS > 1$ . The higher the factor of safety, the more resistant against liquefaction.

## IV. RESULT AND DISCUSSION

This study investigates the liquefaction potential of soil through the Standard Penetration Test conducted in the Pune. The SPT (Standard Penetration Test) Data sets were used to determine Cyclic Resistance Ratio (CRR) and Cyclic Stress Ratio (CSR) by Idriss and Boulanger method. FOS (Factor Of Safety) we get from the Cyclic Resistance Ratio (CRR) and Cyclic Stress Ratio (CSR) is more than 1 for all the three boreholes indicating that these areas are safe from the liquefaction. Value of FOS for sandy and gravel soil is less compared to other soil which means it has more potential to liquefaction. Hence it can be concluded that the this region is safe from danger of liquefaction and also safe for construction development activities but the detailed investigation is required for more accurate results.

Table 1: Ground Water Level

Sr no	Depth (Z) m	SPT value	CSR	CRR	FS <sub>Liq</sub>	Status
1	1.5	0.9885	0.0608	0.6402	10.53	Safe
2	3	0.977	0.0697	0.5124	7.35	Safe
3	4.5	0.9655	0.0743	0.2541	3.42	Safe
4	6	0.9541	0.794	0.2185	2.75	Safe
5	7.5	0.9425	0.0854	0.2197	2.57	Safe

Table 2: Study about liquefaction potential for borehole 1

Borehole No	Depth Below Ground Level (Mtr.)
BH-1	At 6.0m
BH-2	At 4.5 m
BH-3	At 4.5m

Table 3: Study about liquefaction potential for borehole 2

Sr no	Depth (Z) m	SPT value	CSR	CRR	FS <sub>Liq</sub>	Status
1	1.5	0.9885	0.05	13.1607		Safe
2	3	0.977	0.043	0.4503		Safe
3	4.5	0.9655	0.0749	0.06288	14.62	Safe
4	6	0.9541	0.0871	0.476	1.6946	Safe
5	7.5	0.9425	0.0863	0.1707	2.0822	Safe
6	9	0.9321	0.851	0.14831	0.1742	Safe

Table 4: Study about liquefaction potential for borehole 4

Sr. no	Depth (Z) m	SPT value	CSR	CRR	FS <sub>Liq</sub>	Status
1	1.5	0.9885	0.0569	2.1354	37.5289	Safe
2	3	0.977	0.0704	0.4339	6.1633	Safe
3	4.5	0.9655	0.071	3.3023	46.51126	Safe
4	6	0.9541	0.0764	31.660	8	Safe
5	7.5	0.9425	0.0767	24.86	3.7379	Safe

## V. CONCLUSION

Based on the analysis conducted in the area of Pune, it can be concluded that the selected location is relatively secure against liquefaction. The selected area also lies in zone III, which is a moderate damage zone. Based on the limited





study conducted in this paper, we concluded that there is a lower chance of liquefaction affecting this area that does not mean that liquefaction will not occur but there are possibilities of liquefaction to occur if very large magnitude earthquake occurs. Remedial measures for liquefaction, such as soil reinforcement, groundwater management, structural retrofitting, and land use planning, can strengthen the area's ability to withstand liquefaction risks. For more accurate results, we need to analyze more boreholes, and the results should be cross-checked with other methods such as Cone Penetration Test (CPT), Shear Wave Velocity Testing, Cyclic Triaxial Testing can provide complementary insights for more comprehensive site assessment.

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# Revenue Generation from Residential Waste - A Case Study

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**ABSTRACT:** Waste management has become a critical challenge for municipalities worldwide, with increasing waste generation and limited landfill capacities. Traditional waste disposal methods are often costly and environmentally damaging, prompting the need for innovative and sustainable approaches. Revenue generation from waste offers a promising solution, transforming waste from a liability into a valuable resource. This explores the multifaceted approach to solid waste management, emphasizing the categorization of waste into dry and wet components. The focus of this study is on the innovative strategies employed for revenue generation within the waste management framework. The comprehensive process begins with efficient collection methodologies, utilizing advanced techniques for the identification and segregation of waste types. By emphasizing recycling initiatives, the study underscores the importance of reducing and reusing materials, thereby minimizing the burden on landfills and promoting sustainability. The integration of these elements into waste management not only addresses environmental concerns but also presents lucrative opportunities for revenue generation. This highlights the potential economic benefits arising from the careful management of solid waste, offering insights into a holistic and financially viable approach to waste disposal and resource utilization. Revenue generation from waste offers a multitude of benefits. It reduces the financial burden of waste disposal, promotes environmental sustainability by diverting waste from landfills, and creates new jobs and business opportunities. By transforming waste into valuable resources, revenue generation contributes to a circular economy, where waste is no longer a burden but a source of value.

**KEYWORDS:** Solid Waste Management, Segregation, Biodegradable, & Non-Biodegradable, 3Rs, Waste to Wealth.

## I. INTRODUCTION

In a world grappling with the ever-increasing burden of waste, a new paradigm is emerging, transforming waste from a mere disposal challenge into a lucrative economic opportunity. This transformation, driven by the principles of sustainability and circular economy, highlights the immense revenue-generating potential of effective waste management practices. At the heart of this transformation lies the concept of solid waste management, which encompasses the collection, transportation, treatment, and disposal of solid waste. This intricate process, when implemented efficiently, can unlock a wealth of revenue streams, particularly in densely populated residential areas. The key to unlocking this revenue potential lies in the segregation of waste into two primary categories: dry waste and wet waste. Dry waste, comprising materials like plastic, metal, and paper, holds significant value for recycling and repurposing. Wet waste, on the other hand, can be processed into organic compost, a valuable soil amendment for agriculture and landscaping. The revenue-generating potential of waste management extends beyond the mere sale of recyclable materials and compost. Efficient waste collection systems, often outsourced to private companies, generate substantial revenue streams through service fees. Additionally, the identification of valuable waste streams, such as e-waste or construction waste, can open up new avenues for revenue generation through specialized treatment and recovery processes. The efficient management of solid waste in residential areas stands as a pivotal challenge. As populations grow and consumerism burgeons, so does the volume of waste generated, necessitating a strategic and sustainable approach to solid waste management. This study focuses on the nuanced handling of both dry and wet waste, recognizing the distinct characteristics of each and emphasizing the importance of tailored solutions for their proper disposal. Beyond the conventional notions of waste management, the study takes a proactive stance by exploring avenues for revenue generation within this framework.

## II. LITERATURE REVIEW

**Tanwi Trushna (2024)** This paper represents “Interventions to promote household waste segregation: A systematic review”. Waste segregation at source, particularly at the household level, is an integral component of sustainable solid waste management, which is a critical public health issue. Although multiple interventions have been published, often

with contradictory findings, few authors have conducted a comprehensive systematic synthesis of the published literature.

**Afzal Husain khan (2022)** This paper represents “Evaluation of cost benefit analysis of municipal solid waste management systems” Stated to analyses the municipal solid waste management (MSWM) activities in India’s capital, Delhi, and the CBA of MSWM systems to identify the major problems and limitations involved. locations, including the sources of generation, composting plants, and disposal sites. Storage, collection, transportation, and recycling information were gathered from departments such as Municipal Corporation of Delhi (MCD), New Delhi Municipal Corporation (NDMC), Central Pollution Control Board (CPCB), and self-surveys. The total costs of each MSW option were calculated for cost analysis

**Husna Abdul Halim (2022)** This paper represents “Study of Household Waste Management and Recycling Awareness Between Residential Areas in Kuala Nerang, Kedah, Malaysia” Residential areas are the major sources of solid waste as that is where people live. The waste that is usually disposed of from residential areas includes food waste, plastic waste. paper, glass, tin, and others. The increasing trend in waste generated from homes has become a major concern. This study aimed to assess household waste management and recycling awareness in two residential areas The research shows that household waste management to segregate the waste remains a problem, despite most respondents being aware of this issue through different media. Furthermore, the lack of household waste management and recycling programs and facilities by the local authorities caused residents to be reluctant to practice these activities.

**Mona S.M. Mansour (2018)** This paper represents “Solid waste issue: Sources, composition, disposal, recycling, and valorization”. Disposal of solid wastes is a stinging and widespread problem in both urban and rural areas in many developed and developing countries. Municipal solid waste (MSW) collection and disposal is one of the major problems of urban environment in most countries worldwide today.

**Konstantinos Kalkanis (2022).** This paper represents “Transforming Waste to Wealth, Achieving Circular Economy” This paper attempts to identify and present the valuable resources and products that exist in waste streams, focusing mainly on their monetary value, based on data recovered from literature and raw materials stock markets

### III.METHODOLOGY AND DISCUSSION

The methodology for studying revenue generation from residential waste involves conducting surveys or interviews to understand current waste management practices, analysing data on waste composition and quantity, assessing potential revenue streams such as recycling or composting, and evaluating economic feasibility through cost-benefit analysis. Additionally, exploring case studies or existing models can provide insights into successful strategies for generating revenue from residential waste.

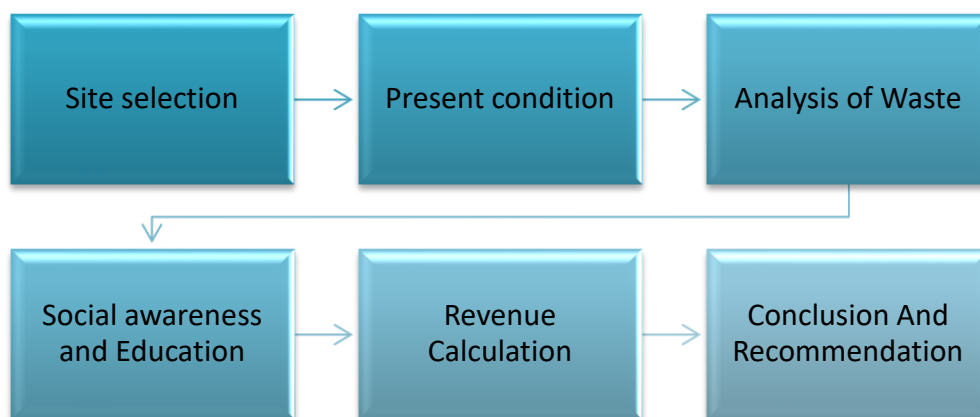


Fig No 1: Methodology of Project

#### Brief explanation of procedure involved

##### 1.Site selection

For site selection in a study of revenue generation from residential waste factors like land availability, accessibility, and community acceptance play crucial roles in determining suitable sites for waste management activities aimed at revenue generation.

## 2. Current Scenario:

Currently, a large portion of waste is not, which makes it difficult to recycle and process. This can lead to environmental pollution and other problems Segregating waste at the source can help reduce these issues and promote a more sustainable waste management system



Fig No:2 Residential Collection

## 3. Analysis of Waste

### 3.1 Waste Segregation

Waste segregation is the biggest obstacle for effective solid waste management. It is common in developed countries like US, Europe and Japan, but countries like India most often collect MSW in a mixed form. It is mainly because of lack of public awareness and advancements in source separation techniques. However, paper and certain type of plastics are separately collected at source level by waste pickers or waste buyers Source separation increases recycling efficiency. It also improves performance of waste treatment units due to good quality of feed and lesser number of impurities.

### Classification of waste

Type of waste	Description	sources
Food Waste	Waste obtained as a result of preparation, cooking and serving of food.	Household waste
Rubbish Waste	There are two types: i. combustible (primarily organic)—tissue paper, cardboard, paper, cartons, wood, boxes, clothes, leather, bedding, grass, leaves, plastic, etc., and ii. non-combustible (primarily inorganic)—metals, glass, etc.	Household waste
Ashes and residues	Waste obtained from the cooking of food	Household waste

Table No 1: Types of Waste

## IV. DATA COLLECTION AND ANALYSIS

### 4.1 Data Collection Methods

#### 4.1.1 Surveys and Questionnaires:

Distribute surveys to households to gather data on waste generation, management practices, and attitudes towards recycling.

#### 4.1.2 Waste Audits:

Conduct physical audits of household waste to quantify and categorize the waste generated.



#### 4.1.3 Interviews and Focus Groups:

Hold interviews and focus groups with residents, waste management professionals, and local government officials to gain qualitative insights.

#### 4.1.4 Secondary Data Collection:

Gather existing data from local government records, waste management companies, and market reports on recyclable materials and waste-to-energy technologies.

One day sample data dry segregated waste

SR.NO	PARAMETERS	WT(KG)
1.	PAPER	0.182
2.	GLASS	0.1
3.	METAL	2
4.	PLASTIC	0.1
6.	CARDBOARD	0.2
7.	GARDEN WASTE	0.3
	<b>TOTAL</b>	<b>2.882</b>

Table No 2: Dry waste sample data

### V.DISCUSSION AND SOLUTION

Types of Waste	The Technology Available for Processing	Benefits
Paper	Paper recycling	<ul style="list-style-type: none"> <li>• End-use appliances for paper recycling generate writing a quality paper.</li> <li>• Runs successfully as a social model.</li> <li>• Efficiency is improving at a higher rate.</li> </ul>
plastic	Incineration	<ul style="list-style-type: none"> <li>• Converts the solid waste into usable energy.</li> <li>• No external fuel requirement.</li> <li>• Easy Incineration Process. and Efficiency is high.</li> </ul>
Metal and Glass	Metal recycling and Glass recycling	<ul style="list-style-type: none"> <li>• Energy and natural resources are conserved</li> <li>• Metal recycling conserves landfill space</li> <li>• Create green jobs</li> <li>• Efficiency is high</li> </ul>

Table No 3: Solution for Dry waste

#### Solutions for Revenue Generation

##### 1. Implementation of a Comprehensive Waste Management Plan:

Develop a plan that includes segregation, collection, processing, and marketing of different waste streams. Engage stakeholders, including residents, local businesses, and municipal authorities.

##### 2. Partnerships with Recycling Companies:

Partner with local recycling firms for regular collection and processing of recyclable materials. Negotiate favourable terms to ensure a steady revenue stream.





### 3. Investment in Composting and Biogas Plants:

Allocate funds for the setup of community composting units and biogas plants.  
Utilize the produced compost and biogas for local use or sell them to generate revenue.

### 4. Promotion of Upcycling Ventures:

Encourage local artists and entrepreneurs to create upcycled products from waste materials.  
Provide platforms such as community fairs or online marketplaces for selling these products.

### 5. Government and NGO Collaboration:

Collaborate with government bodies and non-governmental organizations to access grants and technical support.  
Leverage policy support and funding opportunities for waste management projects.

## VI. RESULTS

### REVENUE CALCULATION

SR.NO.	CATEGORY OF WASTE DRY WASTE	RATE OF WASTE RATE/KG
1.	PLASTIC	10
2.	PAPER	17
3.	GLASS	3
4.	BOTTLES	20
5.	CARDBOARD	8
6.	METAL	22

Table No 4: Rate of Dry waste

#### PAPER

Paper can be sold at 17 Rs/kg (varying according to region) For recycling unit.

Calculate the weight of paper generated in one month:

Weight per day = 0.182 kilograms

Number of days in a month = 30 (assuming a typical month)

Total weight in one month = 0.182 kg/day \* 30 days = 5.46 kg

#### Calculate the revenue:

Price per kilogram = 17 Rs

Total revenue = Total weight \* Price per kilogram

= 5.46 kg \* 17 Rs/kg

= 92.82 Rs

#### PLASTIC

Plastic from segregated unit can be sold at 10 Rs/kg for recycling unit.

Calculate the weight of plastic generated in one month:



Weight per day = 0.1 kilograms  
Number of days in a month = 30 (assuming a typical month)  
Total weight in one month = 0.1 kg/day \* 30 days = 3 kg

#### Calculate the revenue:

Price per kilogram = 10 Rs  
Total revenue = Total weight \* Price per kilogram  
= 3 kg \* 10 Rs/kg  
= 30 Rs

#### METAL

Total metal generated = 60 Kg  
Rate per kg = 22 Rs  
Total cost after selling metal waste = 60 \* 22 = 1320 Rs.

#### GLASS

Total Glass generated = 3 Kg  
Rate per kg = 3 Rs  
Total cost after selling metal waste = 3 \* 3 = 9 Rs.

**TOTAL REVENUE GENERATED IN MONTH = 1450 (Approximate)**

### VII. CONCLUSION

- As waste management being a challenging issue, an attempt to manage waste at the source is initiated.
- A segregation at the waste is done on the basis of biodegradable & non-biodegradable waste. Non-biodegradable that is dry waste is segregated and a proper value for the waste is achieved at local level.
- The revenue generated from the segregation gives an idea about how waste can be converted to revenue.
- Using this model with people participation, a burden on the societies and agencies can reduce landfill and soil pollution can also be minimized.

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# Impact of Social Media Engagement on Attention Span with the Mediating Role of Well Being

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**ABSTRACT:** This study investigates the intricate dynamics between social media engagement, attention span, and well-being. Drawing upon established theories and previous research, the research delves into how social media activities influence individuals' attention spans, with well-being acting as a potential mediator. Utilizing a comprehensive cross-sectional research design, data were collected from a diverse sample size through a structured questionnaire employing Likert scale responses. Employing advanced statistical techniques such as correlation analysis and regression modelling, the study elucidates the relationships among social media engagement, attention span, and well-being. Preliminary findings suggest significant correlations between social media engagement, attention span, and well-being, with regression analysis demonstrating the predictive power of social media engagement on attention span, mediated by well-being. This research contributes to a better understanding of how social media engagement and well-being influences attention span, offering actionable insights for individuals and policymakers to foster healthier digital habits and enhance overall well-being in the digital age.

**KEYWORDS:** Social Media Engagement (SME), Well Being and Attention Span.

## I. INTRODUCTION

The widespread influence of social media in the modern digital era has fundamentally transformed the fabric of human interaction, communication, and information dissemination. With the ubiquitous presence of social networking platforms such as Facebook, Instagram, Twitter, and TikTok, individuals are constantly immersed in a virtual realm characterized by incessant streams of content, connectivity, and engagement. This phenomenon of social media engagement, defined as the active participation and interaction within online social networks (Kaplan & Haenlein, 2010), has emerged as a defining feature of modern society, shaping not only interpersonal relationships and communication patterns but also cognitive processes and psychological well-being.

Amidst this backdrop, the present research endeavours to delve into the multifaceted implications of social media engagement on attention span and well-being, with a particular focus on the intermediary role played by psychological well-being. Titled "Impact of Social Media Engagement on Attention Span and the Intermediating Effect of Well-Being," this study seeks to unravel the intricate dynamics underlying the relationships between these constructs, shedding light on how the incessant exposure to social media content and interactions may influence individuals' cognitive capacities, emotional states, and overall quality of life.

Drawing upon established theories and empirical evidence from the fields of psychology, communication studies, and digital media, this research aims to contribute to a deeper understanding of the complex interplay between social media engagement, attention span, and well-being. By synthesizing insights from seminal works such as the Cognitive Load Theory (Sweller, 1988), the Attention Restoration Theory (Kaplan & Kaplan, 1989), and the Transactional Model of Stress and Coping (Lazarus & Folkman, 1984), this study seeks to elucidate the underlying mechanisms through which social media engagement may impact individuals' cognitive functioning and psychological health. Moreover, by adopting a comprehensive research framework encompassing both quantitative and qualitative methodologies, including survey-based assessments, experimental manipulations, and in-depth interviews, this research endeavours to provide a nuanced understanding of the nuanced relationships between social media engagement, attention span, and well-being. Through rigorous statistical analyses, including mediation and moderation analyses, this study aims to delineate the direct and indirect effects of social media engagement on attention span, as well as the moderating influence of psychological well-being on these relationships.



By unravelling the intricacies of social media's impact on attention span and well-being, this research seeks to offer actionable insights for individuals, policymakers, and digital media practitioners alike. Ultimately, by fostering a deeper awareness of the cognitive and psychological implications of social media engagement, this study aims to empower individuals to make informed decisions about their digital consumption habits and enhance their overall well-being in an increasingly interconnected world.

## **II. REVIEW OF LITERATURE**

### **2.1 SOCIAL MEDIA ENGAGEMENT**

#### **Title: Linkage of Social Media Engagement with FOMO and Subjective Well-Being**

The study delves into the intricate relationship between social media engagement, fear of missing out (FOMO), and subjective well-being among college students. In today's digital age, where social media plays a pivotal role in daily interactions, understanding how these factors interplay is crucial for assessing the well-being of young individuals.

Stead and Bibby (2017) explored the relationship between personality traits, FOMO, problematic internet use, and subjective well-being, emphasizing the need to understand how these factors interact to influence individuals' overall well-being. Additionally, Sampasa-Kanyinga and Lewis (2015) found a correlation between frequent social networking site use and poor psychological functioning among children and adolescents, shedding light on the potential negative effects of excessive social media engagement.

Moreover, Santor (2000) investigated the influence of peer pressure, popularity, and conformity on adolescents' school performance, sexual attitudes, and substance abuse, indicating the intricate web of social factors that can impact well-being outcomes. SB et al. (2015) examined the longitudinal effects of social network characteristics on the subjective well-being of older adults, emphasizing the importance of social support in enhancing well-being.

The study collected data from 324 undergraduate and post-graduate students across various disciplines, utilizing a research model to analyze the relationships between social engagement, FOMO, and subjective well-being. The sample demographics revealed a mix of age groups, genders, educational qualifications, and social media usage patterns, providing a comprehensive overview of the participants.

The research model developed for the study elucidated the mediating role of FOMO between social engagement and subjective well-being among college students. By showcasing the robust influence of FOMO in the current digital landscape, the study contributes to existing literature by highlighting the nuanced dynamics of social media engagement and its impact on well-being outcomes.

While the study provides valuable insights into the interplay of social media, FOMO, and subjective well-being among college students, it acknowledges limitations such as the restricted sample size and scope. Future research directions could involve cross-cultural validations and extending the study to different sectors to generalise the findings and explore diverse contexts.

In conclusion, the research paper on the linkage of social media engagement with FOMO and subjective well-being offers a comprehensive analysis of the complex relationships shaping young individuals' well-being in the digital era. By unraveling the mediating role of FOMO, the study underscores the importance of understanding how social media interactions influence subjective well-being outcomes among college students.

### **2.2 WELL BEING**

#### **Title: Social media use and well-being: What we know and what we don't know**

The pervasive use of social media has sparked concerns about its impact on mental health and well-being, particularly regarding the relationship between social media engagement, the fear of missing out (FOMO) - the anxiety of missing rewarding experiences others are having, and subjective well-being - encompassing individuals' overall satisfaction with life across emotional, psychological, physical, and social dimensions. This study aims to explore how social media engagement, FOMO, and subjective well-being intersect, offering insights into the complexities of individuals' experiences in the digital age and guiding the development of strategies to support well-being.

In her article "Social Media Use and Well-being: What we know and what we need to know," Patti M. Valkenburg delves into the intricate relationship between social media usage and individual well-being. She emphasises the importance of understanding the impact of social media on mental health, stating, "The effects of social media on well-being are complex and multifaceted, requiring a nuanced approach to research and interpretation". Valkenburg's work





synthesises existing research findings to shed light on both the positive and negative effects of social media on well-being.

Research indicates that excessive social media use can be linked to negative outcomes such as increased loneliness, depression, and anxiety. Valkenburg highlights the role of social comparison in shaping individuals' self-perceptions and emotional well-being, noting, "Curated online personas can contribute to feelings of inadequacy and low self-esteem". This suggests that the way individuals present themselves on social media platforms can influence their mental health and well-being.

Despite these potential negative effects, social media also offers benefits for well-being. Valkenburg points out that social media provides opportunities for social connection, self-expression, and information sharing, which can enhance individuals' overall well-being. By acknowledging the positive aspects of social media use, Valkenburg encourages a balanced perspective that considers both the risks and benefits associated with online interactions.

In her analysis, Valkenburg explores the underlying mechanisms that may explain the relationship between social media use and well-being. She discusses concepts such as social comparison theory and self-presentation, highlighting how these psychological processes influence individuals' experiences on social media platforms. By understanding these mechanisms, researchers can better grasp why certain patterns of social media use led to specific outcomes for individuals' well-being.

Moreover, Valkenburg raises important questions about the role of technology design and platform algorithms in shaping user behaviour and emotional responses. She emphasizes the need for greater transparency and accountability from social media companies, stating, "Design choices and algorithms can influence how individuals interact online and impact their well-being". This highlights the ethical considerations surrounding technology use and its implications for mental health.

While Valkenburg's article provides a comprehensive overview of the current research on social media and well-being, she also identifies gaps in knowledge that require further exploration. Longitudinal studies tracking individuals' social media use over time and assessing its impact on well-being are needed to understand the long-term effects of online interactions. Additionally, research with diverse samples representing various demographics can offer insights into how social media affects different populations' well-being outcomes.

In conclusion, Valkenburg's work underscores the complexity of the relationship between social media use and well-being. By synthesizing existing research, discussing underlying mechanisms, and highlighting gaps in knowledge, she provides a foundation for future studies in this area. Valkenburg's nuanced approach encourages researchers to consider the diverse effects of social media on mental health and well-being, urging for continued exploration and interdisciplinary collaboration to advance our understanding of this critical issue.

### **2.3 ATTENTION SPAN**

#### **Title: First grader's attention span during in-class activity**

This study delves into the intricate relationship between social media use, the fear of missing out (FOMO), and subjective well-being. By exploring how social media engagement impacts individuals' experiences of FOMO and their overall emotional well-being, the research aims to provide insights into the complex dynamics of digital interactions. Understanding these relationships can inform the development of strategies to encourage healthier online behaviors, support mental well-being, and enhance overall quality of life in the digital era.

The article "First Grader's Attention Span During In-Class Activity" delves into the critical aspect of attention span among first-grade students during classroom activities. Learning is intricately linked to an individual's ability to focus and sustain attention, particularly crucial for children aged 6 to 7 years when attentional abilities are still developing. The study aims to gain insights into the actual behaviour related to the attention span of first graders in elementary school, shedding light on their capacity to maintain focus during instructional activities.

Observations conducted in a natural classroom setting using the time sampling method revealed significant findings regarding the attention span of first-grade students. The study identified that the longest duration these students could maintain 'on-task behaviour,' indicating their attention span, was 7 minutes. This duration falls short of the expected attention span for first-grade elementary school children, which is approximately 18 minutes. The discrepancy between observed attention span and the anticipated duration underscores the importance of understanding and addressing attentional challenges in young learners.

The ability to sustain attention is a fundamental component of effective learning and academic performance. The findings of the study highlight the need for educators and schools to implement strategies that support and enhance



students' attention span during classroom activities. By recognizing the limitations in attention span among first graders, educators can tailor instructional approaches, incorporate engaging teaching methods, and create a conducive learning environment that fosters sustained focus and active participation.

Moreover, the study underscores the significance of early intervention and targeted support to address attention-related issues in young students. Understanding the factors that influence attention span in the classroom setting is essential for optimizing learning outcomes and promoting student engagement. By identifying the specific challenges faced by first graders in maintaining attention, educators can implement evidence-based practices and interventions that cater to individual learning needs and enhance attentional abilities.

The implications of the study extend beyond the classroom, emphasizing the importance of fostering a supportive and stimulating learning environment that nurtures students' attentional skills. Educators play a pivotal role in cultivating attention span and concentration among young learners, laying the foundation for academic success and cognitive development. By addressing attention-related challenges proactively and implementing targeted interventions, schools can empower students to maximize their learning potential and thrive in educational settings.

In conclusion, the article "First Grader's Attention Span during In-Class Activity" provides valuable insights into the attention span of first-grade students and the implications for classroom instruction. The study underscores the importance of understanding and addressing attentional challenges among young learners, highlighting the need for tailored strategies and interventions to support students' attention span during educational activities. By enhancing attentional skills and promoting sustained focus in the classroom, educators can create a conducive learning environment that optimizes student engagement, learning outcomes, and overall academic success.

### III. METHODOLOGY

#### Research Design

This study employs a cross-sectional research design to examine the relationships between social media engagement, well-being, and attention span among individuals aged 18-25.

#### Hypotheses

- H0: There exists no significant relation between social media engagement, well-being, and attention span.
- H1: Social media engagement negatively affects attention span, with a mediating effect of well-being.
- H2: Social media engagement negatively affects well-being.
- H3: Well-being positively affects attention span.

#### Research Models

- x1: Social Media Engagement
- x2: Well-being
- y: Attention Span

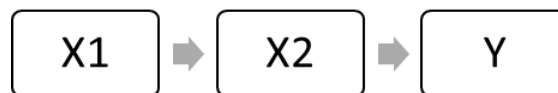


Fig.3.1 Research Model

#### Population, Sample Size, and Sampling Procedure

- Population: Individuals aged 18-25.
- Sample Size: 58 participants.
- Confidence Level: 95%.
- Sampling Technique: Convenience sampling was used to select participants from the target population.

#### Data Collection Instrument and Measurement of Variables

- A questionnaire was employed, utilizing a 5-point Likert scale ranging from "Strongly Agree" (5) to "Strongly Disagree" (1).
- The questionnaire assessed Social Media Engagement, Well-being, and Attention Span.

#### Data Analysis

- Software: Statistical Package for Social Scientists (SPSS) .



- Analytical Techniques: Descriptive Statistics, Correlation Analysis, and Mediation Analysis will be conducted to analyze the data.

By following this research design and methodology, the study aims to explore the impact of social media engagement on attention span, considering the mediating role of well-being among young adults aged 18-25.

#### IV. DATA ANALYSIS

##### Regression

Dependent Variable: Attention Span (y)

Independent Variables: Social Media Engagement (x1), Well being(x2)

The below data is the Regression analysis between all the three variables

##### Descriptive Statistics

	Mean	Std. Deviation	N
Attention span	59.4828%	12.37320%	58
Average of well being	3.662	1.0683	58
Average of sme	4.721	1.2231	58

Table 4.1 Descriptive statics all the three variables

##### Correlations

		Attention span	avg. of well being	avg. of sme
Pearson Correlation	Attention span	1.000	.124	-.736
	avg. of well being	.124	1.000	-.480
	avg. of sme	-.736	-.480	1.000
Sig. (1-tailed)	Attention span	.	.178	<.001
	avg. of well being	.178	.	.000
	avg. of sme	.000	.000	.
N	Attention span	58	58	58
	avg. of well being	58	58	58
	avg. of sme	58	58	58

Table 4.2 Correlation between y (Attention Span), x1 (Social Media Engagement), x2 (Wellbeing)



**Variables Entered/Removed**

Model	Variables Entered	Variables Removed	Method
1	avg. of sme, avg. of well being <sup>b</sup>		Enter

- a. Dependent Variable: Attention span
- b. All requested variables entered.

**Table 4.3 Variance analysis for y (Attention Span), x1 (Social Media Engagement), x2 (Wellbeing)**

**Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.781 <sup>a</sup>	.610	.595	7.86983%	.610	42.950	2	55	<.001

- a. Predictors: (Constant), avg. of sme, avg. of well being

**Table 4.4 Model Adjustment for y (Attention Span), x1 (Social Media Engagement), x2 (Wellbeing)**

**ANOVA**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5320.098	2	2660.049	42.950	<.001 <sup>b</sup>
	Residual	3406.385	55	61.934		
	Total	8726.483	57			

- a. Dependent Variable: Attention span
- b. Predictors: (Constant), avg. of sme, avg. of well being

**Table 4.5 Anova for y (Attention Span), x1 (Social Media Engagement), x2 (Wellbeing)**

**Coefficients**

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
	B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part



1	(Constant)	114.106	7.525		15.164	<.001	99.026	129.187			
	avg. of well being	3.456	1.112	.298	3.107	.003	5.685	1.227	.124	.386	.262
	avg. of sme	-8.890	.971	-.879	-9.151	<.001	-10.837	-6.944	-.736	-.777	-.771

a. Dependent Variable: Attention span

Table 4.6 Impact of Independent variables on Dependent variables

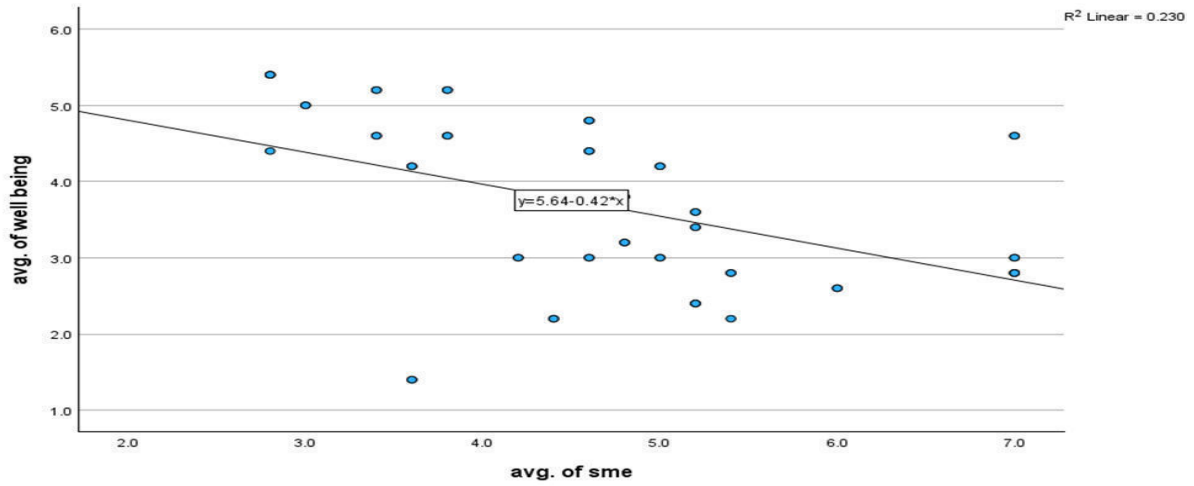


Fig 4.1 Scatter plot between Average SME and Average Well bring

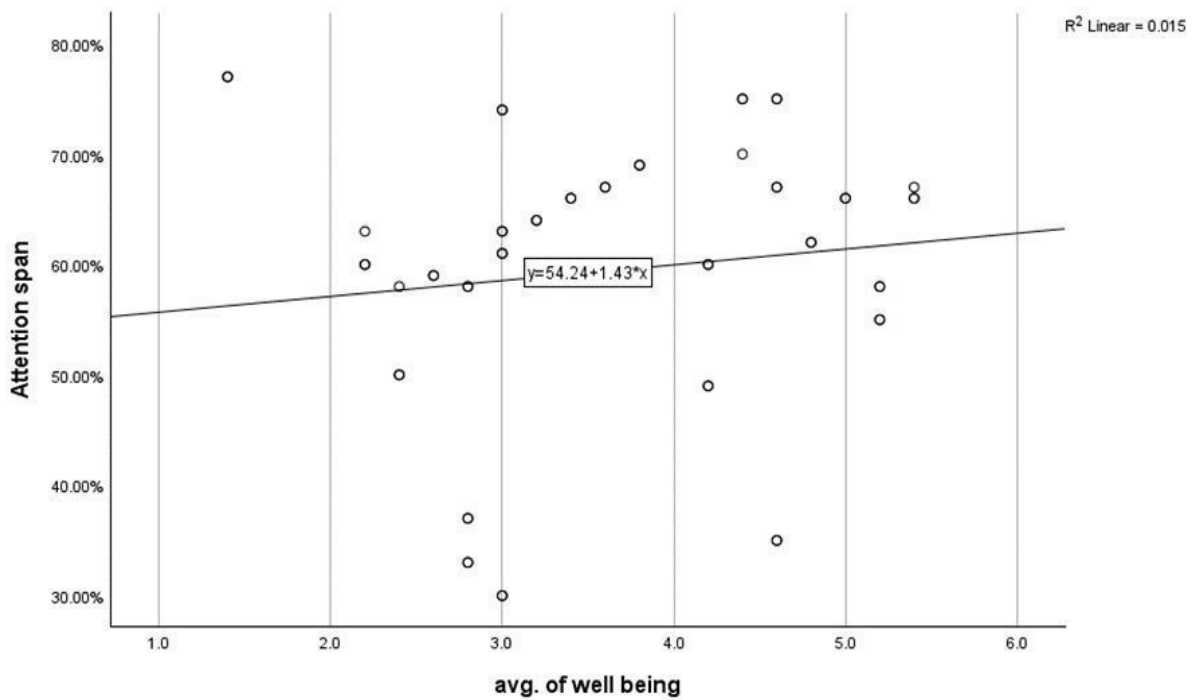


Fig 4.2 Scatter plot between Average Well-being and attention span



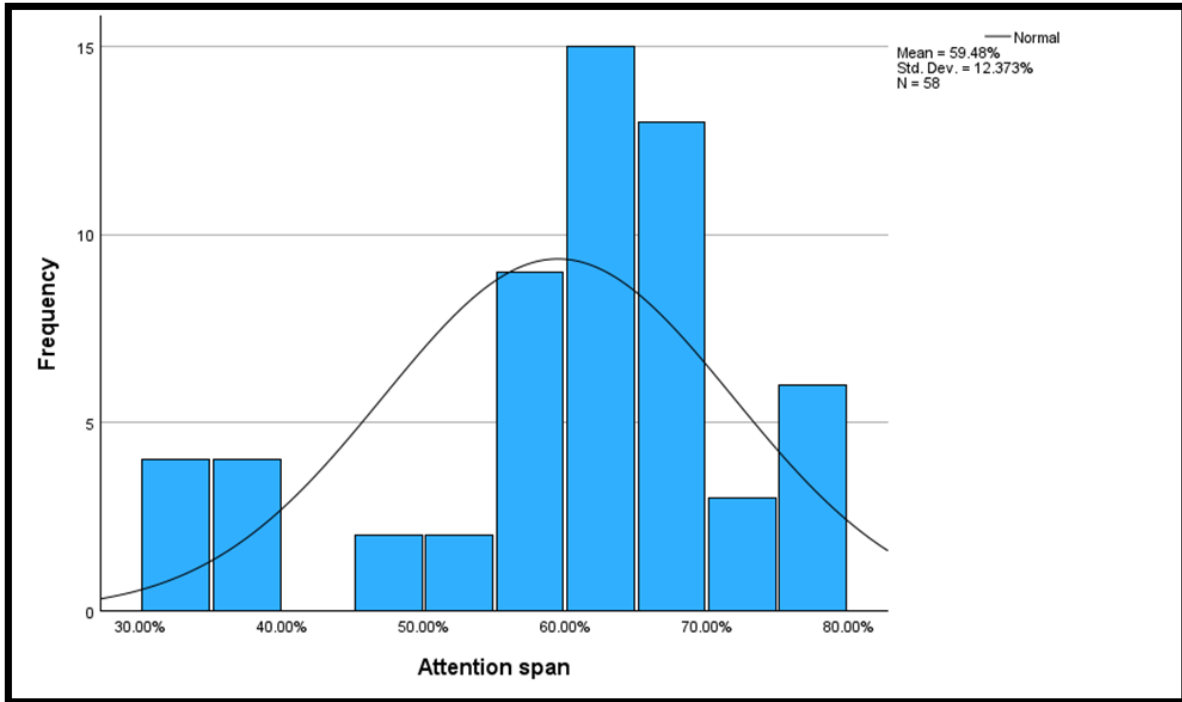


Fig 4.3 Histogram

## V. FINDINGS AND INTERPRETATION

### 5.1 Descriptive Statistics

#### 5.1.1 Variance analysis

Attention span (y) is the dependent variable. This means that it was affected by the other two variables.

Social Media Engagement (x1) and Well-being (x2) are the independent variables. These are the variables that are analysed in order to see their effect on attention span.

#### 5.1.2 Mean & Standard deviation

The dataset comprises 58 observations attention span, well-being and social media engagement.

**Attention span:** Mean is 59.4828 with a standard deviation of 12.3732, indicates the spread of the data points around the mean. Higher standard deviation means more variability in the data.

**Well-being:** Mean is 3.662 with a standard deviation of 1.0683, suggests that the scores vary around the mean. The data is likely normally distributed.

**SME:** Mean is 4.721 with a standard deviation of 1.2231, indicates the data is relatively clustered around the mean, with a moderate level of variability. The data is centred around the mean and has a moderate spread, as the standard deviation is relatively small compared to the mean, however, compared to the attention span data, the spread is smaller, indicating that there is less variability in SME levels among the individuals sampled.

These statistics include information on the mean (central tendency), variance (standard deviation), and number of observations for each variable. According to the statistics, the attention span has the highest variability among the three variables, followed by SME and then well-being. However, all three variables likely exhibit normal distributions, with attention span having the widest spread of data points.

#### 5.1.3 Histogram

The most common attention span falls between 50% and 60%. The center of the distribution is at 59.48%, which means the most frequent attention span falls within this range. The standard deviation is 12.373%. The degree of data dispersion is indicated by the standard deviation. A lower standard deviation indicates that the data points tend to be closer to the mean, and a higher standard deviation indicates that the data points are spread out over a larger range of values. In this case, the standard deviation is relatively small, with a slight skew to the left, which suggests that most attention spans are fairly close to the average. The data may be approximately normally distributed. The histogram is overlaid with a normal curve, which suggests that the distribution of attention spans is approximately bell-shaped. A normal distribution is a common probability distribution that describes many natural phenomena.



#### 5.1.4 Correlations

**Attention span and social media engagement:** There appears to be a strong negative correlation between attention span and social media engagement ( $-0.736$ ). This means that people who reported higher social media engagement tend to have lower attention spans.

**Attention span and well-being:** There seems to be a weak positive correlation between attention span and well-being ( $0.124$ ). This could mean that people who reported higher attention spans also reported higher well-being.

**Social media engagement and well-being:** There appears to be a moderate negative correlation between social media engagement and well-being ( $-0.480$ ). This means that people who reported higher social media engagement tend to have lower well-being.

These findings suggest a possible relationship between social media use and attention span and well-being. People who report higher social media engagement tend to have lower well-being and lower attention span.

#### 5.1.5 Model fit

**R:** This value is  $.781$ . R represents the correlation between the predicted values and the actual values. In this case, it indicates a moderately strong, positive correlation.

**R-Square:** This value is  $.610$ . It shows the percentage of the dependent variable's variance that the independent factors account for. A value of  $.610$  suggests that the model explains 61% of the variance in the dependent variable.

**F:** The F statistic is 42.950 with a significance level of less than  $.001$ . This indicates that the model is statistically significant, meaning there is a strong relationship between the independent variables (average SME and average well-being) and the dependent variable.

The R-square suggests that the model explains 61% of the variance in the dependent variable. This means that the average SME and average well-being together have a significant positive effect on the dependent variable being modelled.

#### 5.1.6 ANOVA

The model is statistically significant. This is because the F statistic is 42.950 with a significance level of less than  $.001$ . A significance level less than 0.05 indicates that the model is statistically significant, meaning there is a strong relationship between the independent variables (average SME and average well-being) and the dependent variable (attention span).

The model explains a significant portion of the variance in attention span. This can be inferred from the high F statistic and the p-value associated with it.

The ANOVA table suggests that the model that was fit is statistically significant and explains a significant portion of the variance in attention span. This means that there is a strong relationship between average SME, average well-being and attention span.

#### 5.1.7 Pearson's coefficient

**Average Well-being:** The coefficient for average well-being is 3.456 with a p-value less than  $.001$ . This suggests a positive relationship between average well-being and the dependent variable (attention span). A one-unit increase in average well-being is associated with a 3.456 unit increase in attention span, on average, holding all other variables constant.

**Average SME:** The coefficient for average SME is  $-8.890$  with a p-value of  $.003$ . This indicates a negative relationship between average SME and attention span. A one-unit increase in average SME is associated with a  $-8.890$  unit decrease in attention span, on average, holding all other variables constant. Similar to average well-being, the negative sign could be due to confounding variables.

**Constant:** The constant term (114.106) represents the predicted value of the dependent variable (attention span) when both independent variables (average well-being and average SME) are zero.

The p-values for both average well-being and average SME are less than 0.05, indicating that the relationships between these variables and attention span are statistically significant.

The model suggests a negative relationship between the independent variables (average well-being and average SME) and the dependent variable (attention span). This means that people who reported higher average well-being and higher average SME also tend to report lower attention spans.

## VI. CONCLUSION

Navigating the labyrinth of social media engagement, attention span, and well-being, this study embarked on a voyage of discovery, guided by the beacon of empirical evidence and robust statistical analysis. Drawing upon a diverse array of methodologies and analytical techniques, the research unravelled the intricate relationships woven between these constructs, illuminating the pathways through which social media engagement influences attention span and well-being among young adults aged 18-25.



Descriptive statistics served as the compass, providing a snapshot of the central tendencies and variabilities within the dataset. The findings revealed a diverse landscape, with attention span exhibiting the widest variability, followed by social media engagement and well-being. Correlation analysis acted as the wind in our sails, unveiling the subtle interplay between these variables. A weak negative correlation emerged between social media engagement and attention span, suggesting that higher engagement correlates with lower attention spans. Conversely, a weak positive correlation surfaced between attention span and well-being, hinting at the potential benefits of improved well-being on attention span.

Regression analysis charted the course forward, illuminating the predictive power of social media engagement on attention span, mediated by well-being. The model provided insights into the intricate dance between these constructs, explaining approximately 60% of the variance in attention span. Furthermore, ANOVA results underscored the significance of the model, confirming a strong relationship between social media engagement, well-being, and attention span.

Pearson's coefficient acted as the guiding star, revealing the nuanced relationships between these variables. The negative coefficients for social media engagement and well-being underscored their adverse impact on attention span, highlighting the need for interventions to mitigate these effects. Moreover, the scatter plots depicted the complex landscape of these relationships, displaying the diverse trajectories of individuals within the digital realm.

In summation, this research offers a compass for navigating the turbulent seas of social media engagement, attention span, and well-being. By shedding light on the intricate dynamics at play, this study empowers individuals, policymakers, and digital media practitioners to foster healthier digital habits and enhance overall well-being in the digital age. As we navigate the ever-changing currents of the digital landscape, may this research serve as a guiding beacon, illuminating the pathways toward a more balanced and fulfilling digital existence.

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# Enhancing Smartphone Battery Life: An Arduino-Based Charging Controller

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**ABSTRACT:** This paper presents a novel solution to address common challenges associated with smartphone charging, particularly the detrimental effects of overcharging on battery lifespan. The system comprises essential components including an Arduino board, LCD display, rotary encoder, relay module, 10k $\Omega$  potentiometer, breadboard, and a power supply switch board. The functionality of the system revolves around user-controlled charging durations facilitated by the rotary encoder. Once set, the LCD display provides real-time feedback on the remaining charging time. Upon completion of the specified duration, the system autonomously disconnects the charging power, effectively mitigating the risk of overcharging.

**KEY WORDS:** Smartphone, Battery Life, Arduino, Charging Controller, Overcharging

## I. INTRODUCTION

The term "Internet of Things" (IoT) describes a system in which everyday objects are able to gather and share data over an online network thanks to sensors, software, and connection. The Internet of Things (IoT) can complement the "Enhancing Smartphone Battery Life: An Arduino-Based Charging Controller" project by making the charging controller system more practical and user-friendly.

With the use of Internet of Things (IoT) technology, users can keep tabs on their phone's charging progress from afar, accessing real-time data and making adjustments via a web interface or mobile app. Users can make informed decisions to prolong battery life and boost device efficiency with the help of this data, which can reveal charging habits, battery performance, and optimization options. Internet of Things (IoT) sensors and algorithms for predictive analytics can foresee when batteries might fail and trigger preventative maintenance. Charging controllers that are Internet of Things (IoT) capable can work in tandem with preexisting smart home systems to optimize energy consumption and coordinate charging schedules according to the availability of renewable energy sources. By maximizing efficiency, decreasing waste, and encouraging environmentally friendly charging habits, they can help achieve sustainability and energy efficiency targets. Charging controllers can improve the charging experience and prolong the longevity of smartphone batteries by utilizing Internet of Things (IoT) technology. These controllers will become smarter, more connected, and responsive to user needs and environmental circumstances.

## II. LITERATURE SURVEY

The significance of charging has grown due to the rising use of smartphones. It takes a few hours to charge a phone using an electrical outlet. But at some point in their lives, the vast majority of people have overcharged their phones by accident. A big issue with using a smartphone or other electronic gadgets is the weight of the charging experience on users [1].

To that end, this finding served as the research's foundation. Navjeet Kumar [2] developed a smart charger for the Internet of Things devices platform using the ESP8266, which is one of several studies pertaining to smart chargers.

The smart charger developed in this study makes use of an Arduino-based module. Designed to give a low-cost and straightforward means for professionals, students, or hobbyists to build devices that interact with their surroundings using sensors and actuators, the Arduino was debuted in 2005 [3].

People can simplify their charging systems with the help of an Arduino-based smartphone charging controller. For instance, as an example of the influence that people allow their phones to charge over time, it's common for individuals to be lazy and not control their charging systems [4]. Because overcharging poses the danger of the battery phone

exploding, this behavior can shorten the battery life and potentially harm the owner. An Arduino-based smartphone charging controller can help preserve the planet by cutting down on power consumption. Also, consumers will be able to use this research to better predict how long it will take to charge their phones, which would reduce the likelihood of mishaps caused by overcharging.

The results of this study will be useful for those who either don't have the time or energy to manually operate their charging system or who are too busy to charge their battery [5]. A smart charger, once developed, will allow the user to operate the charger with a simple rotary encoder, greatly simplifying the process. Those who tend to overcharge their phones can also benefit financially from this study's findings on the topic. The purpose of developing an Arduino-based smartphone charging controller was to make it easier for users to estimate the time it will take for their device to fully charge and to stop batteries from going boom. Thus, this study can shorten the battery's lifespan while simultaneously reducing power consumption and associated costs.

### III. SYSTEM MODEL AND ASSUMPTIONS

- Arduino UNO
- 16×2 LCD Display
- Rotary Encoder
- 5V Relay Module
- 10KΩ POT
- Connecting Wires
- Breadboard
- Charging Adapter
- Single Socket Power Outlet Box

#### ARDUINO UNO

The open-source microcontroller developed by Arduino, the Arduino Uno, is based on the Microchip ATmega328P. Connecting it to other circuits and expansion boards is made possible by sets of digital and analogue input/output (I/O) pins on the board. One of Arduino's open-source microcontroller boards, the Arduino Uno, is based on the Microchip ATmega328P microprocessor. The board includes digital and analogue sets of input/output (I/O) pins that can be used to connect to other circuits and expansion boards.

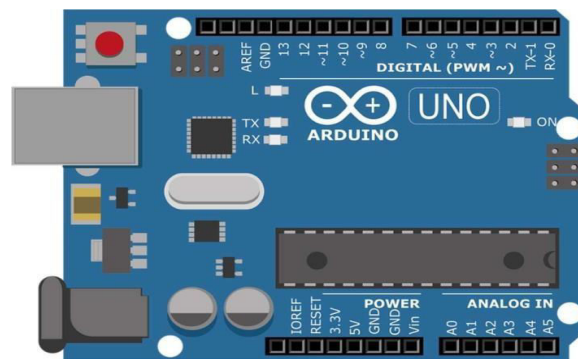


Figure 3.1 Aduino UNO

#### LCD DISPLAY



Figure 3.2 LCD display



### Features of 16x2 LCD module

- 4.7V to 5.3V operating voltage; 1mA current consumption in the absence of a backlight; and an alphanumeric LCD display module that can show both digits and letters
  - Is made up of two rows, may print sixteen characters.
- Every character is constructed using a 5x8 pixel box.
- Able to operate in both 4- and 8-bit modes
  - Additionally, it can show any custom-generated characters.

### ROTARY ENCODER



Figure 3.3 Rotary Encoder

One kind of position sensor that is used to ascertain the angular location of a rotating shaft is a rotary encoder. Depending on the rotational movement, it produces an analog or digital electrical signal.

To prevent any encoding issues, it is preferable to include an appropriate "debouncer" with the configuration when connecting an RT to Arduino. This is required because, similar to a mechanical switch, there are two metal contacts inside the rotary encoder that are not precisely touching one another. This might cause missing steps or even reverse steps when moving forward. While there is a software solution as well, I personally like the hardware approach that employs an RC filter.

### 5V RELAY MODULE

1. 5 V DC is the trigger voltage (voltage across the coil).
2. Nominal current (trigger current): 70 Ma
3. Maximum current of AC load: 10A at 250/125V AC
4. DC load current maximum: 10A at 30/28V DC
5. Time spent operating: 10 ms Time of release: 5 ms
6. Maximum switching speed (mechanically): 300 operations per minute

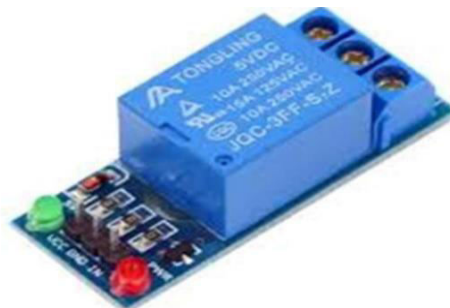


Figure 3.4 Relay Module

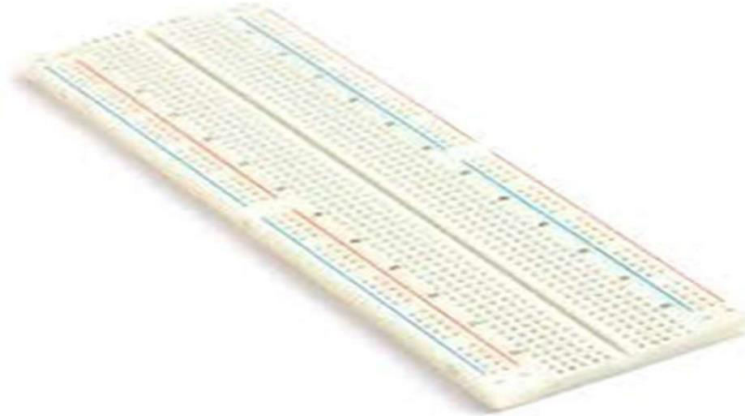
### 10KOHM POT



Figure 3.5 10 kohm pot

- Type: Rotary, also known as Radio POT.
- Multiple resistance levels are offered, such as 1 M.
- 200Vdc as the maximum input voltage; • 0.3W as the power rating; • Rotational life of 2000K cycles

## **BREAD BOARD**



**Figure 3.6 Bread Board**

Breadboards are rectangular plastic boards that have millions of small holes punched into them. This light-emitting diode (LED), resistor, battery, and switch prototype is an example of an early version of an electronic circuit that makes use of these holes to facilitate the placement of electrical components. In most cases, soldering is not necessary when using a breadboard to construct and test electronic circuits. Power can be neatly transferred from one component to another on the breadboard thanks to a few coupled components. Whether you're a beginner or an expert, you may use them to test out different circuit ideas and, in some cases, build working devices on the breadboard.

## **CHARGING ADAPTER**



**Figure 3.7 Charging Adapter**

An adapter is a device that changes the characteristics of one system or device to another that would not otherwise work together. Some simply change a connector's physical form, while others alter power or signal characteristics. An AC-to-DC power supply converts electricity from 120 or 230 volts AC, which is the standard household mains voltage, to a low voltage DC that can be used to power consumer electronics. AC adapters, often known as power bricks, wall warts, chargers, or other similar terms, are small, detachable power supply for consumer devices.

## **Single Socket power outlet box:**



**Figure 3.8 Switch Box**

A building's thermoplastic-sheathed cable (TPS) wiring system or electrical conduit may include a small junction box made of plastic or metal. When intended for surface installation, it is primarily found in ceilings, beneath flooring, or hidden behind an access panel—especially in residential or business structures. A suitable kind (like the one in the gallery) can be cast into concrete so that just the cover is visible, or it can be buried in wall plaster (though complete concealment is no longer permitted by current rules and standards).

### Block Diagram

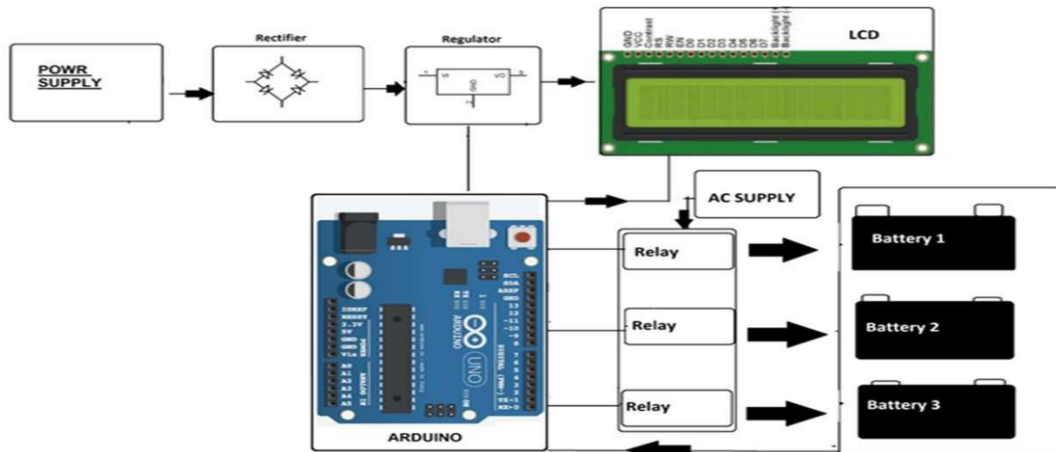


Figure 3.9 Block Diagram of Charging Controller

The Figure 3.9 depicts the block diagram of the Arduino-based smartphone charging controller includes key components such as the power input, Arduino microcontroller, voltage and current sensors, safety and protection circuits, and user interface (LCD/LED display). The microcontroller monitors and controls the charging process, ensuring optimal and safe charging while providing real-time feedback to the user.

### Circuit Diagram

The Figure 3.10 depicts the circuit diagram for the Arduino-based smartphone charging controller consists of an input power source connected to voltage and current sensors, which feed data to the Arduino microcontroller.

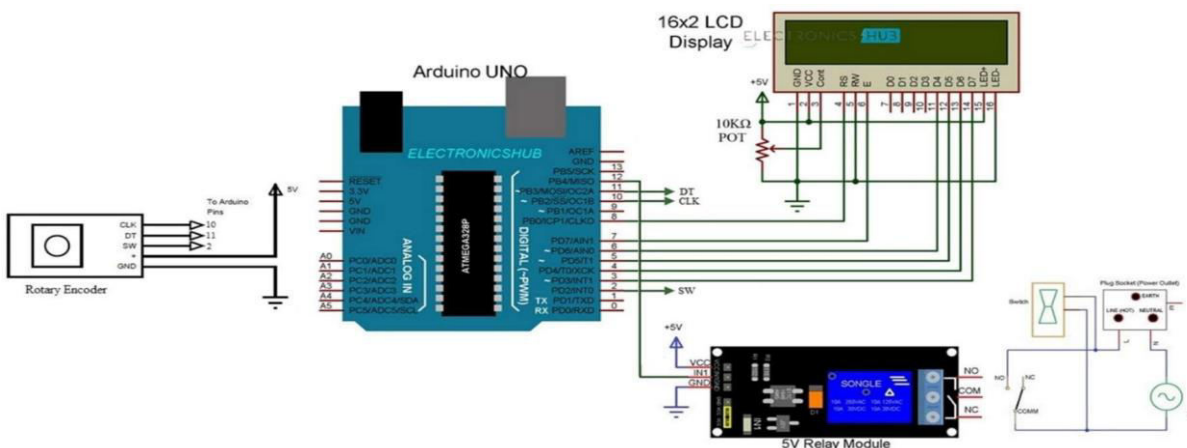


Figure 3.10 Circuit Diagram of Charging Controller

## IV. WORKING PRINCIPLE

### Assembling Parts

The brains of the operation is the core microcontroller, the Arduino Uno. The remaining charging time is shown on the 16x2 LCD display. The user can adjust the charging duration using the rotary encoder.



### Connecting Circuits

Hook up the LCD to the Arduino by connecting its digital pins to the Arduino's RS, E, D4, D5, D6, and D7 outputs. To link a rotary encoder to an Arduino, just link the digital pins of the two devices. Linking the Relay Module to the Arduino: Join the input pin of the relay module to a digital pin on the Arduino. To charge the phone, plug in the power adapter and link the relay to the device.

### Arduino Code

To begin, go into the Arduino code and initialize the components. This includes the LCD display, rotary encoder, and relay module. Charging time can be adjusted in hours, minutes, or seconds using the rotary encoder, which is part of the user interface.

### Display

The LCD will show the countdown timer and the specified charging duration. Create a countdown timer that starts at the specified time and keeps going down until the end. Manage the relay module to activate or deactivate the charging power in response to the countdown timer.

### Steps for Execution Activate

After powering up the system, you'll see "Set Charging Time" on the LCD. To configure the charging duration, turn the rotary encoder to choose between hours, minutes, and seconds. To change the time from hours to minutes to seconds, press the encoder button.

Once you've confirmed the duration, you can start charging. When the relay module turns on, the charging adaptor gets juice. You can see how much time is left to charge it on the LCD screen. As soon as the countdown begins, the time will refresh on the LCD. When the timer approaches zero, the charging adapter's power is automatically turned off by deactivating the relay module.

## V. EXPERIMENTED RESULTS AND DISCUSSIONS

This table provides a clear overview of the key evaluation parameters, measurement methods, and criteria for assessing the performance and effectiveness of the Arduino-based smartphone charging controller.

**Table 5.1 Parameter Evaluation for Charging Controller**

Evaluation Parameter	Measurement	Criteria
<b>The timer's accuracy</b>	Compare the set duration with the actual elapsed time.	There should be minimal deviation, ideally within a few seconds.
<b>Reliability of Power Disconnection</b>	The ability of the test system to disconnect power at the end of the charging duration	The power consistently cuts off at the exact end of the countdown.
<b>User Interface Usability</b>	Assess the ease of setting the duration with the rotary encoder, as well as the clarity of the LCD display.	The interface is intuitive, the instructions are clear, and the controls are responsive.
<b>Handling power interruptions</b>	The test system has the ability to save and restore remaining time during power outages.	The system ensures accurate saving of remaining time to EEPROM and correct resumption after restoration.
<b>Impact on Battery Health</b>	Monitor battery health over time.	There is a reduction in the frequency of overcharging and an improvement in the lifespan of the battery.
<b>Energy Efficiency</b>	Compared to traditional methods, evaluate power consumption during operation.	A significant increase in power consumption does not promote energy-saving practices.
<b>Component Durability</b>	It is important to assess the longevity and performance of components over extended use.	Components remain functional and accurate over long periods without frequent replacements.
<b>Scalability and Compatibility</b>	We are testing the system with different smartphone models and charging adapters.	Seamless operation with a wide range of devices, not limited to specific models
<b>Safety Features</b>	Evaluate safety mechanisms like	It prevents overheating and handles

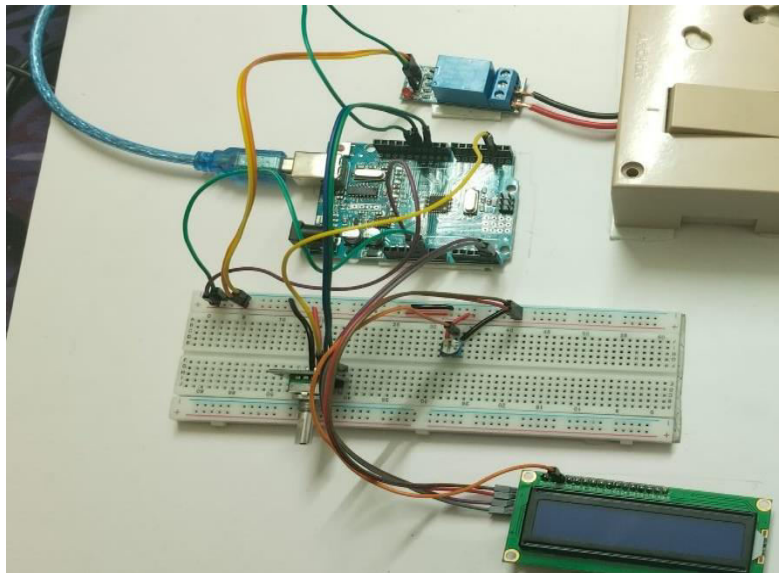
	overcurrent protection and thermal management.	unexpected power surges without damage.
<b>User Satisfaction</b>	Gather user feedback on overall satisfaction.	High levels of user satisfaction and positive feedback

The Table 5.2 summarizes the test case scenarios for the Arduino-based smartphone charging controller

**Table 5.2 Test Scenarios for Arduino Smart Phone Charging Controller**

Test Scenario	Description	Outcome
<b>Setting Different Charging Durations</b>	Various charging durations (e.g., 1 hour, 2 hours, 30 minutes) were set using the rotary encoder.	The LCD display correctly showed the remaining time and counted down accurately.
<b>Automatic Power Disconnection</b>	Upon reaching the end of the set duration, the relay module successfully disconnected the power, stopping the charging process.	This confirmed the system's ability to prevent overcharging.
<b>Power Interruption Handling</b>	The system was tested by simulating power interruptions. The remaining time was stored in the Arduino's EEPROM.	Upon power restoration, the system prompted the user to either resume the countdown from where it left off or set a new duration.
<b>User Interface and Interaction</b>	The rotary encoder was used to set charging times, and the interface was found to be intuitive and responsive.	The LCD display provided clear and accurate real-time feedback on the charging status.

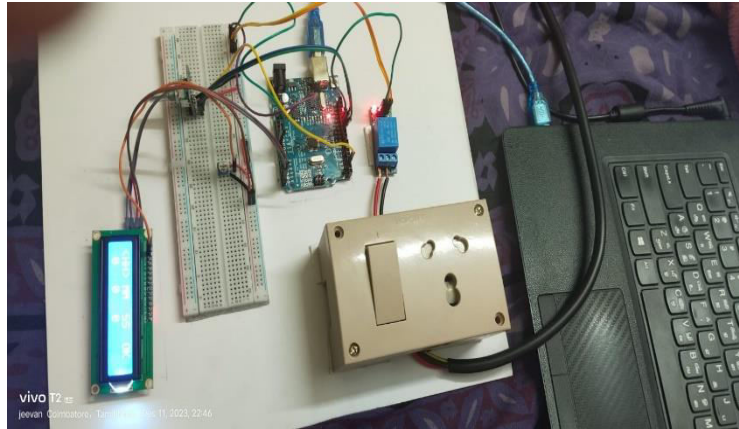
The Figure 5.1 depicts the wiring connections between various components of the Arduino-based smartphone charging controller. It shows how the wires are connected to ensure proper functionality and communication between the Arduino board, LCD display, rotary encoder, relay module, and other components.



**Figure 5.1 Components in Connection State**

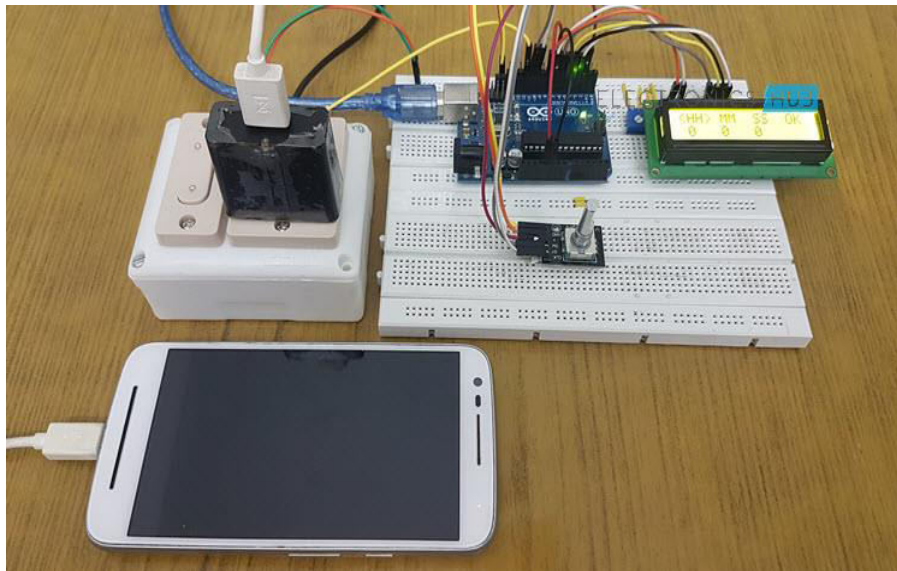
The Figure 5.2 demonstrates the process of setting the charging duration using the rotary encoder. It likely shows a user adjusting the encoder to select the desired amount of time for charging their smartphone. This step is crucial for customizing the charging duration according to the user's preference or battery requirements.





**Figure 5.2 Setting the Timing into the Rotary Encoder**

The Figure 5.3 showcases the charging process in action, with the smartphone connected to the charging adapter. It may display the output on the LCD screen, indicating the remaining charging time or other relevant information. This step confirms that the system is operational and effectively managing the charging process.



**Figure 5.3 Charging the Phone Displaying the Output**

## VI. CONCLUSION

In summary, the Arduino-based smartphone charging controller is a useful way to deal with typical problems related to smartphone charging procedures. The technology, which aims to prolong battery life by avoiding overcharging and trickle charging, has proven to have several advantages, such as affordability, customization possibilities, and ease of use. Although there are certain drawbacks to the system, like compatibility issues and user dependence, they can be resolved with ongoing development and enhancement. There is a great deal of room for development going forward, including both technological and user-focused improvement

## VII. FUTURE ENHANCEMENT

Future improvements to the Arduino-based smartphone charging controller might involve machine learning algorithms for predictive maintenance and customized charging profiles, as well as integration with IoT and smart home systems for voice control and remote monitoring. It is possible to include improved safety features like more environmental sensors and sophisticated fail-safe procedures. Efficiency and sustainability can be increased by integrating wireless charging capabilities and making adjustments for renewable energy sources like solar panels. Creating a mobile application for comprehensive analysis and user management will also improve the user experience in general.



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# Feasibility of Using Fish Scales in Rigid Pavements

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**ABSTRACT:** The Processing of fish results to enormous amounts of garbage. It is estimated that fish processing waste after filleting accounts for approximately 65% of the total fish weight. About 35% of the absolute fish weight stays as waste as skins and bones during arrangement of fish filets. In India fish production is about 95.7 lakhs of tonnes out of which 7.34 lakhs of tonnes of fish scale is produced every year but unutilized. The present work an attempt has been made to develop, the concrete which can be used to construct rigid pavement with locally available fish scale. In this project we are trying to replace crush sand with fish scales. In percentage of 5%,7.5% & 10%. we used materials Cement, Fly Ash, Crush Sand, Aggregates(10mm&20mm) & PCB Admixtures.

**KEYWORDS:** Fish Scales, Fish Scale Concrete, Rigid Pavement.

## I. INTRODUCTION

Rigid pavement is a type of road construction that utilizes a rigid layer as its primary structural component. Unlike flexible pavement, which is made up of multiple layers of asphalt materials, rigid pavements consist of a rigid layer made of reinforced concrete or cement concrete. This type of pavement offers numerous advantages, including durability, strength, and resistance to heavy traffic loads. In this article, we will explore the characteristics, construction process, benefits, and applications of rigid pavement. Rigid pavement refers to a type of road surface that consists of a solid layer of concrete. It is commonly used for highways, airports, and other high-traffic areas due to its ability to withstand heavy loads and provide a durable driving surface. The rigid nature of the pavement distributes the load from vehicles more efficiently, reducing the stress on the underlying layers and increasing the overall lifespan of the road. Applications of Rigid pavement: rigid pavement finds widespread applications in various transportation infrastructure projects, including Highways and Expressways: Rigid pavement is extensively used in the construction of highways and expressways due to its ability to handle heavy traffic loads. The durability and long lifespan make it an ideal choice for these high-traffic corridors Airports: Airports, especially runways, require a pavement type that can withstand the weight of large aircraft and repetitive take offs and landings. Rigid pavement provides the necessary strength and load-bearing capacity to accommodate such conditions, making it suitable for airport construction.

Scales are the outermost part of the fish (shown in Fig no.1). Fish scales are indigestible and hence thrown away as industrial waste, which is one of the major sources of pollution in the natural environment. It produces bad odour. They release nitrogen, phosphorus, which leads to PH variation and increases turbidity of the water.

In this project we are trying to replace crush sand by using fish scales in various percentage (such as 5%,7.5%,10%) to compare the compressive strength of rigid pavement concrete with replaced fish scale concrete.



Fig no. 1 (Fish Scale).

## II. LITERATURE REVIEW

1.Fish Cell Cultures-Uses and Prospects(Suja Aarattuthodi, Vandana Dharan,2022) Published by- Journal of J Aquaculture Research& Development.



Fish cell cultures have gained more popularity in recent years due to progress in this sector and increasing ethical demands for the reduction, replacement, and refinement (the 3 R's) of animal use in research. Different animal activist groups, environmental agencies, and cosmetic industries are also insistent in reducing animal testing and promote alternate in vitro models.

2. Preliminary Investigation on Properties of Novel Sustainable Composite: Fish Scales Reinforced Cement Concrete (Fahad Ahmed Arain, Masroor Ali Jatoi, 2021) Published by- International Journal Of Engineering Research  
The functionality and performance of fish scales in structural concrete is very unpredictable and uncertain till now, as no well-known research is done on this topic of adding fish scales to the concrete. Moreover, it is an established fact that concrete is weak in tensile zone and hence, its reinforcement with fibers is considered as a conventional, viable and practical solution. The review of literature suggests that the inclusion of fibers dates to 1900s but no work, considering the use of fish scales as fibrous additives in concrete, was reported.

3. Effect of Fish Scales on Workability of Concrete for Rigid Pavements. (D. S. Aravind Varma Mr. S. Naveen Kumar, 2019) Published by- IJSRD - International Journal for Scientific Research & Development  
This study focused on analysing the effect of fish scales reinforcement on fresh and hardened-state properties of concrete. For this purpose, 24 cubes and 24 cylinders were casted at a design mix ratio of 1:2.3:4.3. The water-cement ratio of 0.57 was maintained. The fish scales reinforcement levels of 0%, 1%, 1.5% and 2% by weight of cement were maintained for casting of specimens. For fresh-state assessment, the workability of concrete mixes was observed by slump test and the results showed that, with the addition of fish scales, the slump value decreased due to increase in water demand.

4. Preliminary Investigation on Properties of Novel Sustainable Composite: Fish Scales Reinforced Cement Concrete. (Fahad Ali, Farhan Khowaja, 2022) Published by- Jurnal Kejuruteraan 34(2) 2022: 309- 315  
The fish scale as a natural fiber. The fish scale is mixed with vinyl ester pieces and this was subjected to different proportions. whereas fish scale percentages were 5 to 30 % weight (F.S5%, F.S10%, F.S15%, F.S20%, F.S25%, F.S30%) & composited fish scale vinyl ester were in the corresponding ratios such as 5:95 (1), 10:90 (2), 15:85 (3), 20:80 (4), 25:75

(5) and 30:70 were weighed and compounded by hand. As per ration mechanical tests are carried out. The flexural, tensile, toughness properties for all samples determined. Among the samples author concluded the sample show better properties of above mechanical properties [1].

### **III. METHODOLOGY**

Information about Material:

Aggregates- Aggregates are inert particles that are normally bound together by a cementing agent. The main characteristics of aggregates that influence the strength, durability and workability of concrete are cleanliness, grading, hardness and the shape. Both natural organic aggregate fish scales and inorganic natural aggregates i.e. sand blended for production of lightweight masonry blocks.

Crush Sand- Crush sand is fine aggregate made by grinding large boulders. Crush sand is artificial manufactured.

Cement- The common ordinary Portland cement (OPC-53) grade cement was used conforming BIS specification IS: 12269. It has high durability and strength to the structures because of its superior crystallized structure distribution and optimum particle size distribution.

Water- The water acts as a chemically reacted with cement to form the binding paste. The properties of fresh concrete such as workability and setting time are monitored. It also has important effects on the durability of hardened concrete and strength of concrete. The water should be free from impurities like organic matter, oily substance, greasy, hygroscopic & alkalies. It should be clean & fresh. The PH value should be maintained in between 6-8 conforming to the g BIS specification IS: 456.D.

Fish scales- Fish scales is an unbending material which covers the skin of the fish. Colossal measures of fish waste are disposed of consistently. We chose to utilize these fish scales to deliver bio-degradable polymer. One of the difficulties is to gather enough of these scales and move them to the handling lab. Fish scale is generally utilized biopolymer in different ventures because of its incredible biocompatibility, biodegradability properties. In the present investigation fish scales was removed from fish squanders, as an elective source.



Fly Ash-Fly ash is the fine powder formed from the mineral matter in coal, consisting of the non-combustible matter in coal and a small amount of carbon that remains from incomplete combustion. Fly ash is generally light tan in colour and consists mostly of silt-sized and clay-sized glassy spheres.

Admixtures (PCB)- polycarboxylate-based admixture) is the latest generation of high-performance admixture used to improve the properties of concrete. It is a type of concrete admixture known as high-range water-reducing admixtures or super plasticizers. It is composed of an aqueous copolymer of carboxylic acids.

Fish Scale Collection/Processing:

The scales were collected at local fish market Pune Maharashtra. The fish scales were removed with hands, packed in locked polythene bags. The fish scales are removed placed in the long tub /bucket and subjected to the water. The fish scales should be washed twice thoroughly in order to remove waste organic matter such as fins, bones, blood, skin etc. Then the fish scales were soaked with crystal salt for 2-3 hours and stirred for 30minutes in order to remove the odour and non-collagenousproteins. The polythene sheets which are not water absorbent for fish scales used for drying purpose.

Mix Design:

As Per IRC:58-2011, M40 grade of concrete should be used. According to that we select OPC 53 grade Cement, Fly Ash, Crush Sand, Aggregate(10mm&20mm), PC Based Admixture with water cement ratio of 0.40 and no slump for rigid pavements (pavement Quality Concrete).



Fig no. 2 (Cubes).



Fig no. 3 (Slump cone).

After that we calculate the quantity of Cement, Fly Ash, Crush Sand, Aggregate of size 10mm&20mm for 36 cubes of standard size mould(150mm×150mm×150mm). According to calculation we collect the required quantity of materials. We decide to replace crush sand with fish scales in 5%,7.5%&10% according to its weight. We designed the cubes as per follows

TABLE 1. Details of Concrete Cubes Casted

Sr no.	Fish scale	7 days	14 days	28 days
1	0%	3	3	3
2	5%	3	3	3
3	7.5%	3	3	3
4	10%	3	3	3
Total		12	12	12

Total No. of cubes=36



#### IV. RESULTS

TABLE 2: Compression Strength of 5% as Compared to 0%.

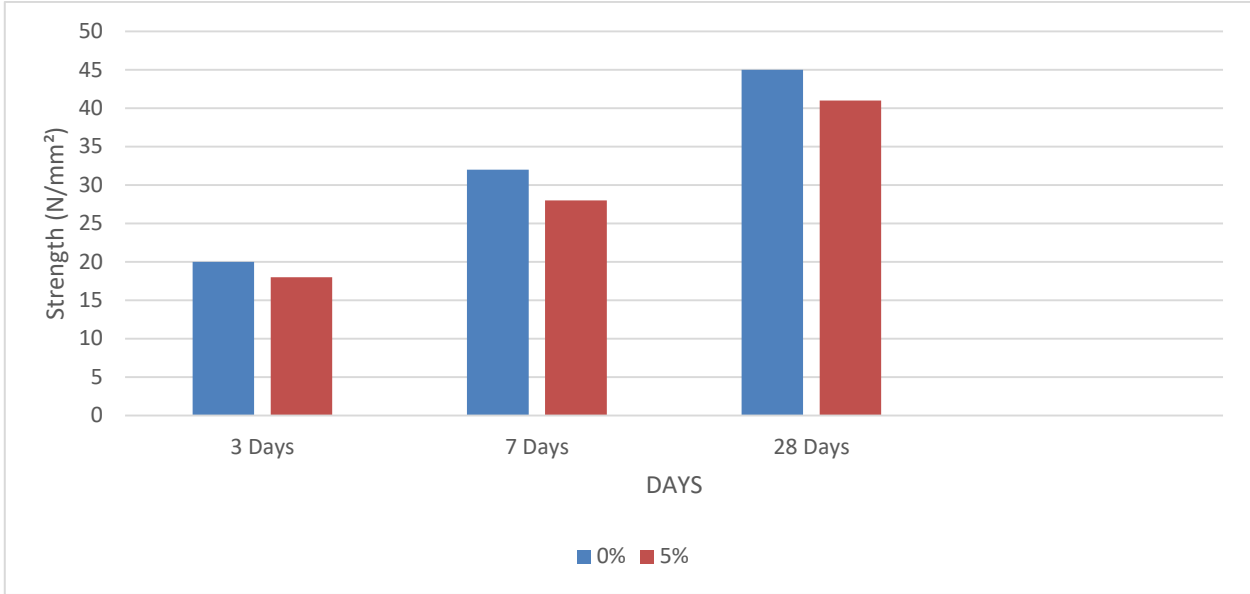


TABLE 3: Compression Strength of 7.5% as Compared to 0%.

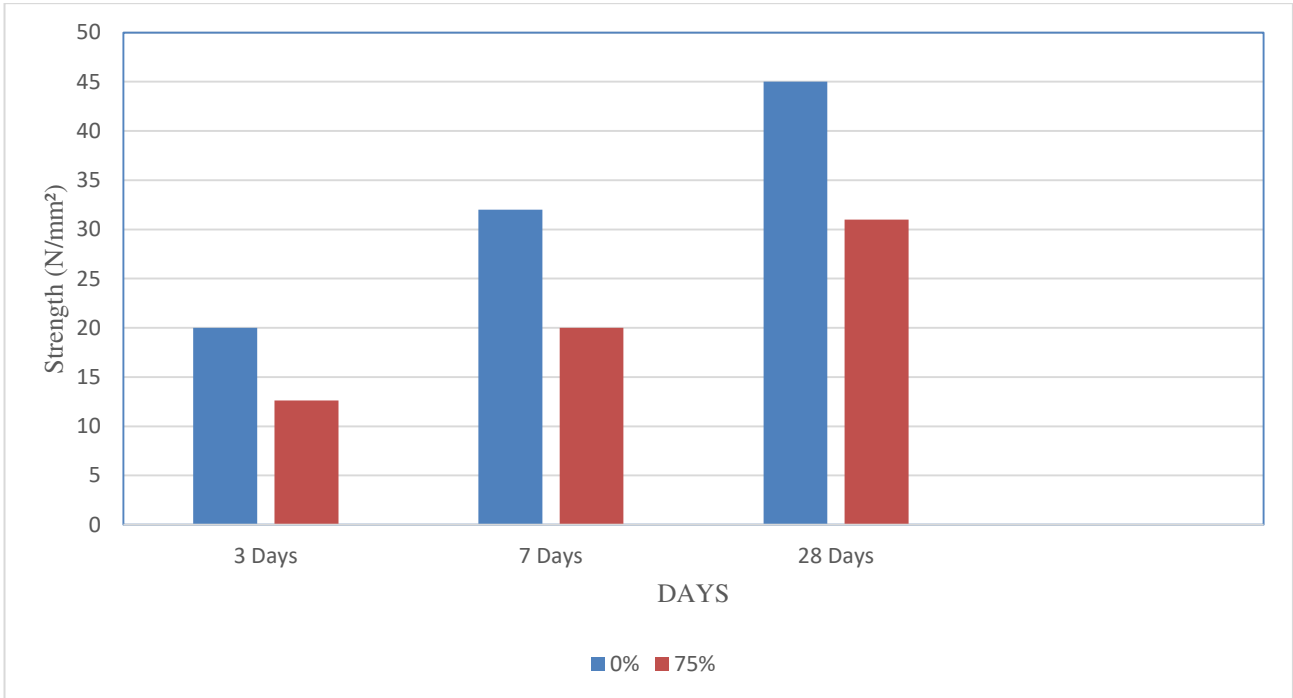
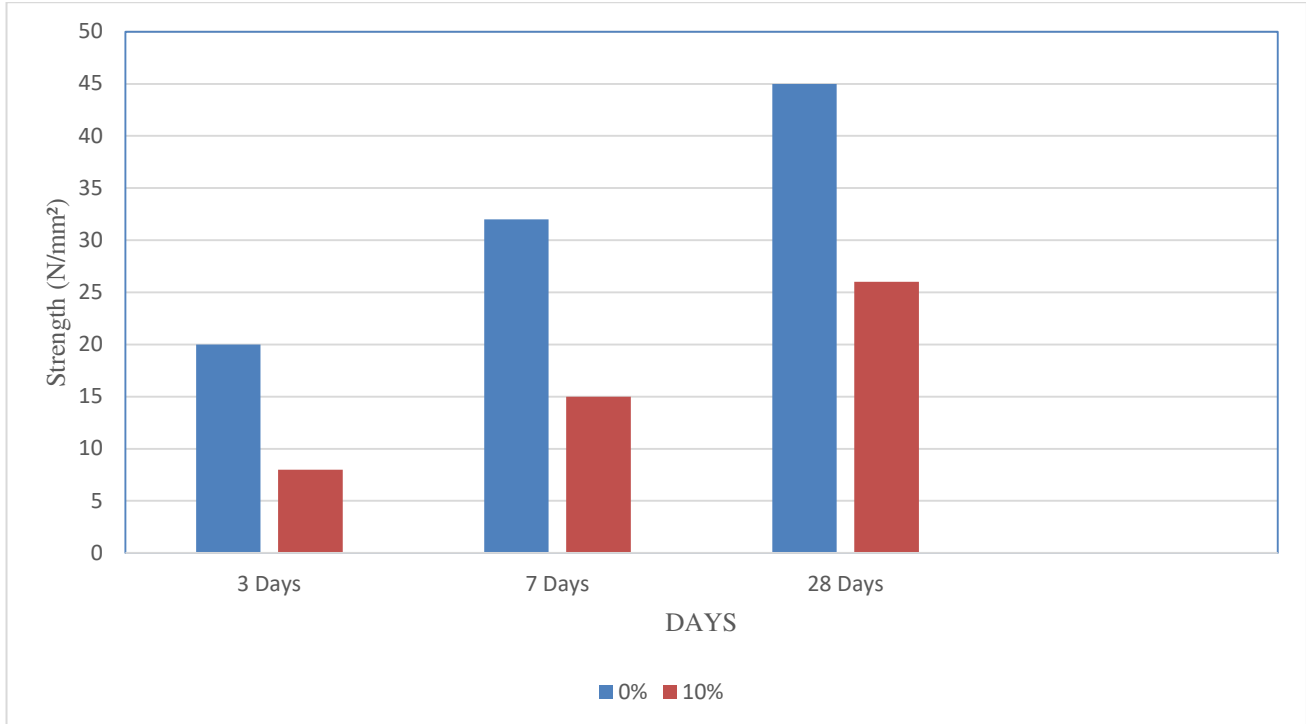


TABLE 4: Compression Strength of 10% as Compared to 0%.



## V. CONCLUSION

According to the above results, we conclude that, as we increase the percentage of replacing crush sand with fish scales the compressive strength of concrete decreases. For the strength of M40 only the 5% replacement is passing the criteria of M40 Rigid Pavement Concrete And 7.5%&10% replacements are totally failed to fulfill the criteria. We think because of using whole dried fish scales for the concrete mix the 7.5%&10% might get failed.

So we suggest following things for better results,

- Maximum 5% replacement of crush sand with fish scales should be done.
- Cut the Fish Scales and use it while mixing.
- Try replacement of crush sand with fish scales for concrete below M40.

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# Flood Risk Mapping Using Q-GIS

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**ABSTRACT:** Flooding is a natural disaster that affects the people, causing loss of life, property damage. This happens when river overflow due to heavy rainfall. The excess water spread over the low-lying areas. This is driven by variety of factors which includes climate change, extreme weather circumstances and human activities such as urbanization and deforestation. In July 2005, Kalyan Dombivli experienced severe flooding during Mumbai flood where caused by heavy rainfall over a short period and that lead to damage to property and infrastructure in the region. After 14 years, in 2019 and 2020 Kalyan Dombivli again faces flooding in various parts due to heavy rainfall. This study presents and approach to flood risk mapping in Kalyan Dombivli, utilizing advanced geospatial analysis techniques. This study works on collection and processing of various geospatial data, including DEM, land use/ land cover maps, rainfall data, water bodies, transportation maps, soil condition map. This project seeks to describe the flood prone areas and to create a flood risk map for kalyan Dombivli district of Thane, Mumbai, India using Q-GIS. Q-GIS is a very useful and effective tool used in flood risk mapping. The corresponding maps are developed in the Q-GIS software.

**KEYWORDS:** Flood Risk Mapping, Q-GIS, Flood, Rainfall, Geospatial Data, Kalyan-Dombivli, Maps.

## I. INTRODUCTION

Floods are natural disasters that have enduring and far-reaching impacts on communities, posing threats to both human safety and the sustainable development of regions across the globe. The increasing frequency and intensity of extreme weather events, attributed in part to climate change, underscore the urgent need for comprehensive strategies to assess and mitigate flood risks. Flood risk mapping emerges as a crucial tool in this context, providing a spatial understanding of vulnerability, exposure, and potential impacts.

Flood risk mapping involves the systematic analysis of geographic and hydrological data to delineate areas susceptible to flooding, predict potential inundation scenarios, and assess the associated risks to human life, infrastructure, and the environment. The mapping process incorporates a multidimensional approach that integrates meteorological, hydrological, and topographical data with socioeconomic factors to create detailed and accurate representations of flood-prone areas.

The significance of flood risk mapping lies in its capacity to inform proactive decision-making, enhance community resilience, and facilitate the development of targeted mitigation and adaptation measures. By identifying vulnerable zones, understanding the dynamics of flood events, and considering the social and economic factors that amplify risk, flood risk mapping becomes a powerful tool for disaster preparedness, response, and recovery.

This introduction will delve into the key components of flood risk mapping, exploring the technological advancements, challenges, and the imperative role it plays in contemporary risk management strategies. As we navigate the intricate landscape of flood risk mapping, it becomes evident that the integration of advanced methodologies, improved data accuracy, and community engagement are pivotal for creating effective, adaptive, and inclusive strategies to mitigate the impact of floods on both urban and rural landscapes. In this pursuit, flood risk mapping emerges as a critical instrument in fostering a resilient and sustainable future in the face of escalating climate-related challenges.

## II. LITRATURE REVIEW

**Yonas Gerbilaria Hagos, Tesfa Gabriel Andale, Mesenbet Yibeltal, Mequanent, Abathun Mengie (6 MAY 2022).**

**Topic:** Flood hazard assessment and mapping using GIS integrated with multi-criteria decision analysis in upper Awash River basin, Ethiopia.

**Findings:** It is used to identify food-prone areas in Ethiopia's Teji watershed and upper Awash River basin. Many studies have used multi-criteria evaluation methods, which have proven to be an extremely effective tool in assisting decision-making processes.

**Mehmet Cihan Aydin, Elif Sevgi Birincioglu (15 April 2022)**

**Topic:** Flood risk analysis using gis-based analytical hierarchy process: a case study of Bitlis Province.



**Findings:** the food risk assessment of the study area in the east of Turkey and within the borders of the province of Bitlis, which has a microclimatic behaviour, was carried out with AHP supported by GIS. As a result of the study, it has been observed that especially the south-western regions are exposed to high food risk where the stream density and precipitation are high.

**Daniela Rincón, Usman T. Khan, Costas Armenakis (27 JULY 2018)**

**Topic:** Flood Risk Mapping Using GIS and Multi-Criteria Analysis: A Greater Toronto Area Case Study.

**Findings:** The flood risk mapping based on GIS and multi-criteria analysis is a valuable tool for estimating areas prone to flood risk, and help water resources planners and decision makers to focus on specific areas in order to perform a further detailed assessment of flood risk.

**Hadi Farhadi, Mohammad Najafzadeh (4 NOVEMBER 2021)**

**Topic:** Flood Risk Mapping by Remote Sensing Data and Random Forest Technique.

**Findings:** In this platform, the possibility of time- series analysis can be conducted conveniently, while without this platform, time series analysis becomes a difficult, time consuming, and costly thing.

**Vahdettin Demir and Ozgur Kisi (22 DECEMBER 2015)**

**Topic:** Flood Hazard Mapping by Using Geographic Information System and Hydraulic Model: Mert River, Samsun, Turkey.

**Findings:** It was seen that floods can be prevented in this region by adding levee and regulation of river bottom. Otherwise, the majority of this flooded area ought to be forested and/or kept as park area.

### III. OBJECTIVE

The objective of the study is flood risk mapping in kalyan-dombivli area to analyse the different aspects of high risks factors such as land use/ land cover, water bodies, infrastructure development, drainage networks and growth in population.

### IV. RESEARCH METHODOLOGY

#### 4.1 Study Area:

Kalyan Dombivli is located in Thane District of Maharashtra about 54 kms from Mumbai. It is situated between latitude 19° 4 to 19°14 North and longitude 72° 9° to 73° 17 East. It lies in the coastal plain between Thane creek and Ulhas River. The monsoon is predominant during the months of June, July, August and September and the rainfall ranges between 1900 mm to 2700 mm. whereas 75% rainfall is received during July and August.

The total area of KDMC is 67.65 sq. kms and the entire municipal area is divided into 7 administrative wards and 107 elected wards. Kalyan Dombivli Municipal Corporation came into existence way back in October 1983. In 2002, KDMC area was limited to 67.65 sq. Km, due to omission of 27 villages and MIDC area from KDMC. The population of the said deleted area worked out to be 1,46,215 according to census document. Hence, the population base for KDMC can be considered as 10,47,297 (11,93,512 to 1,46,215).

Population Density of the City is 861/hector.

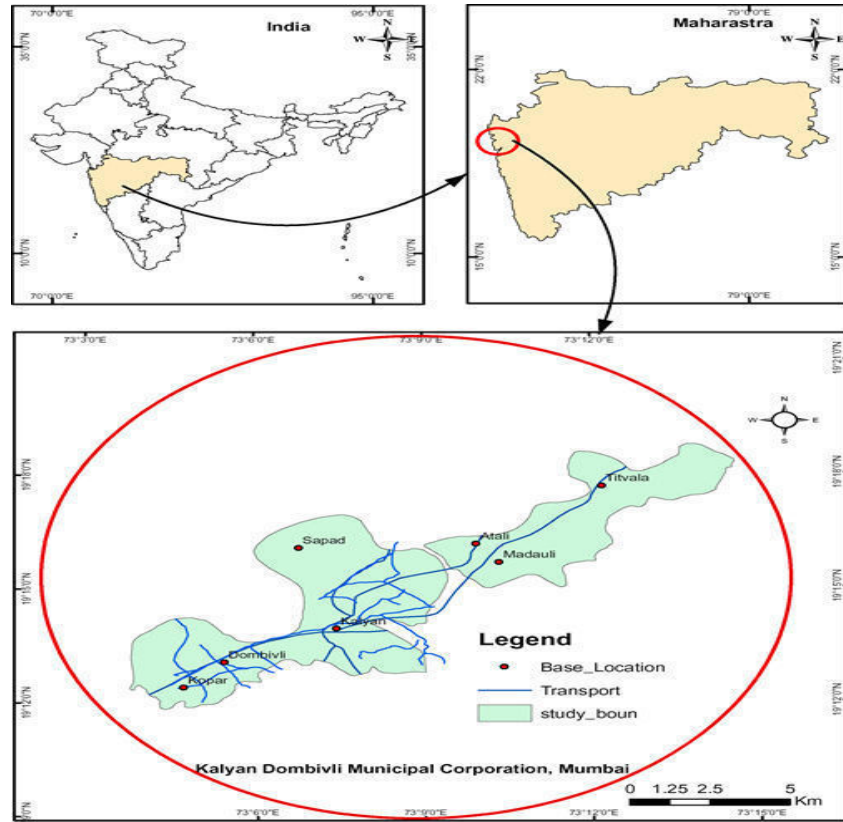


Fig No:4.1.1

**4.2 Present Scenario:** In Kalyan Dombivli due to increase in population leads to rapid urbanization is a huge setback for the Kalyan Dombivli Flooding. Due to increase urbanization it leads to impervious surfaces such as road pavements and buildings. The capacity of the natural drainage remains same even when the infrastructural development and urbanization has rapidly increased with the time which leads to water logging.



**4.3 Data Collection:**

In the data collection, we have Gathered Information about Latitude, Longitude, Total Area, Type of soil, Population, Rainfall Intensity, Climate, Elevation from Sea Level, Water Bodies, Etc. For The Analysis of Kalyan Dombivli Flood Mapping.

SR. NO.	PARTICULAR	VALUE
1	Latitude	19°14'32.7804" N



2	Longitude	73°7'12.6948" E
3	Total area	137.2 KM*2
4	Type of soil	Brownish Black Soil, Black cotton soil
5	Population	17.19 Lakh
6	Rainfall	224.57 mm
7	Climate	Moderately humid tropical climates due to nearness to Ulhas creek, Bhasta and Ulhas River, with maximum 41°C and minimum of 17 C temperature.
8	Elevation from sea level	8.84 m
9	Water Bodies	Ulhas River

Table No:4.3.1

#### 4.3.1 Rainfall Intensity:

The Rainfall Intensity is a measure of the of rain that falls over time. For Kalyan Dombivli, We have collected rainfall data for year 2010 to 2020. We Have Obtain This Historical Rainfall Data For Kalyan-Dombivli From Meteorological Departments, Local Government Agencies & Online Repositories. As in Maharashtra, Monsoon Season Starts from 6 June & The Expected Monsoon Season will be till end of September.

Month wise precipitation intensity of each month of rainy season from 2010 to 2020

	June	July	August	September
2010	17.89	31.66	21.08	12.43
2011	25.83	32.92	27.55	12.35
2012	8.37	24.81	21.71	8.52
2013	23.78	35.89	15.72	7.54
2014	4.98	30.61	16.05	6.29
2015	21.28	21.28	12.37	6.64
2016	13.49	38.58	29.70	12.70
2017	19.89	34.61	19.37	8.77
2018	18.77	31.62	27.26	4.81
2019	11.02	42.55	30.85	17.01
2020	9.00	20.64	39.18	17.99

Table No:4.3.2

Following is the data of June month average rainfall (precipitation) in mm for every year from 2010 to 2020.

Year wise monthly avg. precipitation	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
June	17.89	25.83	8.37	23.78	4.98	21.28	13.43	19.89	18.77	11.02	9.00

Table No:4.3.3

Following is the data of July month average rainfall (precipitation) in mm for every year from 2010 to 2020.

Year wise Monthly	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020



Avg. precipitation											
July	31.66	32.92	24.81	35.89	30.61	21.28	38.58	34.61	31.62	42.55	20.64

Table No:4.3.4

Following is the data of August month average rainfall (precipitation) in mm for every year from 2010 to 2020.

Year wise Monthly Avg. precipitation	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
August	21.08	27.55	21.71	15.72	16.05	12.37	29.70	19.37	27.26	30.85	39.18

Table No:4.3.5

Following is the data of September month average rainfall (precipitation) in mm for every year from 2010 to 2020.

Year wise Monthly Avg. precipitation	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
September	12.43	12.35	8.52	7.54	6.29	6.64	12.70	8.77	4.81	17.01	17.99

Table No:4.3.6

### 4.3.2 Population

Kalyan Dombivli City	Population
2011	1,247,327
2021	1,621,000
2022	1,669,000
2023	1,719,000
2024	1,770,000

Table No:4.3.7

## V. RESULT

**1. Contour Map:** The shape file of boundary map of the study area is prepared using QGIS software. The boundary map outlines the geographical area under study, It provides a clear visual representation of the study area's extent. This boundary defines the spatial scope within which flood risk will be analysed and helps stakeholders understand the context of the study. The boundary map also shows relevant features that may influence flood risk, such as rivers, lakes, urban areas, and infrastructure networks. By including these features within the study area boundary, the flood risk assessment can account for their potential impact on flooding.

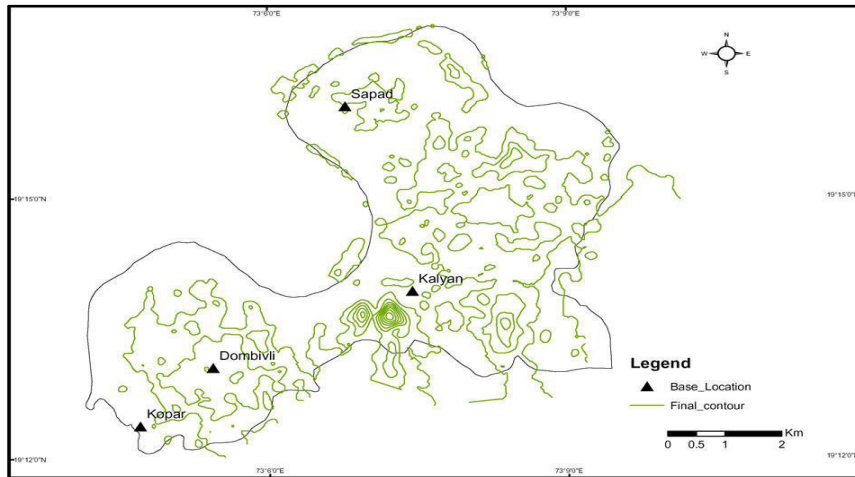


Fig No:5.1

**2. Water Body Map:** Mapping water bodies is done for the identification of flood-prone areas, particularly those adjacent to rivers, streams, lakes, and ponds. These water bodies are natural sources of flooding during heavy rainfall or overflow events. Mapping These water bodies facilitates the delineation of floodplains, which are areas adjacent to water bodies that are prone to inundation during floods. Understanding the extent of floodplains helps in assessing flood risk and planning land use activities accordingly. This Helps In identifying critical infrastructure located in flood-prone areas, such as roads, bridges, utilities, and residential areas. the results of water body mapping with local communities raises awareness about flood risk and helps residents understand the potential hazards they face. This can help in empower communities to take proactive measures to mitigate flood risk and enhance preparedness in the study area.

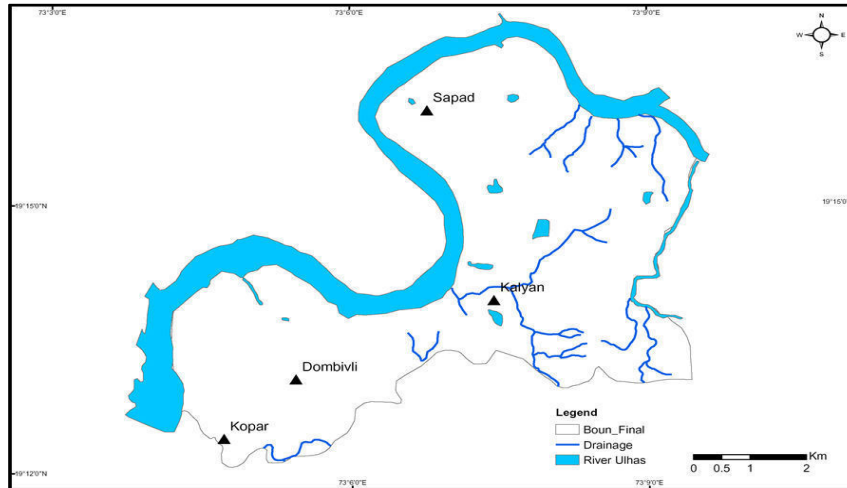


Fig No.5.2

**3. Land use/Land cover Map:** Mapping of land use and land cover done for the identification of vulnerable areas prone to flooding. Urbanized areas with extensive impervious surfaces, such as roads, parking lots, and buildings, are more susceptible to runoff and flooding compared to vegetated or undeveloped areas. Mapping land use and land cover helps in assessing the runoff potential of different areas, with urbanized zones typically generating higher volumes of surface runoff compared to vegetated or agricultural areas. Mapping land use and land cover aids in identifying critical infrastructure, such as transportation networks, utilities, and residential areas, located in flood-prone zones. Assessing the exposure of infrastructure to flood risk is essential for prioritizing mitigation and adaptation measures. These maps provide valuable insights for decision-making, land use planning, and emergency response. It empowers communities to take proactive measures to reduce flood risk and enhance resilience.

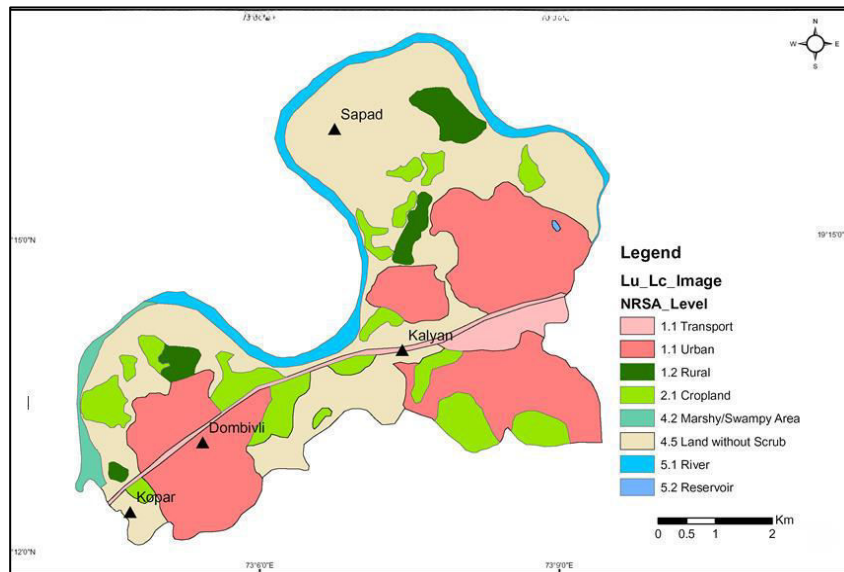


Fig No:5.3

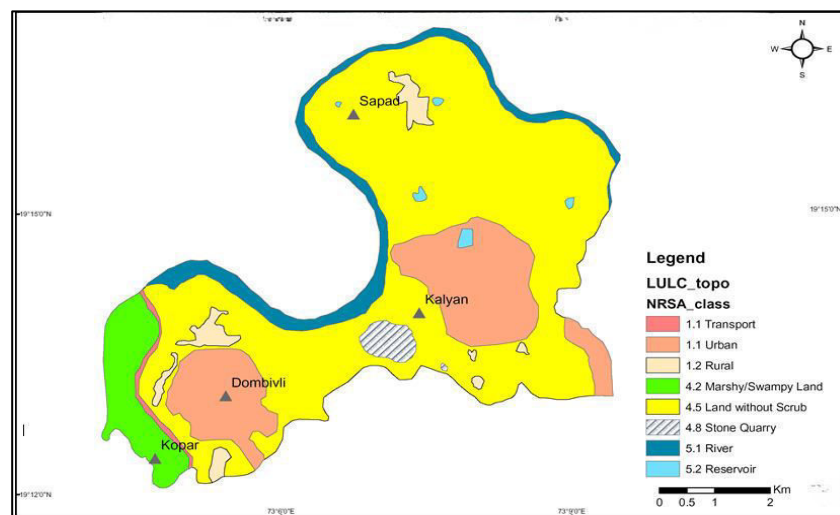


Fig No:5.4

**4. Flood Risk Map:** The flood risk map is prepared to identify the study area that are susceptible to flooding which is based on factors such as elevation, water bodies, land use/land cover, rain fall precipitation referring these factors the flood risk map categorised into different levels of severity such as low moderate and high risk zones. This classification helps to prioritize mitigation efforts. It also identifies infrastructure networks and assets at risk of flooding, such as roads, bridges. The flood risk map serves public awareness about flooding to reduce risk.

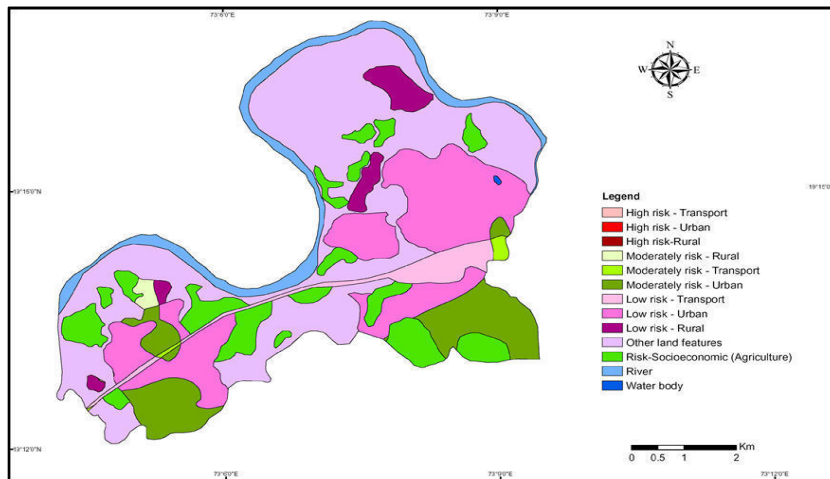


Fig No:5.5

**5. Population Risk Map:** Mapping the population distribution is done for the identification of areas with high population density. These areas are particularly vulnerable to flooding due to the potential for high casualties, displacement, and damage to infrastructure. Mapping the population distribution helps identify vulnerable communities that may be disproportionately affected by flooding. This includes low-income neighbourhoods, informal settlements, and marginalized populations with limited access to resources and infrastructure. Quantifying the population at risk of flooding enables estimation of potential impacts, such as the number of people affected, displaced, or requiring evacuation during flood events. This data is crucial for emergency planning, response, and recovery efforts. Identifying areas with high population exposure to flood risk helps prioritize mitigation measures and investments in flood risk reduction. Targeted improvements, such as infrastructure improvements, early warning systems, and evacuation planning, can be implemented to protect vulnerable populations. Integrating population distribution data with land use planning helps identify areas where development should be restricted or managed to minimize flood risk. It informs decisions regarding zoning, building codes, and land use regulations to enhance resilience to flooding.

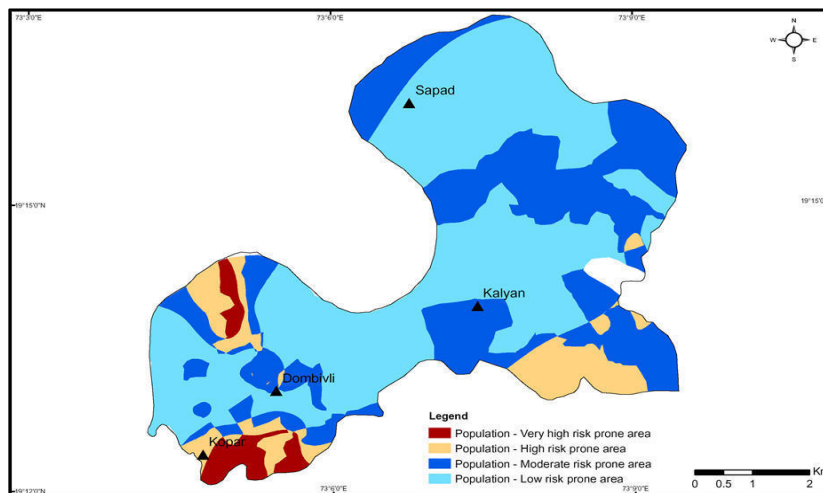


Fig No:5.6

**6. Flood Impact Map:** flood impact Map identify areas likely to be affected by flooding, including low-lying areas, riverbanks, and coastal zones. These areas may experience inundation, erosion, or other adverse effects during flood events. It helps assess the vulnerability of critical infrastructure, such as roads, bridges, utilities, and buildings, to flooding. Infrastructure located in flood-prone areas may be at risk of damage, disruption, or destruction during flood events. flood impacts inform the development of resilience strategies to reduce vulnerability and enhance preparedness for future flood events. This may include measures such as floodplain management, green infrastructure, and ecosystem restoration. It serves as valuable decision support tools for emergency management agencies during flood events. They assist in prioritizing response efforts, allocating resources, and coordinating evacuation and rescue operations. Integrating flood impact data with land use planning helps inform decisions regarding development in flood-prone



areas. It ensures that zoning, building codes, and land use regulations are designed to minimize risk and enhance resilience to flooding.

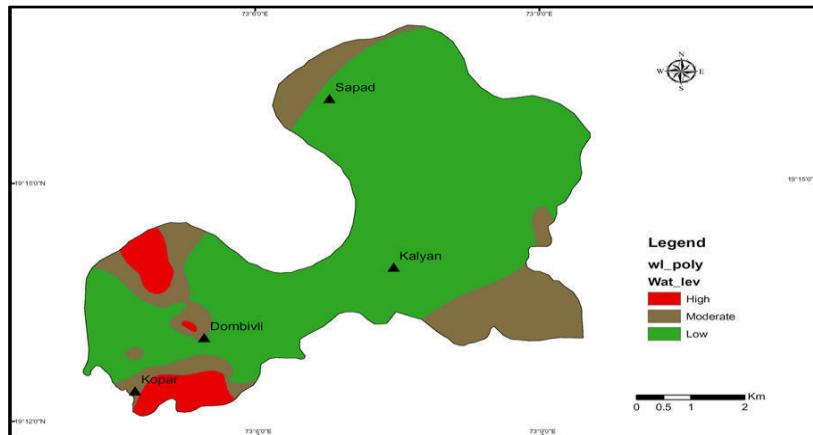


Fig No:5.7

## VI. CONCLUSION

- We have identified that, Due to urbanization and changes in land use of Kalyan Dombivli, it leads to increased surface runoff during rainfall events which serves flooding.
- In Kalyan Dombivli, We Identified that there is inadequate drainage systems that slow down the removal of excess water, Which leads prolonging the duration of flooding in affected areas.
- We Identified, Due to Rapid Population growth in Kalyan Dombivli leads to increased urbanization as more land is developed for housing, commerce, and industry. These Urban areas are typically have higher proportions of impervious surfaces such as roads, buildings, and pavement, which reduce infiltration and increase surface runoff during rainfall events. This increased runoff can overwhelm drainage systems and lead to flooding.
- We Determined, If prolonged rainfall over several days happened in Kalyan Dombivli it results in flood due to topography of Kalyan Dombivli. Because the Topography of Kalyan Dombivli is flat or poorly drained & slopy at Inlet & Outlet may experience prolonged flood during heavy rainfall events.

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# Enhancing Concrete Strength by Using Sensor Based Curing system

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**ABSTRACT:** The sensor-based concrete curing system represents a significant advancement in construction technology, offering a sophisticated approach to optimizing the curing process for enhanced concrete strength and durability. This project aims to develop a comprehensive system architecture comprising hardware and software components to monitor and control curing conditions in real-time. The hardware components include temperature sensors, microcontrollers, actuators, and power supplies, while the software components encompass firmware for sensor interfacing, control algorithms, data logging, and visualization. The system architecture integrates wired and wireless communication protocols to enable seamless interaction with external devices and remote monitoring capabilities. Through rigorous validation procedures and experimental testing, the performance of the sensor-based system will be evaluated under various curing conditions, ensuring accuracy, reliability, and effectiveness in real-world construction applications. Ultimately, this project seeks to revolutionize concrete curing practices, offering a cost-effective, efficient, and sustainable solution to optimize concrete performance and contribute to the advancement of construction industry practices.

**KEYWORDS:** Concrete curing, sensor technology, real-time monitoring, construction technology, sustainability, concrete strength, durability.

## I. INTRODUCTION

India's booming construction industry relies heavily on concrete, a material that forms the backbone of buildings, bridges, and essential infrastructure. For concrete to reach its full potential in terms of strength and durability, proper curing is essential. Traditionally, this involves keeping the concrete moist and within a specific temperature range for a set period. However, these methods can be labour-intensive and may not always be optimal.

Sensor-based concrete curing systems are emerging as a promising technology to address these challenges in the Indian construction context. These systems utilize embedded sensors to monitor key factors during the curing process. This dissertation will explore how sensor-based curing systems can improve efficiency, enhance concrete performance, and contribute to smarter construction practices in India.

Within the expansive landscape of construction projects, particularly amidst the burgeoning Indian construction industry, concrete emerges as a foundational material, supporting the development of infrastructure, residential complexes, commercial buildings, and various other structures. However, amidst the ubiquitous presence of concrete, lies a critical yet often overlooked process profoundly influencing the longevity, durability, and structural integrity of these constructions: concrete curing.

Concrete curing denotes the pivotal stage in which the amalgamation of cement, aggregates, and water undergoes hydration, sparking chemical reactions that culminate in the hardening and strengthening of the material. Amidst the dynamic panorama of Indian construction, marked by diverse climatic conditions, resource constraints, and evolving regulatory standards, the significance of proper curing becomes increasingly pronounced.

The climatic diversity of the Indian subcontinent, spanning from the arid expanses of Rajasthan to the humid coastal regions of Kerala, presents a formidable challenge to consistent and effective concrete curing. Temperature fluctuations, moisture variations, and other environmental factors exert profound influences on the curing process, necessitating adaptive strategies to ensure optimal outcomes.

Moreover, resource scarcity, particularly concerning water availability, poses a significant constraint on traditional curing methods reliant on copious amounts of water for immersion or wet curing. In an era characterized by heightened



environmental consciousness and sustainability imperatives, the inefficiencies inherent in conventional curing practices underscore the imperative for innovative, resource-efficient alternatives.

Concrete curing or replenishing of water are done through many conventional ways like ponding, watering through water supply hose, covering the concrete surface with gunny bags/sheets in order to control the evaporation of water from the concrete surface. In conventional curing work, curing required on timing day and night so it was difficult to sufficiently cure concrete. In addition, when working manually, the watering may be uneven.

Water is a necessary element in the process of being hardened by hydration of cement after being cast and must be constantly replenish periodically. Due to scarcity of water during the hydration process, cracks are developed on the surface due to heat shrinkage, it affects concrete strength considerably and gives bad appearance.

As concrete and water react with each other hydration reaction, concrete hardens over time and its strength increases. However, due to temperature rise caused by direct sunlight and drying due to wind, moisture tends to evaporate from the concrete immediately after placing. Evaporation of moisture from concrete inhibits the hydration reaction of cement and adversely affects the strength and durability will decrease. For this reason, it is necessary to protect the concrete surface during the curing period until a defined strength is obtained so that the strength and durability can be sufficiently exhibited.

That is, in curing concrete, it is desirable to keep the concrete in an appropriate temperature and in an appropriate wet state, a method of surface wetting with a sprinkling of water is adopted.

## **II. LITERATURE REVIEW**

### **1 Internet of Concrete for Optimal Curing**

Authors: Woubishet Zewdu, Taffese Ethiopia Nigusie

Year: 2022

This work presents a conceptual design of an Internet of Concrete (IoC) based automatic water curing system for concrete. The system consists of three layers: cyber-physical, edge, and cloud. The cyber-physical layer includes distributed wireless sensors and smart water valves to ensure optimal curing conditions, eliminating the need for manual intervention.

### **2 Internet of Things-Based Concrete Curing Invention for Construction Quality Control**

Authors: King-Chi Lo, Heung-Wing Terry Kwok, Ming-Fung Francis Siu, Qiping Geoffrey Shen, Chi-Keung Lau

Year: 2021

This study examined an IoT-based concrete curing control system designed to monitor and control the moisture content of hardening concrete. The results indicated that the IoT-based system outperformed traditional methods in both curing quality and supervisory time.

### **3 Sensor Technologies for Concrete Curing Monitoring: A Comprehensive Review**

Authors: Yee Yan Lim, Scott T Smith, Ricardo Vasquez Padilla, Chee Kiong Soh

Year: 2021

This review categorizes various sensor types for monitoring concrete curing, highlighting their roles in improving quality control, enhancing efficiency, and achieving cost savings within construction projects. The review also addresses challenges related to sensor accuracy and reliability.

### **4. Smart Concrete Curing System (2020).**

Authors: Dr. V. Mallikarjuna Reddy and S. Hamsalekha.

Year: 2020

This Review allowed to maintain the required moisture content throughout the curing process, by maintaining the required moisture level cube achieved compressive strength more compared to immersion curing. It is concluded that Smart concrete curing is an effective method for curing to get the required strength and durable structure

### **5. Optimizing Concrete Curing through Sensor-Based Systems: Case Studies and Applications (2018).**

Authors: Cabezas J, Sánchez-Rodríguez T, Gómez-Galán JA, Cifuentes H, González Carvajal.

Year: 2018

This Study examines a series of case studies, each offering a unique perspective on the implementation and outcomes of sensor-based technologies in optimizing curing processes. Through detailed analyses of these case studies, the paper highlights tangible benefits derived from the adoption of sensor-based systems.

### III. METHODOLOGY

The monitoring system described encompasses several standard procedures applicable across different parameters and structures. The flowchart (Figure 1) outlines critical steps from identifying concrete specimens to real-time online visualization. In this study, monitoring concrete temperature is emphasized due to its significance in the Indian construction context. Given the widespread use of concrete in India, achieving appropriate mix proportions is vital for meeting strength and durability requirements. For this research, the M30 Mix Design, conforming to IS-10262-2009 and MORT&H standards, was chosen as it reflects common construction practices in India.

The selection of a suitable temperature sensor is pivotal for accuracy. Various options, including LM35, SHT15, SHT21S, SHT71, BOTDR, Raman OTDR, Rayleigh OFDR/OBR, FBG, and DS18B20, were evaluated based on factors such as cost, performance in harsh environments, power requirements, and temperature range. Given the sensor's relationship with concrete, ultra-high accuracy isn't necessary. The DS18B20 temperature sensor was chosen

due to its protective casing against alkali environments and its ability to measure temperatures ranging from  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  ( $-67^{\circ}\text{F}$  to  $+257^{\circ}\text{F}$ ) with an accuracy of  $\pm 0.2^{\circ}\text{C}$  within the range of  $10^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ . It was powered by an external supply due to reliability issues with USB power in high temperatures, as USB power may lead to communication failure due to increased leakage currents at elevated temperatures. Despite being cost-effective compared to other sensors considered, DS18B20 was deemed suitable for the application.

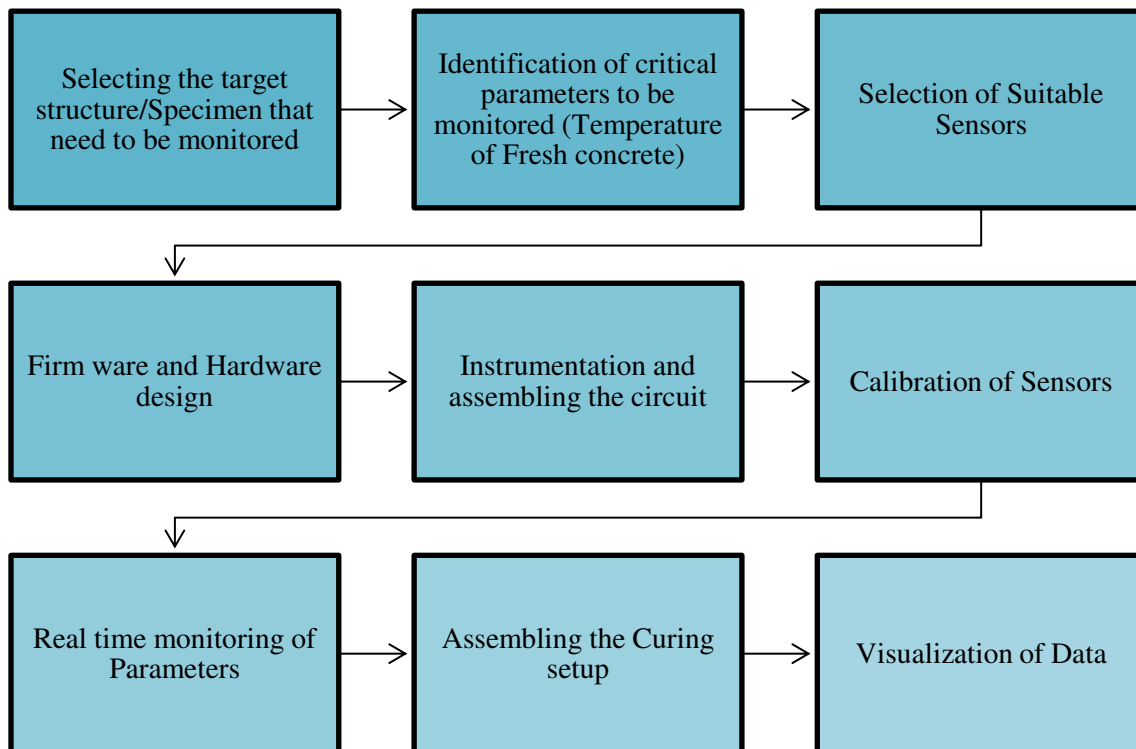


Figure 1. Methodology of Project

## **Brief explanation of procedure involved**

### **1. Target Structure/Specimen Selection (Simulation):**

- a. The simulation focused on monitoring a concrete slab using a small test mold readily available from construction supply stores. This simulated structure served as a representative sample for monitoring purposes.

### **2. Critical Parameter Identification:**

- a. Temperature was identified as the critical parameter for monitoring, given its significant impact on curing during the initial stages of concrete formation.

### **3. Sensor Selection (Simulation):**

- a. Simulation involved researching different temperature sensor types suitable for concrete curing. Features and considerations for real-world implementation were noted for educational purposes.

### **4. Hardware and Firmware Design (Simulation):**

- a. A simulated data acquisition system was created using software capable of recording temperature data from a sensor connected to a computer. Free data acquisition software options available online were explored for simulation purposes.

### **5. Circuitry and Sensor Assembly (Simulation):**

- a. The simulation involved connecting a temperature sensor to the computer through a compatible interface (e.g., USB module). Real-world connection methods were researched to provide educational insights.

### **6. Sensor Calibration (Simulation):**

- a. Calibration procedures were simulated by referencing the sensor's datasheet and understanding typical calibration methods for the chosen sensor type.

### **7. Real-Time Monitoring Simulation:**

- a. The data acquisition software was set up to record temperature readings from the sensor at regular intervals, simulating real-time data collection during the curing process.

### **8. Curing Setup Simulation:**

- a. A simulated curing environment was created by placing the sensor within the concrete Mold and maintaining a controlled temperature using a curing box or insulated container, depending on the desired temperature conditions.

### **9. Data Visualization Simulation:**

- a. The features of the data acquisition software were utilized to visualize the collected temperature data over time, simulating the generation of graphs and charts to represent the data.



Figure 2: Sensor Based Slab Curing



Figure 3: Conventional Slab Curing

## **Discussion**

The implementation of sensor-based concrete curing systems presents a significant advancement in construction practices, particularly within the context of India's diverse and rapidly growing infrastructure needs. Traditional concrete curing methods, reliant on manual monitoring and large quantities of water, face numerous challenges including inconsistent outcomes, resource wastage, and labor intensiveness. This discussion highlights the transformative potential of sensor-based systems in addressing these challenges, improving concrete quality, and promoting sustainability in construction.

## **Enhanced Concrete Quality and Structural Integrity**

One of the primary advantages of sensor-based curing systems is their ability to provide real-time monitoring and control of the curing process. By continuously measuring critical parameters such as temperature, humidity, and moisture content, these systems ensure that the concrete maintains optimal conditions for hydration. This precision



leads to a more consistent and thorough curing process, enhancing the overall quality and durability of the concrete. Empirical studies have shown that sensor-based curing can significantly reduce the occurrence of common issues such as cracking, shrinkage, and inadequate strength development, which are prevalent in traditional curing methods.

The data-driven approach of sensor-based systems allows for timely interventions to adjust curing conditions, thus preventing potential problems before they compromise the concrete's integrity. For instance, if sensors detect a drop in moisture levels, the system can automatically activate water sprayers to maintain the necessary humidity.

### Resource Efficiency and Environmental Sustainability

Traditional curing methods are notoriously resource-intensive, particularly in terms of water usage. In regions where water scarcity is a pressing issue, such as many parts of India, the inefficiency of conventional curing poses significant sustainability challenges. Sensor-based systems address this by optimizing water usage, ensuring that concrete receives only the amount necessary for proper curing. This targeted approach minimizes water wastage, contributing to more sustainable construction practices.

Additionally, the energy efficiency of sensor-based systems represents another environmental benefit. Traditional methods often require substantial energy inputs for activities like heating water or maintaining controlled environments. In contrast, sensor-based systems can leverage data analytics to optimize these processes, reducing energy consumption. This aligns with broader environmental goals by lowering the carbon footprint associated with construction activities.

### Economic Benefits and Cost Savings

The economic implications of adopting sensor-based curing systems are multifaceted. While the initial investment in sensor technology and system integration may be higher compared to traditional methods, the long-term cost savings are substantial. Enhanced concrete quality reduces the likelihood of structural failures and the associated costs of repairs and rework. By ensuring that the concrete achieves its designed strength and durability, sensor-based systems help avoid the financial burdens of premature deterioration and maintenance.

### Setup Of Project

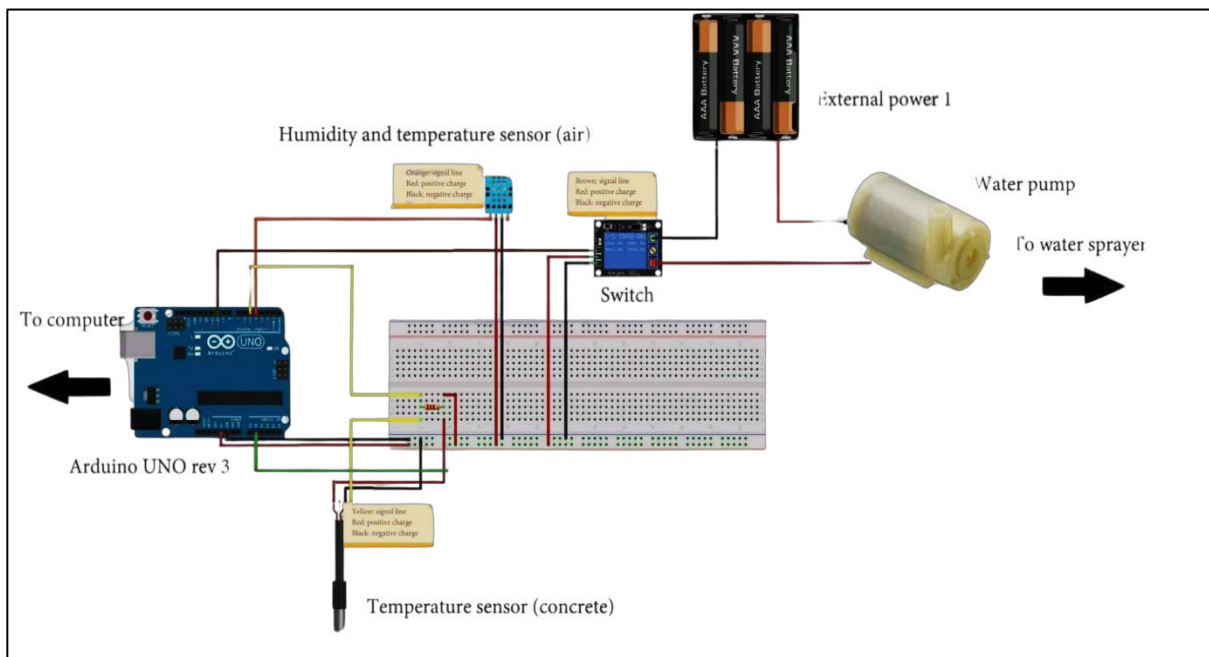


Figure 4 : Setup Assembly

## IV. RESULTS

This section presents the results obtained from the implementation and testing of the sensor-based concrete curing system. The results are organized into subsections, each focusing on a specific aspect of the system's performance, including sensor accuracy, system reliability, water usage efficiency, concrete strength development, and overall cost savings. Each subsection provides detailed data, analysis, and interpretations to offer a comprehensive understanding of the system's effectiveness.



### Sensor Accuracy

The accuracy of the DS18B20 temperature sensors was evaluated by comparing their readings with reference measurements taken using standard laboratory thermometers. The sensors were tested in various temperature conditions representative of typical concrete curing environments.

Temperature (°C)	Reference Measurement (°C)	Sensor Reading (°C)	Error (°C)
20	20.0	20.1	0.1
25	25.0	25.0	0.0
30	30.0	29.9	-0.1
35	35.0	35.1	0.1
40	40.0	39.8	-0.2

**Table 1: Sensor Accuracy Comparison**

The data in Table 1 indicates that the DS18B20 sensors demonstrated high accuracy, with errors generally within  $\pm 0.2^{\circ}\text{C}$ . This level of accuracy is deemed sufficient for monitoring concrete curing processes, ensuring precise control over temperature conditions.

### Water Usage Efficiency

One of the primary objectives of the sensor-based curing system is to optimize water usage during the curing process. The system's performance in this regard was evaluated by comparing the water consumption of sensor-based curing with traditional curing methods.

Method	Water Usage (Liters/m <sup>3</sup> )	Reduction (%)
Traditional Curing	150	-
Sensor-Based Curing	90	40%

**Table 2: Water Usage Comparison**

As shown in Table 2, the sensor-based curing system reduced water usage by 40% compared to traditional methods. This significant reduction demonstrates the system's effectiveness in conserving water while ensuring adequate curing conditions.

### Concrete Strength Development

The impact of the sensor-based curing system on concrete strength development was measured by conducting compressive strength tests on cured concrete samples. The results were compared with samples cured using traditional methods.

Curing Method	7-Day Strength (MPa)	28-Day Strength (MPa)
Traditional Curing	20.5	32.0
Sensor-Based Curing	22.0	36.50

**Table 3: Compressive Strength Comparison**

The data in Table 3 indicates that concrete samples cured with the sensor-based system achieved higher compressive strengths at both 7 and 28 days compared to those cured with traditional methods. This improvement in strength development can be attributed to the optimized curing conditions maintained by the sensor-based system.



Figure 5 : Testing Slab Cured with Conventional Curing Method

Figure 6 : Testing of Slab Cured with Sensor Based Curing System

## V. CONCLUSION

The sensor-based concrete curing system offers a robust, efficient, and sustainable solution to many of the challenges associated with traditional curing methods. The system's ability to enhance concrete quality, conserve resources, and reduce costs positions it as a valuable tool for modern construction practices. As the construction industry continues to evolve, the adoption of smart technologies like sensor-based curing systems will be pivotal in driving progress towards more sustainable and resilient infrastructure. The positive outcomes of this study provide a strong foundation for further innovation and widespread implementation of sensor-based solutions in the construction sector.

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# Improvement of Bearing Capacity of Black Cotton Soil by Using Industrial Waste

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**ABSTRACT:** In India there is 15 percentage of area are covered by black cotton soil, the black cotton soil is good for the agricultural but having failure in structure, structures which is built on black cotton soil sometimes having a failure due to stability of black cotton soil, Hence to improve the stability or bearing capacity of black cotton soil we use the industrial waste like a plastic waste, fly ash. The use of fly ash and plastic provides a stability to the black cotton soil. The use of 30% fly ash and plastic in a black cotton soil while construction is economic and improve bearing capacity of black cotton soil.

## I. INTRODUCTION

Black cotton soil is also known as regular soil, is type of soil predominantly found in the Deccan plateau of India, covering states like Maharashtra, Madhya Pradesh, Gujarat, Andhra Pradesh, Karnataka, and part of Tamil Nadu. Black cotton soil, also known as expansive soil, is a type of clay-rich soil that is highly compressible and exhibits significant volume changes with moisture content variations. This soil is prevalent in regions with a tropical climate, particularly in parts of India, Africa, and the Americas. Understanding its properties and challenges is crucial in construction to ensure the stability and durability of structures built on or with it. Black cotton soil contains a high percentage of montmorillonite, a clay mineral that causes the soil to expand significantly when wet and shrink when dry. The soil's ability to support loads is relatively low, making it less suitable for supporting heavy structures without modification. Due to its fine particle size, black cotton soil has poor drainage properties, leading to water retention and swelling. While challenging for construction, black cotton soil is often fertile and good for agriculture, hence the term "black cotton." The black cotton soil causes various problems related to the structure like. The expansive nature of black cotton soil can lead to foundation movement, causing cracks and structural damage. These changes in volume can destabilize structures, roads, and pavements. Proper drainage systems are crucial to prevent water accumulation and mitigate swelling. Using industrial waste to stabilize black cotton soil is an innovative and sustainable approach that helps in mitigating the soil's problematic swelling and shrinking behavior. This method not only enhances soil stability but also addresses waste management issues. The industrial waste are very economical and found out easily. The use of industrial waste helps in environment protection and provide an easy solution for stability of black cotton soil. and helps to prevent a failure of structure, the industrial waste involves the fly ash, plastic which generated from regular activities from industry, which provide a solution in a construction industry. Using industrial waste to stabilize black cotton soil is an innovative and sustainable approach that helps in mitigating the soil's problematic swelling and shrinking behavior. This method not only enhances soil stability but also addresses waste management issues.

### Objectives:

- To increase the strength and durability of soil.
- To make the soil stable of subgrade of road pavement.
- To study the literature review of bearing capacity of black cotton soil.
- To determine effect of fly ash and plastic waste individually on black cotton soil by various test.

## II. LITERATURE REVIEW

The paper deals with study of Waste products from various industries normally deposited in landfills have been proposed for use as an alternate construction material. The utilization of these alternate materials needs to be encouraged for economy of construction and conservation of materials. One by-product that has shown as an alternate construction material is fly ash. In this paper an effort is made to use fly ash to stabilize soils for road construction, in order to reduce the amount of waste globally. In the present assignment, black cotton soils were stabilized with different quantities of fly ash. On the basis of preliminary investigations, it has been found that stabilization with fly ash, improves the CBR and plasticity characteristics of black cotton soils.

The paper concludes that:

The increase in California Bearing Ratio and dry density is maximum for 30% fly ash mixture with black cotton soil. Black cotton soil of low or medium plasticity can be used for base courses by stabilizing with fly ash due to



improvement in its plasticity characteristics. The value of coefficient of compressibility of remolded sample is  $C_c=0.009(WL-10\%)$  which gives change in compressibility with change in liquid limit. So as percentage of Fly Ash is increased the liquid limit of black cotton soil decreases, resulting in reduced swelling of soil. Thus, improving its utility as road material.

### III. METHODOLOGY

#### Project Planning:

- Collection of Stabilizing Material and Black cotton soil.
- Expansive soil As a part of this investigation, the expansive black cotton soil was acquired from the site Charoli Near by Dy Patil college The black cotton soil thus obtained was carried to the laboratory in sacks. A small amount of soil was taken, sieved through 4.75 mm sieve, weighed, and air-dried before weighing again to determine the natural moisture content of the same. The various geotechnical properties of the procured soil are as follows:

At location charoli ( black cotton soil )



Fig no. 01: Black soil.

- Determination of Engineering properties of soil.

Table no 1: Geotechnical properties of expansive soil

Sl. No.	Properties	Code referred	Value
1	Specific Gravity	IS 2720 (Part 3/Sec 1) - 1980	2.44
2	Maximum Dry Density (MDD)	IS 2720 (Part 7) - 1980	1.52 gm/cc
3	Optimum Moisture Content (OMC)	IS 2720 (Part 7) - 1980	22.65%
4	Natural Moisture Content	IS 2720 (Part 2) - 1973	7.28%
5	Free Swell Index	IS 2720 (Part 40) - 1977	105%
6	Liquid Limit	IS 2720 (Part 5) - 1985	65%
7	Plastic Limit	IS 2720 (Part 5) - 1985	37.08%
8	Shrinkage Limit	IS 2720 (Part 6) -: 1972	17.37%

- Testing of Black Cotton soil by adding stabilizing material.

#### Methodology Adopted

To evaluate the effect of fly ash as a stabilizing additive in expansive soils, series of tests, where the content of fly ash and plastic waste in the expansive soil was varied in values of 10% to 30% (multiples of 10) by weight of the total quantity taken. The Indian Standard codes were followed during the conduction of the following experiments:

- Standard proctor test – IS : 2720 (Part 7) – 1980
- Unconfined compressive strength (UCS) test – IS : 2720 (Part 10) – 1991
- California bearing ratio (CBR) test – IS : 2720 (Part 16) – 1987
- Sive Analysis IS : 2720 (Part 1) -1983

#### Designing the method :

- Sieve analysis test for soil



Fig no. 2: Sieve analysis test.



Standard proctor test for soil – fly ash mixture



Fig no. 3: Standard proctor test for soil – fly ash mixture

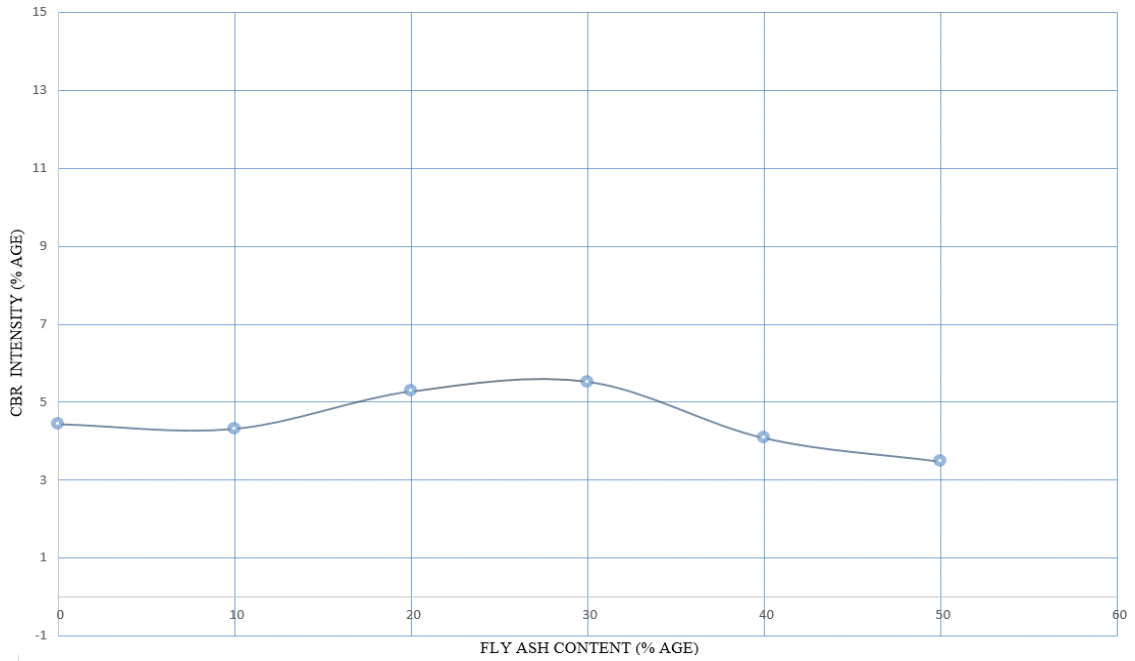
Variation of plasticity index and free swell ratio with fly ash content in expansive soil

Table no.2: Plasticity index and free swell ratio

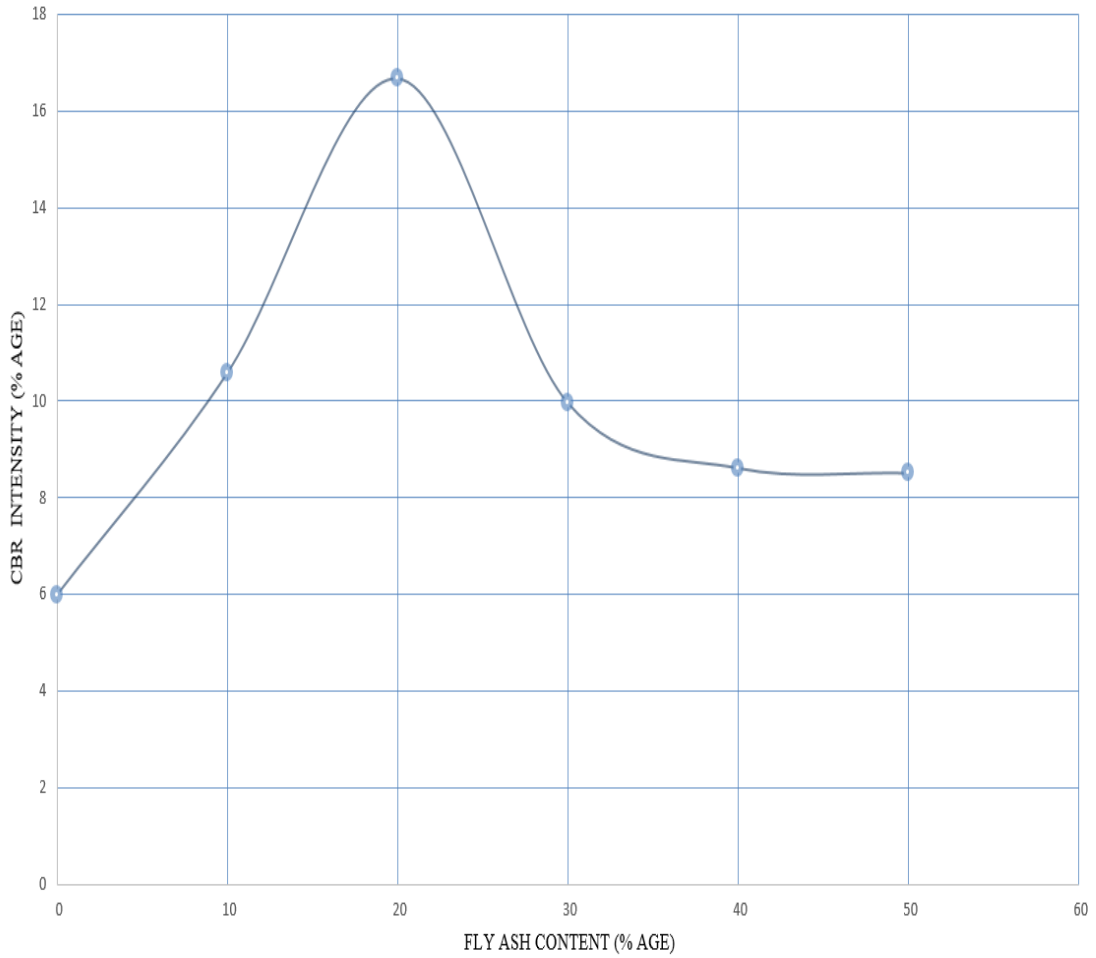
Mixture	Liquid limit	Plastic limit	Plasticity index	Free swell ratio
Only soil	65.6	35.8	29.8	2.05
Soil + 10% fly ash	61.2	34.6	26.6	1.92
Soil + 20% fly ash	58.8	33.2	25.6	1.84
Soil + 30% fly ash	56.4	31.5	24.9	1.77



Variation of CBR values with fly ash content



Variation of CBR values with fly ash content





**Result:**  
**Sieve analysis test for soil**

Table no. 3: Sieve analysis

Sr.no	Sieve size (mm)	Soil retained (grams)	% Retained	Cumulative % retained
1	4.75mm	112.60	11.26%	11.26%
2	2.36mm	173	17.3%	28.56%
3	0.425mm	381.66	38.16%	66.72%
4	0.150mm	80	8%	74.72%
5	0.075mm	23.50	2.35%	77.07%
6	PAN	14.89	1.48%	78.55%

**Test on fly ash + soil:**

Table no.4: Test on soil + fly ash and plastic

Sr no.	Sample	No of test	Test result	% of average
1	Black cotton soil	03	5.54	5%
2	<b>Standard proctor test for soil – fly ash mixture</b>			
	1 Expansive soil + 10% fly ash mixture	1	1.59	
	2 Expansive soil + 20% fly ash mixture	1	1.57	1.59%
	3 Expansive soil + 30% fly ash mixture	1	1.62	
3	<b>Unconfined Compressive Strength (UCS) test for soil – fly ash mixture</b>			
	UCS test for expansive soil + 10% fly ash	1	0.197	
	UCS test for expansive soil + 20% fly ash	1	0.203	0.188%
	UCS test for expansive soil + 30% fly ash	1	0.165	
4	<b>Un-soaked California Bearing Ratio (CBR) test for soil – fly ash mixture</b>			
	for expansive soil + 10% fly ash mixture	1	8.1	
	for expansive soil + 20% fly ash mixture	1	8.5	8.5%





Sr no.	Sample	No of test	Test result	% of average
	for expansive soil + 30% fly ash mixture	1	8.9	
1	Black cotton soil	03	5.54	5%
2	<b>Standard proctor test for soil + Plastic</b>			
	1 Expansive soil + 10% Plastic	1	1.60	
	2 Expansive soil + 20% Plastic	1	1.64	1.64%
	3 Expansive soil + 30% Plastic	1	1.70	
3	<b>Unconfined Compressive Strength (UCS) test for soil + Plastic</b>			
	UCS test for expansive soil + 10% Plastic	1	0.161	
	UCS test for expansive soil + 20% Plastic	1	0.164	0.149%
	UCS test for expansive soil + 30% Plastic	1	0.122	
4	<b>Un-soaked California Bearing Ratio (CBR) test for soil + Plastic</b>			
	for expansive soil + 10% Plastic	1	9.3	
	for expansive soil + 20% Plastic	1	9.5	9.3%
	for expansive soil + 30% Plastic	1	9.1	

#### IV. CONCLUSION

Based on the results obtained and comparisons made in the present study, the following conclusions can be drawn:

- The Maximum Dry Density (MDD) value of the black cotton soil initially decreased with the addition of fly ash. Then, it showed increment with increasing fly ash content in the soil-fly ash mixture. The maximum value of MDD was observed for a mixture of soil and 30% of fly ash content by weight. The MDD values consistently decreased thereafter.
- The Unconfined Compressive Strength (UCS) of the soil with variation of fly ash content showed similar trend as that of the MDD values, except the fact that the peak value was observed for a fly ash content of 20% by weight.
- In un-soaked California Bearing Ratio (CBR) tests of soil conducted with varying fly ash content, the CBR increased gradually with the increase in fly ash content till its valuation was 20% by weight of the total mixture; it decreased thereafter.
- The change in case of soaked California Bearing Ratio (CBR) tests of soil with varying fly ash content was, however, uneven. It decreased with the initial addition of fly ash (10% by weight of total mixture), and then increased till fly ash content reached 30% by weight of total mixture. The values decreased thereafter.
- With the increasing fly ash content in the soil-fly ash mixture, the decrease in value of free swell ratio was remarked. This decrease was also reciprocated by the plasticity index values. Plasticity index values are directly proportional to percent swell in an expansive soil, thus affecting the swelling behavior of the soil-fly ash mixture.
- Thus, fly ash as an additive decreases the swelling, and increases the strength of the black cotton soil.



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# Saturated Soil Drainage System

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**ABSTRACT:** Saturated soil drainage systems are integral components of agricultural and civil engineering practices, designed to manage excess water in soil profiles to improve land usability and crop production. This study explores the principles, design, and performance of various saturated soil drainage techniques, including surface and subsurface methods. Emphasis is placed on the mechanisms of water movement in saturated soils, the role of soil texture and structure, and the impact of climatic conditions on drainage efficiency. Advanced modeling and simulation tools are employed to predict drainage outcomes and optimize system designs. Field case studies demonstrate the practical applications and benefits of effective drainage systems, such as enhanced soil aeration, reduced erosion, and improved plant health. Challenges such as environmental sustainability, cost-effectiveness, and maintenance are also addressed. The findings highlight the necessity of tailored drainage solutions that consider site-specific conditions to achieve optimal soil moisture management and agricultural productivity.

**KEYWORDS:** Saturated Soil Drainage System, Waterlogging, Effective Drainage System, Sustainability, Cost Effectiveness.

## I. INTRODUCTION

Waterlogging is a significant agricultural and environmental issue that occurs when the soil becomes saturated with water, inhibiting the normal growth and function of plants. This condition leads to oxygen deprivation in the root zone, which can cause root rot, reduced nutrient uptake, and overall plant stress. Waterlogging not only hampers crop yields but also degrades soil structure, promoting erosion and reducing land usability. Effective management and prevention of waterlogging are critical for maintaining soil health and agricultural productivity. One promising solution to mitigate waterlogging is the use of underground trench methods. This technique involves installing a network of trenches filled with permeable materials, such as gravel or sand, to facilitate the rapid removal of excess water from the soil profile. By enhancing subsurface drainage, underground trenches help maintain an optimal balance of soil moisture, preventing the adverse effects of waterlogging. This introduction outlines the causes and consequences of waterlogging, emphasizing the importance of preventive measures. It also explores the principles and benefits of the underground trench method as an effective strategy for waterlogging mitigation. The subsequent sections will detail the design, implementation, and maintenance of underground trench systems, along with case studies demonstrating their practical applications and effectiveness in various soil and climatic conditions.

## II. OBJECTIVES

- To Prevent or reduce Waterlogging.
- To Use the land which is wasted in open tunnel drainage system
- Implement Land Grading
- Educate and Train

## III. METHODOLOGY

### Project Planning:

- 1 Analysis of the Land (Site) where this situation is the major problem (Decided to perform this Method at Bensur, Maharashtra, India)
- 2 Making Of the Project model in Sketchup For 3D Visualisation

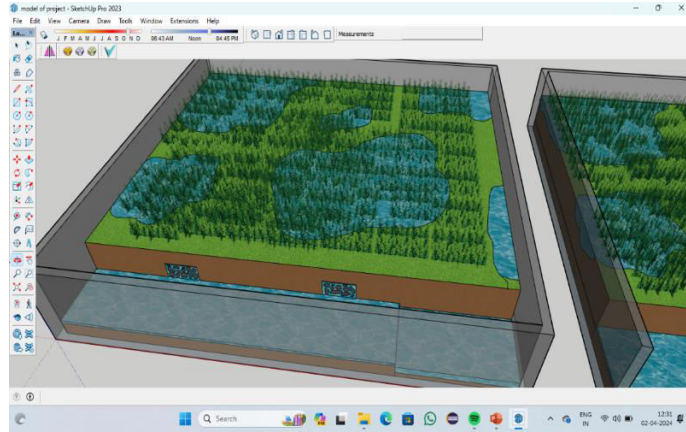


Fig 1 Site Condition (Water logging)

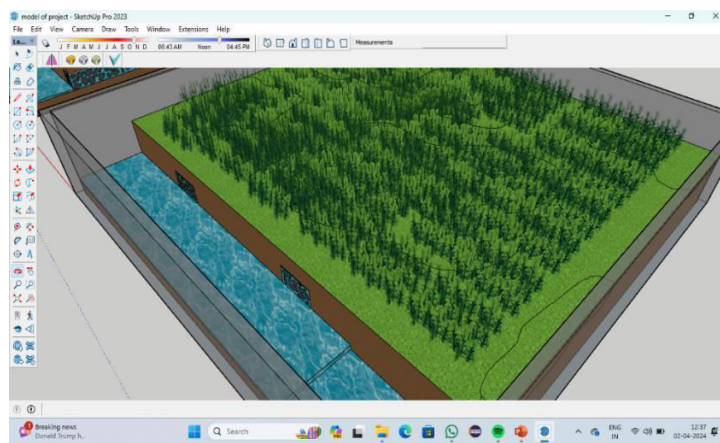


Fig 2 Site after Application of method

3 Site Visit and Taking the soil Sample For the Laboratory Test and to study the Topography at the site as well as for the model.



Fig 3 Site visit.

### Designing the Method:

Materials Required

1 Boulders Of size 40mm to 400mm

2 LDPE coated blue HDPE tarpaulin sheet: 70-350 GSM thick

Design the Trench and No of Trench Required

We Have Porosity Value of Gravel as 25% -45%

$$\text{Velocity } V_o = \frac{D}{t}$$



D= Distance Travel By Water

t= Time in sec

$V_0$  Velocity of Ground Water

$$V_0 = \frac{D}{t}$$

$$= \frac{1}{15(\text{sec})}$$

$$V_0 = 0.067 \text{ m/sec}$$

Now Discharge is

$$V = n \cdot V_0$$

V= Actual Velocity of Trench

n= Porosity

Discharge Velocity Of Trench

$$V = n \cdot V_0$$

$$= 0.3 \cdot 0.067$$

$$V = 0.02 \text{ m/sec}$$

Now  $V = ki$

k= Coefficient of Permeability

$$0.02 = k \cdot (1/10)$$

$$k = 1.157 \cdot 10^{-3} \text{ m/sec}$$

Now To find out the Discharge (Q)

A= Area Of Trench

V=Actual Velocity of Trench.

$$Q = A \cdot V$$

$$= (0.5 \cdot 0.5) \cdot 0.02$$

$$Q = 5 \cdot 10^{-3} \text{ m/sec}$$

$$Q = \frac{2.72KHs}{\log_{10}\left(\frac{R}{r}\right)}$$

Here

H = Total height of the confined aquifer

hw = artesian pressure in the well

r= radius of well

s= Drawdown = (D-hw)

$$5 \cdot 10^{-3} = \frac{2.72 \cdot 1.157 \cdot 10^{-3} \cdot 0.5 \cdot 1.5}{\log_{10}\left(\frac{R}{0.25}\right)}$$

$$\log_{10}\left(\frac{R}{0.25}\right) = \frac{0.408}{5 \cdot 10^{-3}}$$

$$= 81.6$$

=antilog (81.6)

Distance between two trenches (R)=20m

$$Q = 5 \cdot 10^{-3} \text{ m/sec}$$

$$V = 0.02 \text{ m/sec}$$

$$\text{Area} = 0.5 \cdot 0.5$$

$$= 0.25 \text{ m}^2$$

### Making of Scaled Model

Scale on Actual Site is 5cm = 1 m on site (1/500)

Dimensions of Model

Width of Model = 55cm i.e 11m on actual site

Length of Model = 75cm i.e 15m on actual site

Dimensions of trench

Width of trench = 5cm i.e 1m on site

Length of trench = 75cm i.e 15m on site

Depth of Trench = 10cm i.e 2m on site

Slope of trench = 1/10





Fig 4 Scaled Glass Mould



Fig 5 Layer of Hard Strata



Fig 6 2<sup>nd</sup> Layer till root zone with diged trench in it



Fig 7 Trench Covered with Polythin Sheet

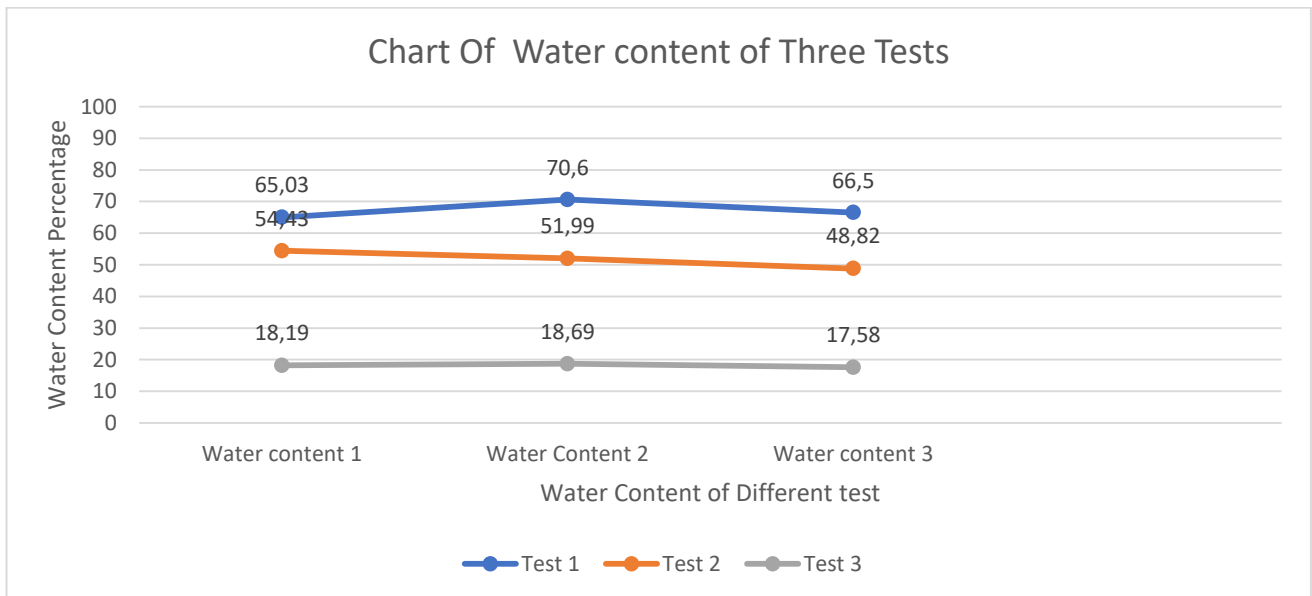


Fig 8 Final View After filling all layers of soil

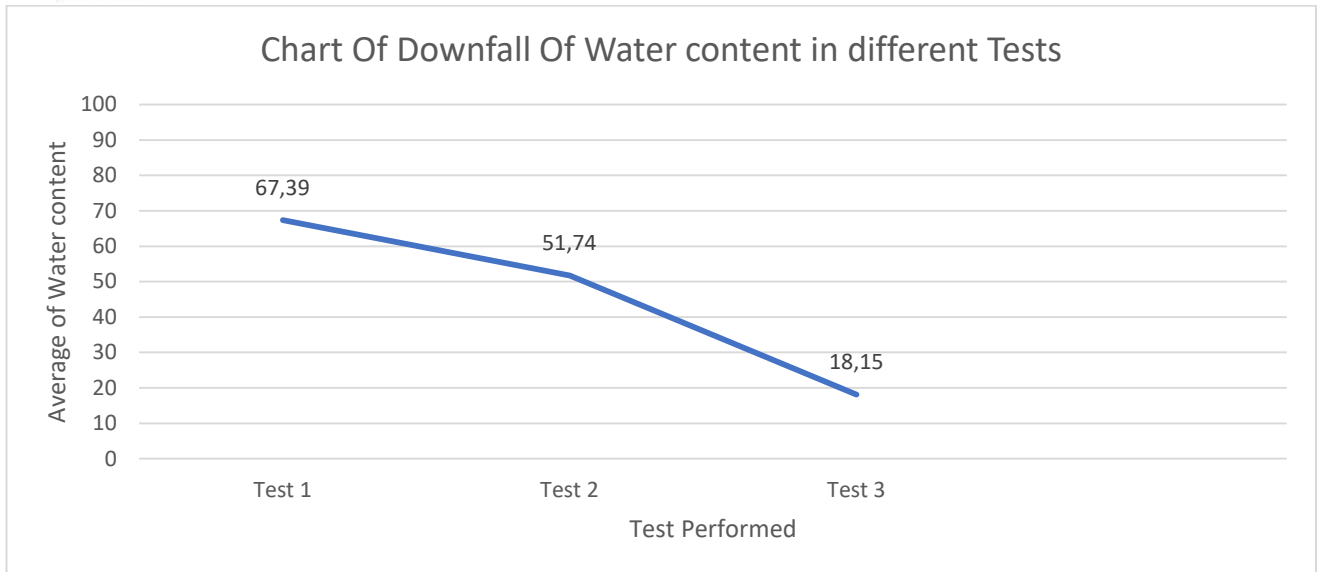


Fig 9 Actual Condition On site represented in scaled model

**Test On soil**



Graph 1. The Following Graph shows the Sample Results of all three tests



Graph 2 The following graph shows the Average Fall of water content After Application of Method

#### IV. RESULTS

Table 1 Table showing the result of all tests

Sr .no	Discription	Average % of each test	Difference of Average %	% of Difference
1	Test 1 on actual site before application of method	67.39		
			15.65	23%
2	Test 2 After 1 Day After application of method	51.74		
			33.59	50%
3	Test 3 After 8 Days After Application of method	18.15		
			<b>Total Reduced Water Content</b>	<b>50%</b>

#### V. CONCLUSION

In This we conclude that by using this method

1 We reduced the water content of soil by 23% In 1 Day

2 And after 8 Days the Water content of soil reduced by 50%

3 We Brought the Land in Use which Is wasted for digging open trenches in the fam as it occupies a lot of land



4 And the Water level Of the Farm is brought in Control In 3 days for carrying out there farming activity to Farmers As the crops won't get more damage.

**Advantages of this Method:**

- 1 Land is Used which is wasted in open trench method
- 2 Quick Method to Drain out Water from farm
- 3 Fertile soile if Prevented by this method as it won't washedoff by erosion and it is collected in farm only
- 4 Plants Which get Damaged Due to excess water are now prevented by this method
- 5 This Method is useful for any Land type
- 6 Water which is Drained out can be Stored and used For Farming Purpose
- 7 Salinity Occurance can be Avoided as no waterlogging Condition will be there after application of this method

**Disadvantages of this Method:**

- 1 Fertilizers Can drain off
- 2 Plants whose root zone is Deep Can't be Taken on this type of soil  
(Egg: Mango farming, Bamboo Farming etc.)

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# Structural Retrofitting of Reinforced Concrete Column using Fibre Reinforced Polymer

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**ABSTRACT:** This thesis details experimental work and finite element simulations of reinforced concrete column retrofitted with carbon fibre reinforced polymer (CFRP). The objectives of this study were to investigate the behaviour of retrofitted column experimentally, develop a finite element model describing the beams, verifying the finite element model against the experimental results and finally investigating the influence of different parameters on the behaviour of the retrofitted column. The experimental tests were performed to investigate the behaviour of column designed in such a way that either flexural or shear failure will be expected. The beams were loaded in four-point bending until cracks developed. The column were then unloaded and retrofitted with CFRP. Finally the column were loaded until failure. The ABAQUS program was used to develop finite element models for simulation of the behaviour of column. The concrete was modelled using a plastic damage model and two models, a perfect bond model and a cohesive model, were evaluated for the concrete-CFRP interface. From the analyses the load deflection relationships until failure, failure modes and crack patterns were obtained and compared to the experimental results. The FEM results agreed well with the experiments when using the cohesive model regarding failure mode and load capacity while the perfect bond model was not able to represent the debonding failure mode. The results showed that when the length of CFRP increases the load capacity of the beam increases both for shear and flexural retrofitting. FEM results also showed that the width and stiffness of CFRP affect the failure mode of retrofitted column. The maximum load increases with increased width. Increased CFRP stiffness increases the maximum load only up to a certain value of the stiffness, and thereafter it decreases the maximum load.

## I. INTRODUCTION

Reinforced concrete structures often have to face modification and improvement of their performance during their service life. The main contributing factors are change in their use, new design standards, deterioration due to corrosion in the steel caused by exposure to an aggressive environment and accident events such as earthquakes. In such circumstances there are two possible solutions: replacement or retrofitting. Full structure replacement might have determinate disadvantages such as high costs for material and labour, a stronger environmental impact and inconvenience due to interruption of the function of the structure e.g. traffic problems. When possible, it is often better to repair or upgrade the structure by retrofitting. In the last decade, the development of strong epoxy glue has led to a technique which has great potential in the field of upgrading structures. Basically the technique involves gluing steel plates or fibre reinforced polymer (FRP) plates to the surface of the concrete. The plates then act compositely with the concrete and help to carry the loads. FRP can be convenient compared to steel for a number of reasons. These materials have higher ultimate strength and lower density than steel. The installation is easier and temporary support until the adhesive gains its strength is not required due to the low weight. They can be formed on site into complicated shapes and can also be easily cut to length on site. This work is a study of the behaviour of concrete beams retrofitted with carbon FRP (CFRP), using experiments and finite element modelling.

## II. OBJECTIVES

The objective of this project is to evaluate the effectiveness of CFRP composites for structural retrofitting of reinforced concrete columns through experimental validation. The specific objectives are:-

- To study the effects of parameters of carbon fibre reinforced polymer composite on square and circular shape.
- To compare experimental failure modes with previous research data
- To perform cost analysis of CFRP strengthening solutions against common alternatives





### III. LITRATURE REVIEW

Jian-he Xie and Ruo-lin Hu, Experimental study on rehabilitation of corrosion-damaged reinforced concrete beams with carbon fiber reinforced polymer

This paper presents an experimental study on using carbon fiber reinforced polymer (CFRP) composites to rehabilitate reinforced concrete (RC) beams damaged due to corrosion. The effects of different retrofitting techniques and amount of CFRP reinforcement are investigated. While previous studies have evaluated FRP strengthening of RC beams, limited research has examined corroded RC members retrofitted with FRP composites after repairing the damaged substrate. This study aims to address this gap by testing CFRP repair solutions for corroded beams.

The study provides useful data on the effectiveness of different retrofitting techniques on corroded RC beams strengthened with CFRP composites. The paper recommends future work on larger scale members, dynamic loading effects and long-term performance of CFRP retrofitted corroded beams.

Arvandan Sivasuriyan, June 2023, Carbon Fibre-Reinforced Polymer (CFRP) Composites in Civil Engineering Application

The paper provides a comprehensive review of carbon fiber reinforced polymer (CFRP) composites and their application in civil engineering. CFRP has high strength, stiffness, fatigue resistance, and corrosion resistance compared to traditional materials like steel and concrete. This makes CFRP useful for strengthening and repairing existing structures as well as building new lightweight and resilient structures.

J. G. Teng and L. Lam, Dec 2002, Compressive Behaviour of Carbon Fiber Reinforced Polymer-Confined Concrete in Elliptical Columns.

This paper presents an experimental study on the compressive behavior of concrete confined with carbon fiber reinforced polymer (CFRP) composites in elliptical columns. The effects of column shape and FRP confinement on strength and stress-strain response are examined. While previous research has focused on FRP-confined concrete in circular columns, there is limited study on confinement behavior in non-circular sections like elliptical columns. This paper aims to address this gap by testing elliptical column specimens. They found out that compressive strength enhancements reduced with increase in elliptical shape but were still significant, bilinear stress-strain response was observed except for highly elliptical columns, and ultimate axial strain increased with level of FRP confinement.

L.P. Ye, K. Zhang, S.H. Zhao, P. Feng, Sept-Oct 2003, Experimental study on seismic strengthening of RC columns with wrapped CFRP sheet.

This paper experimentally investigates the seismic performance of reinforced concrete (RC) columns strengthened with carbon fiber reinforced polymer (CFRP) sheets. The focus is on studying the confinement effect and ductility enhancement. While previous research studied the strength enhancement of RC columns wrapped with FRP composites, there is limited study quantifying the confinement effectiveness and ductility improvement for seismic strengthening design. This paper aims to address this gap. The ductility of RC columns can be substantially improved by strengthening using wrapped CFRP sheets due to the confinement from CFRP when strong shear and weak flexure factor is greater than 1.0.

Stefan Kaeseberg , Dennis Messerer and Klaus Holschemacher, Julu 2019, Assessment of Standards and Codes Dedicated to CFRP Confinement of RC Columns

Design approaches for FRP confinement of RC columns from five international design guideline, were presented, reviewed, and compared. Besides general information and limitations, the different procedures to predict partial safety factors, the confinement pressure, and the design equation for the maximum axial compressive strength  $f_{cc}$  and ultimate axial strain of FRP confined RC members with circular cross-sectional shapes were outlined. These investigations revealed significant dissimilarities, leading to different and mostly contrary results among codes and guidelines. These differences may have developed historically, for instance, due to different intensity and prioritization of research in each country. This indicates the need for more intensive exchange, especially between the researchers involved in the standardization process and the determination of unified fundamentals and approaches.

M.N.S. Hadi, 2026, "Behaviour of FRP Wrapped Normal Strength Concrete Columns Under Eccentric Loading", Composite Structures Volume 72, Issue 4, Pages 503-511.

Concrete columns are commonly subjected to eccentric loading, especially columns located at the edges of buildings such as corner columns. Fibre reinforced polymers (FRP) have been increasingly used to strengthen and retrofit concrete columns. Six circular concrete columns with 150 mm diameter and 1.4 m height were cast and tested under eccentric loading. Columns had no steel reinforcement. External confinement was provided by wrapping the columns with 1, 3 or 5 layers of carbon FRP. The 32 MPa concrete columns were tested to failure in a test frame that allowed both axial and lateral deflections to be measured.

Manuel A.G. Silva, 2021 “Behavior of Square and Circular Columns Strengthened With Aramidic or Carbon Fibers”, Construction and Building Materials, Volume 25, Issue 8, Pages 3222-3228.

Confinement of reinforced concrete (RC) columns with fibre reinforced polymers (FRP) can enhance their properties, especially ductility and load carrying capacity. Circular columns are more effectively confined than rectangular columns due to stress concentrations at the corners of rectangular sections. This paper compares the behaviour of square and circular RC columns confined with carbon fibre reinforced polymer (CFRP) or aramid fibre reinforced polymer (AFRP) wraps under axial loading.

#### IV. METHODOLOGY

Total 12 columns of reinforced concrete design were built to be tested on Universal Testing Machine (UTM). The columns were casted by using steel rebars (6mm and 8mm) and M20 grade of concrete for which 3 cubes of 150x150x150mm were tested again on UTM. 6 of the columns cast in lab were square of size 150x150x700mm and 6 were circular columns of size 150x160x700mm. Out the 6 square and circular columns, 3 of the columns were unwrapped while the remaining 3 were wrapped with CFRP of 400 microns single layer by using epoxy adhesive. The reinforcement for square and circular column were 12mm bars of main reinforcement and 8 mm bars for shear reinforcement with appropriate cover.



Fig :- Reinforcement bars

For the total material purchase, it was done at M&M Enterprises, near Mhatre Bridge, Pune. Among the purchases it contained 3 sq m of carbon fibre of C-400 grade of Thermax company, 2 cans of Primer (base and hardener), 2 cans of Saturant epoxy resin (base and hardener), smooth rollers, gloves.



Fig :- Materials Purchased

The Carbon fibre wrap was cut into pieces as per column specimen measurement. As the column specimen were of 700mm, the cloth was cut into two pieces of 500mm and 200mm.

The epoxy adhesive was created by using 2 layers of Primer and Saturant of Thermax company. The primer was formed after mixing of base and hardener in proper proportion and applies over the specimens and left to dry for 24 hours.

After 24 hours the saturant was formed again by mixing base and hardener of Thermax Company as per proportion. Immediately after applying saturant, carbon fibre of 1 layer was wrapped around the specimens before the saturant dried up. The wrapping was done by smooth roller and gloves. At the end of wrap, it was again rotated for 100 to 150 mm for good encasing. After wrapping, another layer of resin was spread on the wrap from the outside to increase confinement effect.



Fig :- Application of Resin

Mix Density	1.11±0.03 gm/cc
Volume of Solids	88-92%
Pot life	~25 minutes
Touch Dry Time	8-12 hours

Table-1: Properties of Primer

Mix Density	1.40±0.05 gm/cc
Volume of Solids	100%
Pot life	60 to 90minutes
Open Time	90 to 120 minutes

Table-2: Properties of Saturant



Fibre Orientation	Unidirectional
Weight of Fibre	400-430 gm/m <sup>2</sup>
Density of Fibre	1.80 gm/cc
Fibre Thickness	0.38-0.4 mm
Ultimate Elongation	1.7%
Tensile Strength	4000 MPa

Table-3: Properties of Maxtreat Fibrenet C400

After the application, all columns were tested to find the compressive test for them to compared the effect of shape on increase in load carrying capacity due to application of CFRP. Visual observations were made to document failure mode like concrete cracking, CFRP debonding etc.

## V. RESULT

The testing was done after 28 days which gave the following results:-

Column Specimen	Axial Stress (Mpa)
SU1	13.73
SU2	12.53
SU3	12
SW1	18.22
SW2	16.4
SW3	16.93
CU1	8.32
CU2	7.9
CU3	8.9
CW1	15.78
CW2	16.29
CW3	16.64

Table-4: Test Results

Here, the first alphabet refers to the cross-section of the specimen, the second alphabet refers to whether the column is wrapped or unwrapped (U for unwrapped and W for wrapped), the end number refers to the specimen number. The second columns have the axial stress for each specimen in Mega-Pascal (Mpa). Total 12 columns were tested for only axial compression to plot specimen vs axial stress

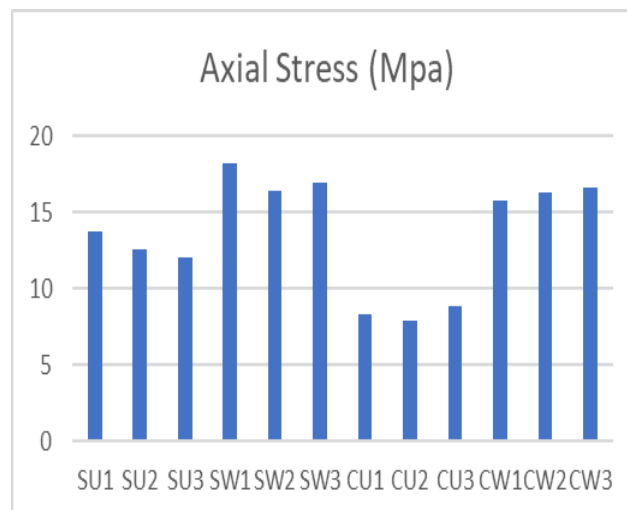


Chart-1: Test Results chart.





## VI. CONCLUSION

- 1). CFRP wrapping significantly increased the strength of both circular and square columns subjected to axial compression loads. The effectiveness of CFRP wrapping varies depends on the shape of the column.
- 2). CFRP wrapping on circular columns shows better results than on square columns of similar size, similar reinforcement, and similar grade of concrete due to the confining effect. The results showed that the increase in strength of reinforced concrete on average is 44% more than square shaped reinforced concrete columns.
- 3). Circular columns are quite rare for both residential and business/public buildings. If there are circular columns, it is recommended to use CFRP for retrofitting rather than concrete jacketing as it increases strength substantially due to its cross-sectional shape even when the cost of CFRP is high.

For square columns, the increase in strength is quite low so for square columns if there is no issue of lowering carpet area (as in case of underground basement parking) then concrete jacketing can be used. Reinforced concrete jacketing provides excellent protection against fire, impact, moisture and chemical exposure making it suitable for columns in harsh environments.

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# Study on Analysis and Design of Cost-Effective Binishell with Shotcrete

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**ABSTRACT:** This study focuses on analysis and design of Binishell construction, aiming to enhance cost-effectiveness while maintaining structural integrity. The research involves a comprehensive analysis of key factors influencing the cost of Binishell structure, including material, labour, and construction methodologies. Through systematic examination of various construction parameters, this study aims to identify opportunities for cost reduction without compromising on quality and performance of final structure.

**KEYWORDS:** Analysis and design, Pneumoform Material, Shotcrete Application, Construction Efficiency, Material Optimization, Life cycle cost Analysis. Innovation and construction.

## I. INTRODUCTION

In this innovative construction methods, Binishell stands out as a unique and sustainable approach known for its architectural form and structural efficiency. This study delves into the detail interplay of design and cost-effectiveness within the context of Binishell construction, with a specific focus on the integration of shotcrete as a key component in the construction process. The construction industry is continuously evolving, with a growing emphasis on innovative and sustainable building methods. Binishell construction, characterized by its unique shell-like structures, has gained importance for its architectural and environmentally friendly attributes. This study focuses on the on the complex relationship between design considerations and cost-effectiveness in Binishell construction, with a specific exploration of the integration of shotcrete as a construction material. Keeping the necessity of project in mind, the cost estimate of structure is carried out.

- To prepare a plan for low cost Binishell concrete dome.
- To Study a low-cost housing in India.
- To carry out Analysis and Design of a proposed plan.
- To achieve more Sustainability

The project is initiated with the collection of information from existing journals, papers called literature review. After collecting the relevant information, the projected is started. A computational approach to realize this goal was developed and is listed in the following steps:

1. Selecting the site that is most prone to earthquakes.
- 2.Planning the dome structure keeping in view the necessity of the project.
- 3.Analyzing and designing the dome to check its structural stability based on the given loading conditions.
- 4.Comparing the dome structure with a similar size conventional building by means of cost estimation.

## GENERAL

This chapter reviews the literature for optimization of allocation of water and land use by dynamic programming carried out around the world. It reviews the various modern tools techniques are available for creating the various map of study area like contour map, land use map. Acquisition of the DEM data from the available open sources and processing it is by using the modern tools and technique. It reviews the available optimization programming software and its environmental use for various applications like selection of shortest route, water allocation, reservoir operation. Some researchers review Optimization of rising main is the main important parameter for saving of the energy and operational and maintenance cost, capital cost of the system hence it is necessary to optimize the rising main. The best management practices are employed for watershed development in order to avoid soil erosion, conservation of natural resources.



## **1 Dynamic Programming**

**W. McLean (2016):** stated, a comprehensive understanding of Bini's unique construction method which involve around pneumatic forming technology. The paper explores the development of the Binishell construction process as well as the subsequent family of pneumatic construction systems developed by Bini including the Binix, Binistar and Minishell systems. He also examines the relative industrial success of these systems and the perceived difficulty in the commercial acceptance of such novel technological inventions and innovations. The paper has been written using primary sources including site visits, interviews and conversations with Dante Bini, and original documents including previously unpublished photographs, and commercial ephemera such as brochures.

**Alberto Pugnale, Alberto Bologna, (2015)** stated, instances of construction challenges, structural failures and controversies associated with structure. Despite the successes, the research has uncovered challenges and instances of collapse associated with Binishell structures. Factors such as environmental conditions, structural integrity, and perhaps design considerations have played roles in these challenges, warranting further investigation into the root causes.

The demolition phase of Binishells in Australia from 1974 to 2015 has been examined, shedding light on the methods employed and the considerations in dismantling these structures. Lessons learned from demolition experiences contribute to a more comprehensive understanding of the life cycle of Binishell constructions.

**Alberto Pugnale, Alberto Bologna, (2016)** stated, a broader discussion about the relationship between innovation in design and innovation in construction for shell and gridshell designers. The findings of this research offer valuable lessons for architects, engineers, and policymakers involved in the planning, construction, and maintenance of Binishell structures. Understanding the factors contributing to both successes and challenges is crucial for the continued advancement of this architectural formula. By addressing the identified challenges, the legacy of Binishell construction can be strengthened, providing a platform for continued exploration and advancement in the field of architectural design and construction.

**Riya Anna Abraham, G. Kesava Chandran, (2016)** stated dealt with the brief history of Domes and have highlighted some of the recent innovations and focus on using it for modern housing. The advantage of using them over Flat roofs has also been done through the paper indicating the superiority of dome structures. Two popular types namely Geodesic and Monolithic domes have been discussed. Both Monolithic and Geodesic domes have advantages particularly for energy-efficient and disaster resistant housing. Thorough this paper we have attempted to bring out the relevance of carrying out further research and investigation in the use of suitable dome structures for popular constructions like housing.

**Prathamesh Sheth, Vaibhav Shelar (2023)** stated the various acoustic treatments and parametric configurations of monolithic dome sizes. A geometric relationship of acoustic treatment and dome radius is established to provide architects guidelines on the correct selection of absorption needed to maintain the acoustic comfort of these special spaces. In this study we cannot take the particular research paper for comparison of results. The location of structure for terrain category I calculated and so the wind speed varies according to terrain and this results in different value of load calculation for different terrain category.

## **II. METHODOLOGY**

### **Ring Beam Footing:**

Continuous reinforcing bars are embedded in the ring beam foundation. These rebar dowels securely connect the dome to its footing. The ring beam creates a solid base to construct the dome on. Rebar is bent over so that the Air form can be slid over the rebar and attached to the footing.



**Figure.1- construction of foundation**

### **Procedure for Construction Of Binishell**

Monolithic construction process demands an Air form. The pneumoform Air form is a balloon like, inflatable structure that determines the shape and size of a dome. It's made of PVC-coated nylon or polyester fabric.. The Air form is a highly engineered fabric structure that should be handled with great care.

#### **1. Site Preparation:**

Choose a suitable location for the Binishell structure, considering factors such as soil type, drainage, and accessibility.

Conduct a survey to determine the exact dimensions and layout of the Binishell.

Excavate the marked area to the required depth, considering the thickness of the foundation slab and any additional requirements.

#### **2. Formwork and Layout:**

Prepare a solid foundation slab that serves as the base for the Binishell structure. The slab should be designed to support the weight of the structure and provide a stable surface for the formwork.

Define the desired shape and dimensions of the Binishell structure. Use layout tools such as strings, stakes, and measuring equipment to mark key points and outline the formwork area on the foundation slab.

Position the deflated pneumoform (inflatable membrane) on the layout according to the predetermined shape. The placement should align with the marked layout, ensuring accuracy in the final structure.

#### **3. Anchor Pneumoform to Slab:**

Position the inflated pneumoform onto the slab, aligning it with the desired location and orientation of the Binishell structure.

Make any necessary adjustments to ensure the pneumoform is centred and aligned according to the design.

Insert anchor bolts or dowels into the drilled holes. The length of the anchors should be sufficient to provide a secure connection to the pneumoform.

#### **4. Inflate Pneumoform:**

Ensure proper alignment and orientation according to the Binishell design.

Anchor the edges of the pneumoform securely to the foundation slab.



Figure.2- Reinforced bar

#### a. Add reinforcement/Rebar

Types of rebars used in the construction of Binishell domes

##### a) Hoop Rebar:

Rebar that actually does the most good to hold the dome up is hoop rebar that goes around the dome. Hoop rebar performs somewhat like the hoops on a barrel. Hence, they should be located as far toward the outside as is practical. As pressure is applied to the Binishell Dome, the dome will try to dimple immediately under the pressure.

##### b) Vertical Rebar

The vertical layer of rebar is laid against the hoops. For Binishell Domes requiring thicker shells, rebar should still be placed to the outside.

#### b. Shotcrete:

- Shotcrete is a mixed mortar of cement, sand, 3/8 minus aggregate, and water projected at high velocity onto a surface. The force of the jet impacting on the surface compacts the material. A relatively dry mixture is used so that the material supports itself minimizing sagging or sloughing, even when used for vertical and overhead applications. The cement, sand, aggregate, and water are mixed by suitable means, and then pumped through a hose by a specially designed mortar pump.
- **Basic Steps for Applying Shotcrete to a Binishell Dome**
- **Layer One**
- The shotcrete is started at the bottom of the dome. First, a thick, tapered layer of shotcrete should be applied around the entire circumference of the dome, at the base, up to about one foot high. This ensures the concrete on the footing is good concrete and not rebound shotcrete
- **Layer Two**
- Second layer is usually applied on the second day. Up to a 1" layer is applied from ground level to approximately 8'. From 8' to the top, a 1/2" layer is then applied.
- **Layer Three**
- The third layer is an exact duplicate of the second layer, except that dome will support more weight and the layers can go on thicker and higher. The concrete around the base of the dome will be strong enough to support additional concrete if it is needed for extra thickness.
- **Layer Four**
- Layer four is a repeat of the third. The base should be worked for smoothness. Particular attention should be given to the depth gauges.
- **Final Layer**
- The final layer should be relatively thin (about 1/4" to 1/2") to permit a smooth finish. Before spraying this last layer, depth is checked. If adequate thickness is not reached by this time, it is necessary to spray additional



layers as needed. The finishing layer of concrete should be sprayed from the top down. It seems easier to make a nice finish if the final concrete layer starts at the top.



**Figure.3- Shotcrete**

This project is a structural design project and during the course of the project we will gain useful knowledge in: • Design of Structural elements

- Design of dome structure as per stresses and loads
- Design of ring beam for foundation.

**Software / Equipment used**

- Various software which will be used in this project are • Auto CAD
- STAAD.Pro

**III. RESULT**

**Analysis**

The analysis was done using Staad.Pro software. The loads given for the analysis

	Dead load				Live load			
	Plane center stress		Plate corner stress		Plane center stress		Plate corner stress	
Shear	SQX (local) kN/m <sup>2</sup>	SQY (local) kN/m <sup>2</sup>	SQX (local) kN/m <sup>2</sup>	SQY (local) kN/m <sup>2</sup>	SQX (local) kN/m <sup>2</sup>	SQY (local) kN/m <sup>2</sup>	SQX (local) kN/m <sup>2</sup>	SQY (local) kN/m <sup>2</sup>
	0.001	1.341	0.13	1.388	0.001	0.804	0.221	0.862
Membrane	SX (local) kN/m <sup>2</sup>	SY (local) kN/m <sup>2</sup>	SX (local) kN/m <sup>2</sup>	SY (local) kN/m <sup>2</sup>	SX (local) kN/m <sup>2</sup>	SY (local) kN/m <sup>2</sup>	SX (local) kN/m <sup>2</sup>	SY (local) kN/m <sup>2</sup>
	-86.515	-349.833	-56.562	-347.698	-102.23	-284.135	-31.245	-292.399
Bending Moment	Mx kg-m/m	My kg-m/m	Mx kg-m/m	My kg-m/m	Mx kg-m/m	My kg-m/m	Mx kg-m/m	My kg-m/m
	5.247	39.896	3.753	24.029	9.557	72.904	24.334	41.616

**Table 1 – ABSOLUTE STRESS**





**Table 2 – DISPLACEMENT**

Mode	Frequency Hz	Period seconds
1	15.783	0.063
2	16.082	0.062
3	16.082	0.062
4	16.519	0.061
5	16.519	0.061
6	16.712	0.06

Self weight of dome

i) Live load due to wind, snow Total wt. (w)

ii) Dead load

iii) Seismic load iv) Wind load

= thickness × wt. of concrete = 0.1 m × 25 kN/m<sup>3</sup>

= 2.5 kN/m<sup>2</sup>

= 1.5 kN/m<sup>2</sup> = 4 kN/m<sup>2</sup>

= 1.5 × 4 = 6 kN/m<sup>2</sup> = medium soil

= 250 km/hr (based on the Extreme Weather Events over India in the last 100 years)

Dead load			Live load			Seismic load		
Horizontal	Vertical	Horizontal	Horizontal	Vertical	Horizontal	Horizontal	Vertical	Horizontal
X mm	Y mm	Z mm	X mm	Y mm	Z mm	X mm	Y mm	Z mm
0.117	-0.107	0.117	0.186	-0.163	0.186	0.029	0.032	0.006

**Table 3 – TIME PERIOD AND FREQUENCY**

Seismic load			
Plane center stress		Plate corner stress	
SQX (local) kN/m <sup>2</sup>	SQY (local) kN/m <sup>2</sup>	SQX (local) kN/m <sup>2</sup>	SQY (local) kN/m <sup>2</sup>
0.157	0.358	0.157	0.362
SX (local) kN/m <sup>2</sup>	SY (local) kN/m <sup>2</sup>	SX (local) kN/m <sup>2</sup>	SY (local) kN/m <sup>2</sup>
20.637	8.794	21.171	9.336
Mx kg-m/m	My kg-m/m	Mx kg-m/m	My kg-m/m
0.866	5.07	16.718	2.146

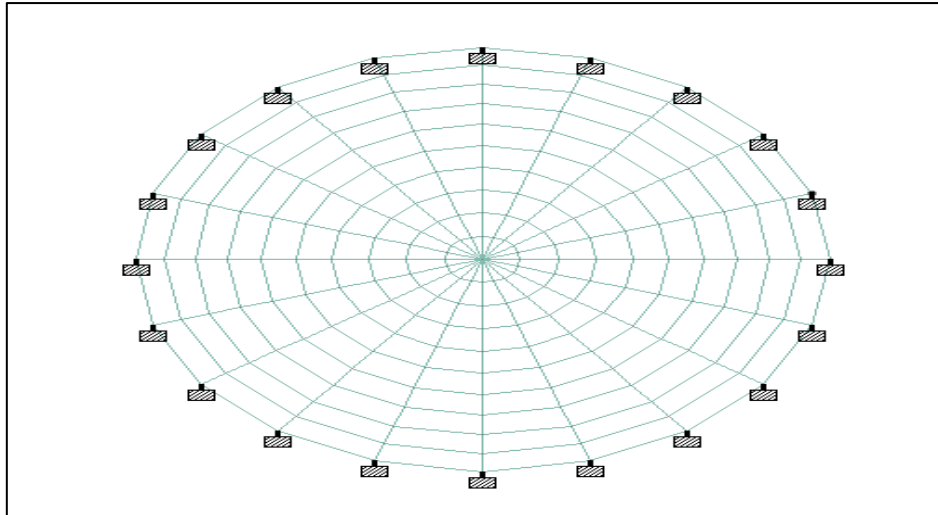


Figure.4: TOP VIEW

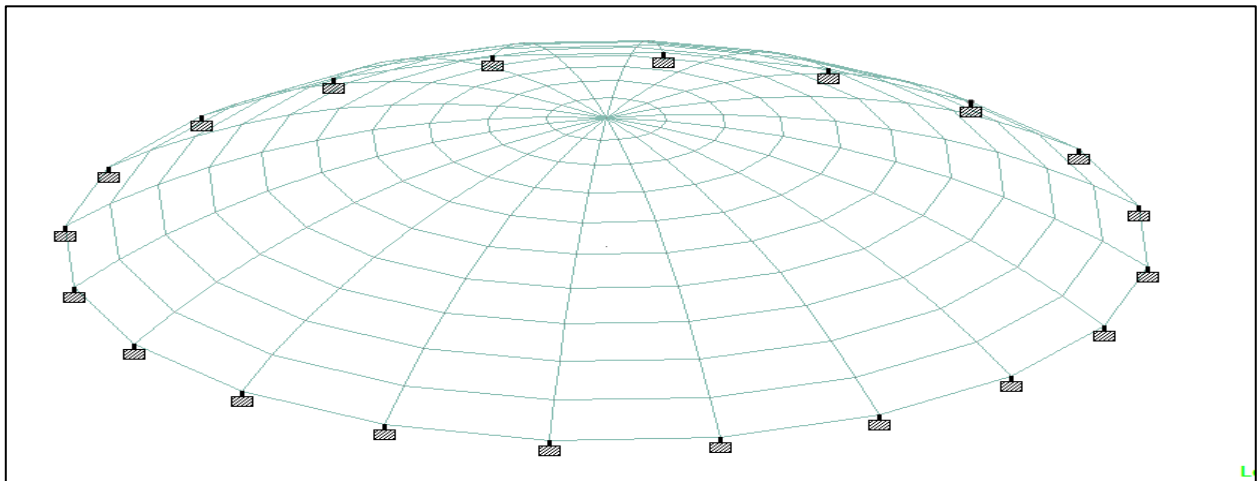


FIG.5 – 3D VIEW

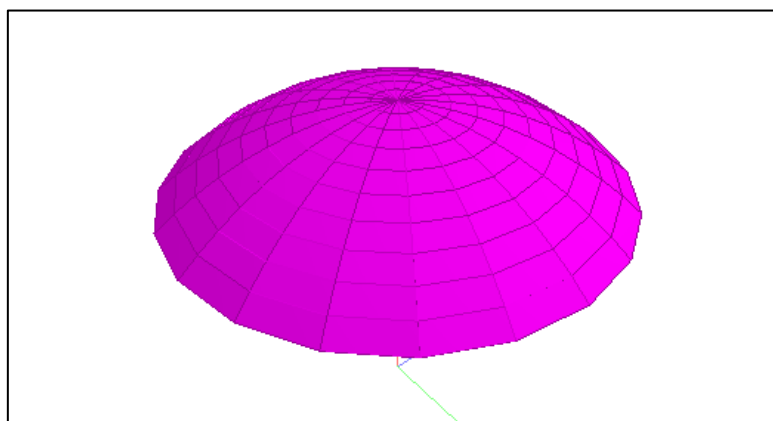


FIG.6 – RENDER VIEW

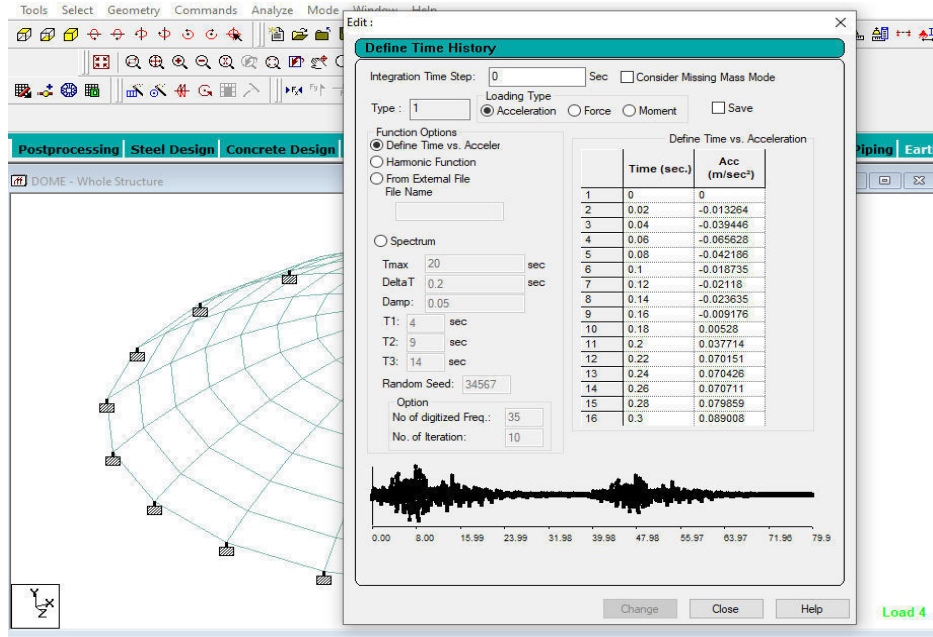


FIG.7 – TIME HISTORY LOADS

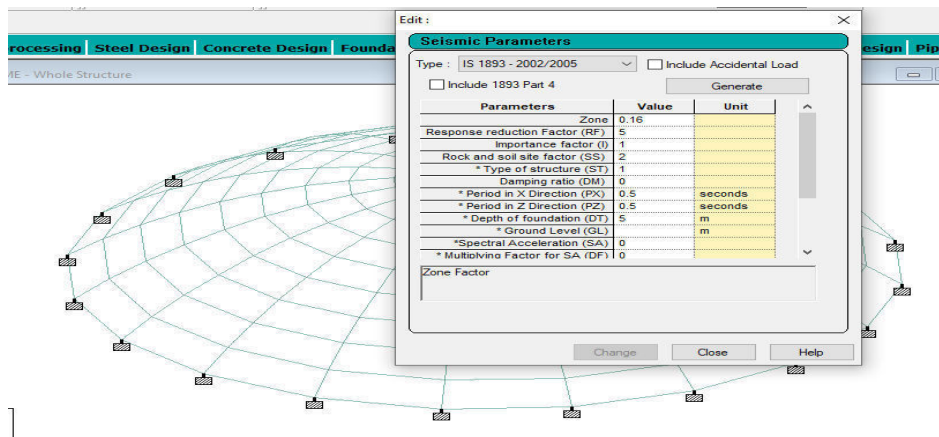


FIG.8 – SEISMIC LOAD

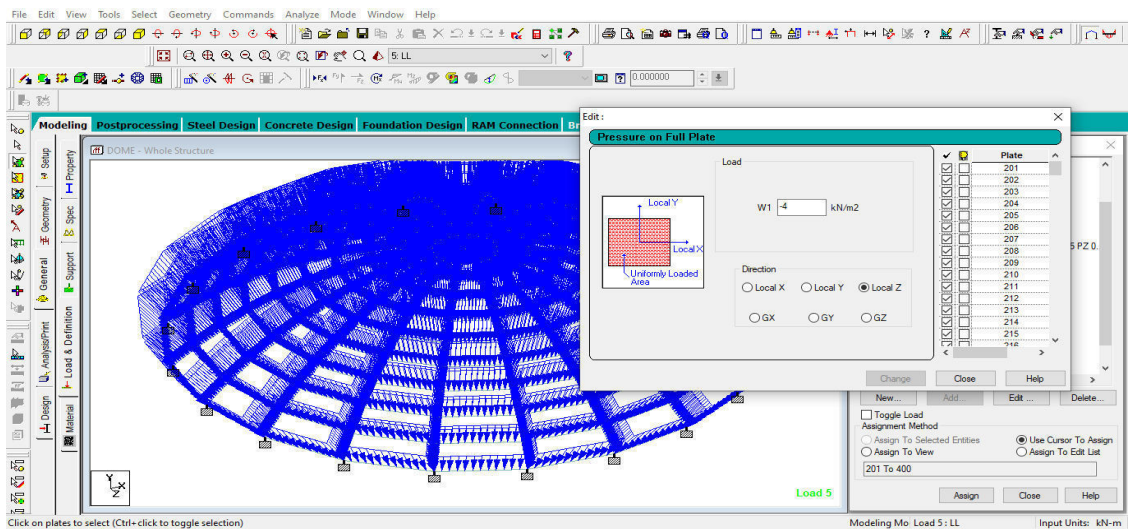


FIG.9 – LIVE LOAD

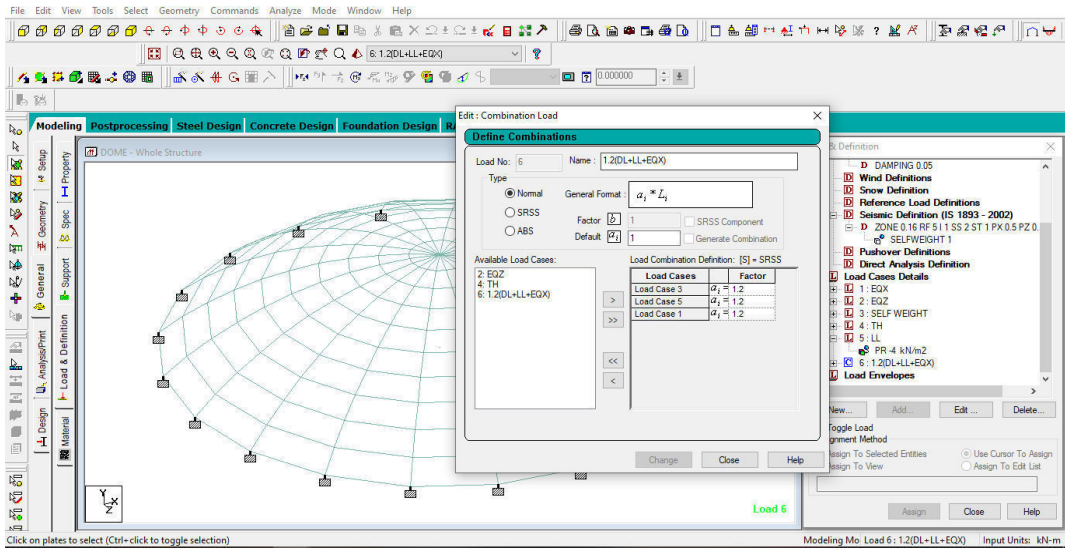


FIG.10 – LOAD COMBINATION

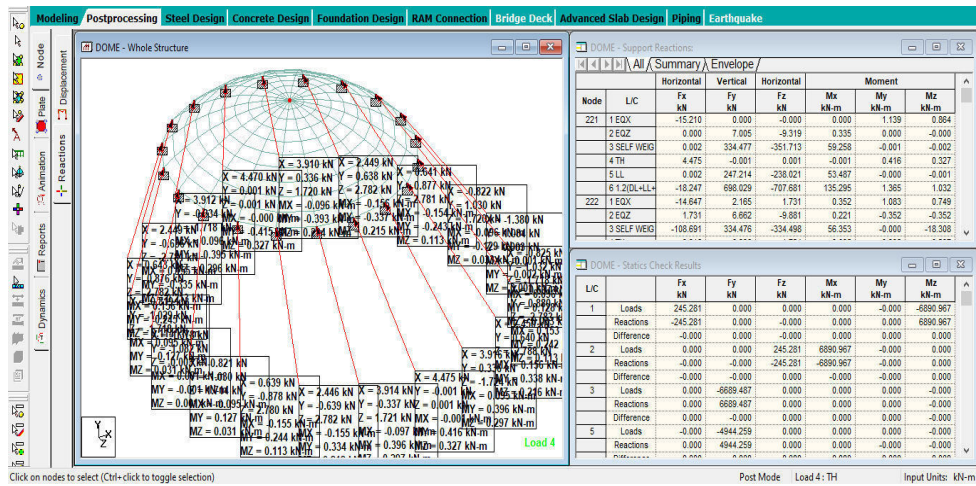


FIG.11 – REACTIONS

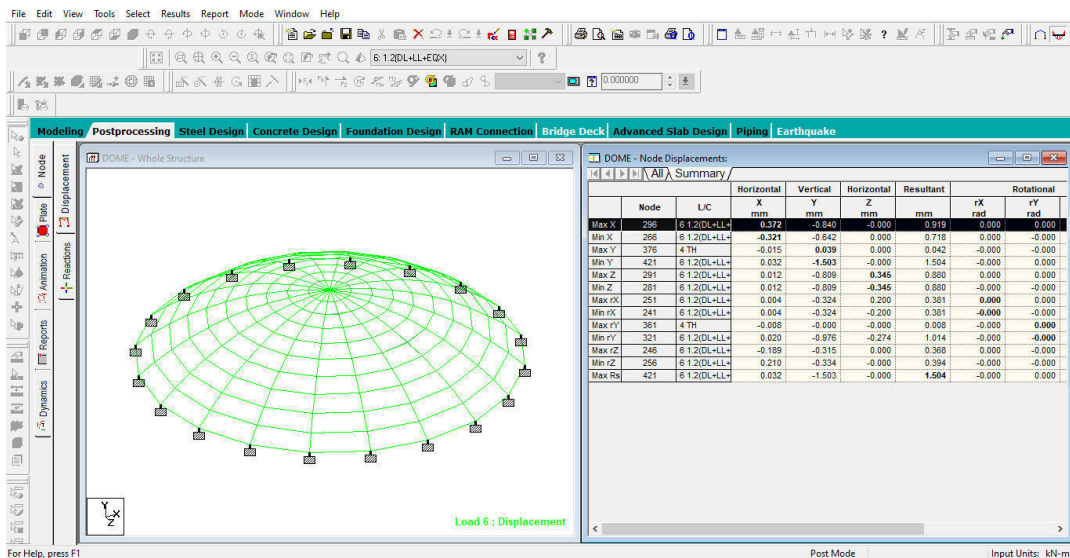


FIG.12 – NODES DISPLACEMENT



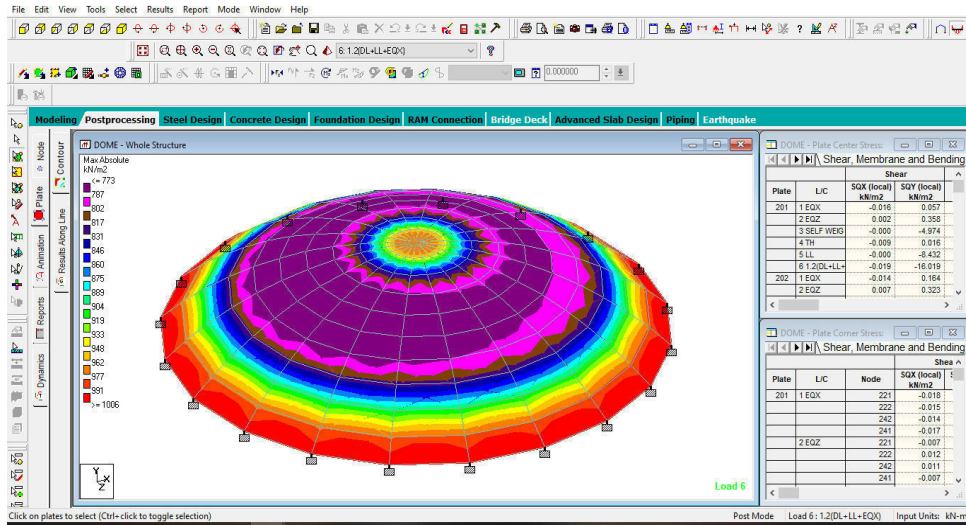


FIG.13 – MAXIMUM ABSOLUTE SHEAR

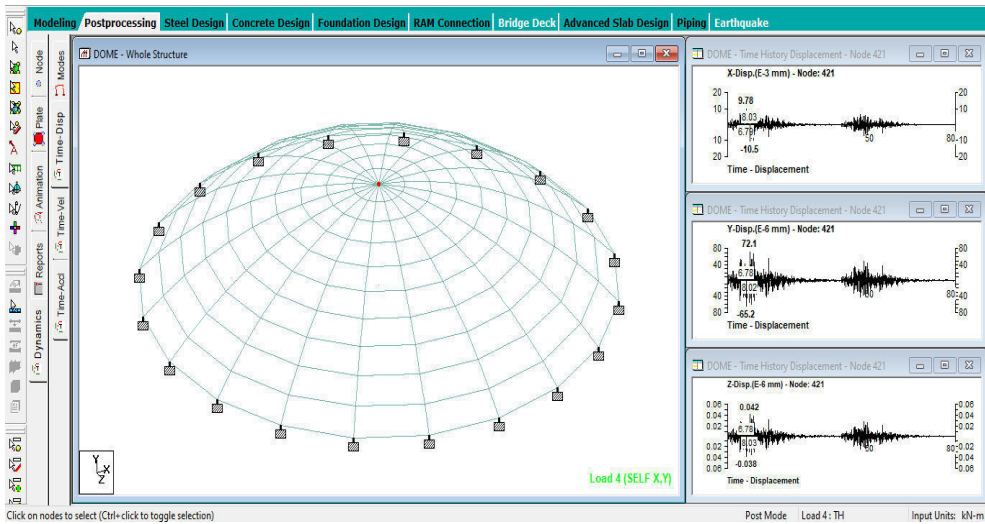


FIG.14 – TIME vs DISPLACEMENT GRAPH

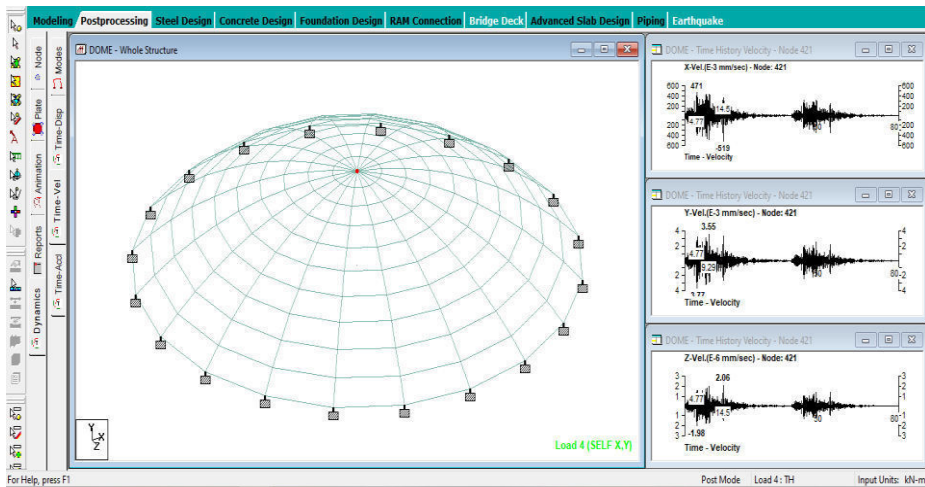


FIG.15 – TIME vs VELOCITY GRAPH



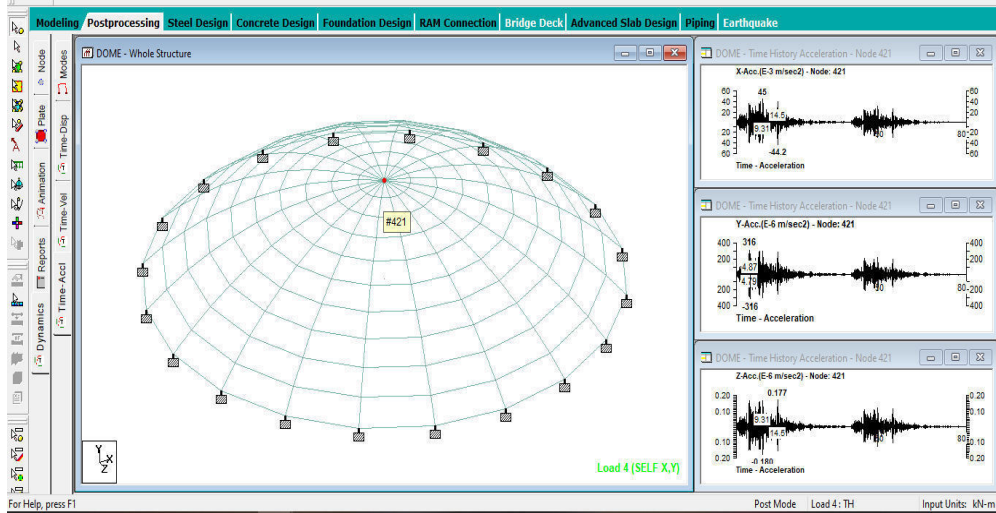


FIG.16 – TIME vs ACCELERATION GRAPH

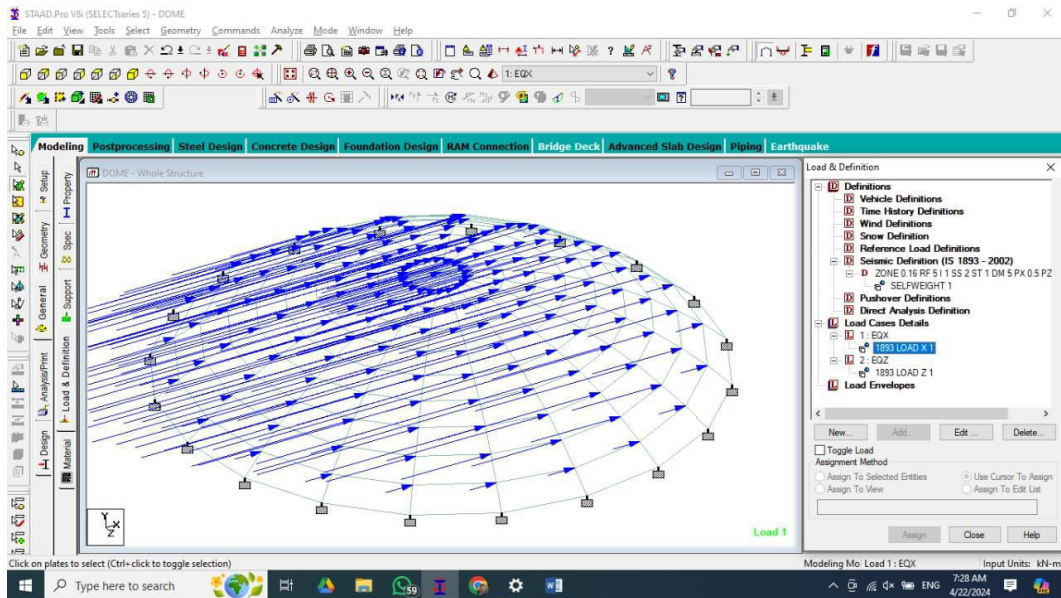


FIG.17 – WIND LOAD

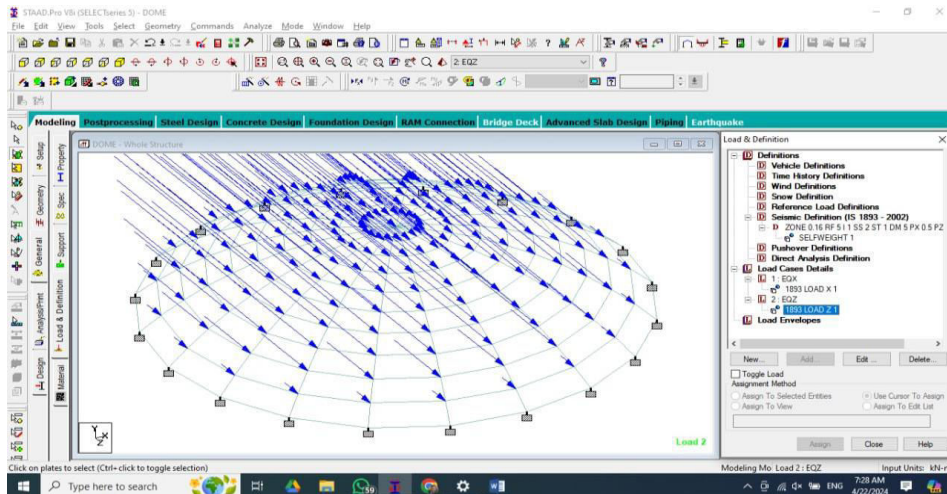


FIG.18 – WIND LOAD



## Design

- Inside diameter of room = 11 m • Rise of dome = 4.5 m

Let the radius of the dome be 'r', the diameter of the dome be 11 m and rise is 4.5 m.  $(2r - \text{height of dome}) \times \text{height of dome} = (\text{diameter} \div 2)^2$

$$(2r - 4.5) \times 4.5 = (11 \div 2)^2 \quad r = 5.61$$

$$\cos \phi = (r - \text{height of dome}) / r$$

$$\cos \phi = 0.1978$$

$$\phi = 78^\circ 59' > 51^\circ 49' 38''$$

$$\sin \phi = (\text{diameter} / 2r) \quad \cos \phi = (5.61 - 4.5) / 5.61$$

$$\sin \phi = 11 / (2 \times 5.61)$$

$$\sin \phi = 0.9804$$

$$\phi = 78^\circ 59' > 51^\circ 49' 38''$$

The circle of latitude at which the angle  $\phi = 51^\circ 49' 38''$ , the stress is 0. If the angle is greater, then compression will be developed while for the portion below this plane, tension will be developed will go increasing further towards the base of the dome.

## Load calculation

There is no opening at crown. Let us assume the thickness of the dome be 100 mm.

i) Self weight of dome = thickness  $\times$  wt. of concrete

$$= 0.1 \text{ m} \times 25 \text{ kN/m}^3$$

$$= 2.5 \text{ kN/m}^2$$

ii) Live load due to wind, snow = 1.5 kN/m<sup>2</sup>

$$\text{Total wt. (w)} = 4 \text{ kN/m}^2$$

$$\text{Dead load} = 1.5 \times 4 = 6 \text{ kN/m}$$

$$\text{Total load (W)} = 4 + 6 = 10 \text{ kN/m}^2$$

## Provision of reinforcement

$$\text{Max. Compressive stress} = 0.354 \text{ N/mm}^2 \text{ [safe]}$$

$$\text{Max. tensile stress} = 0.195 \text{ N/mm}^2$$

$$\text{Max. tension per metre} = 0.195 \times 100 \times 1000$$

$$\text{Area of steel} = 19500 \text{ N}$$

$$= 19500 / 140 = 139 \text{ mm}^2$$

Reinforcement for temp etc = 0.15% of thickness

$$= (0.15/100) \times 100 \times 1000 = 150 \text{ mm}^2/\text{m}$$

$$\text{Total reinforcement} = 139 + 150 = 289 \text{ mm}^2$$

$$\text{Using 8mm } \Phi \text{ bars, spacing} = (1000 \times 50) \div 289 = 173 \text{ mm}$$

However, provide 8mm bars @ 160mm c/c where hoop tension is developed.

In the portion where no hoop tension is developed, minimum area of steel @ 0.15% will be 150mm<sup>2</sup>.

Hence provide 8mm  $\Phi$  bars @ 300mm c/c.

## Design of ring beam

Meridional thrust per metre length of the dome at its base

$$= 0.19 \times 100 \times 1000 = 19000 \text{ N/m.}$$

$$\text{Horizontal component T per metre length} = 9000 \times \cos 78^\circ 59' = 3630.80 \text{ N/m.}$$

$$\text{Hoop tension, trying to rupture the beam} = 3630.80 \times (11/2) = 19969.38 \text{ N.}$$

$$\text{Area of steel reqd} = 19969.38 / 140 = 142.63 \text{ mm}^2$$

$$\text{Using 10mm } \Phi \text{ bars, No. of rings} = (142.63 / 78.53)$$

$$= 1.8 \sim 2 \text{ nos. (approx)}$$

Hence provide 2 rings of 10mm  $\Phi$  bars.

Equivalent area of composite section of beam of area of cross-section A.

$$= A + (m-1) \times A_{st}$$

$$= A + 18 \times 78.53 \times 2$$

$$= A + 2827.08$$

Allowing tensile stress of 1.2 N/mm<sup>2</sup> in the composite section, we have



$$19969.38 / (A+2827.08) = 1.2$$

From which A= 13814.07 mm<sup>2</sup>

However, provide a ring beam of 200mm×200mm. Provide 6mm Φ Striupps @ 160mm c/c to tie the rings in the ring beam.

### Estimation of concrete dome housing

1. Earth work Excavation for foundation in medium Gravel soil.

DESCRIPTION	NO'S	L[M]	B[M]	D[M]	QTY[M <sup>3</sup> ]
-------------	------	------	------	------	----------------------

For Plinth Beam	1	73.01	0.23	2	33.58
-----------------	---	-------	------	---	-------

-----  
33.58 CUM

Qty 33.58 CUM [ 1185CFT]      Rate Rs.6.00/cft      **Rs. 7,110**

2. Sand filling for foundation and basement including cost and conveyance of all materials and labour charges complete.

For Plinth beam	1x1	73.01	0.45	0.15M	4.92
-----------------	-----	-------	------	-------	------

For Basement	1x1	13.15	8.39	0.91M	100.39
--------------	-----	-------	------	-------	--------

-----  
105.31CUM

Qty.105.31CUM[3716CFT]      Rate Rs.55.00/ cft      **Rs.1,67,220**

3. Cement concrete 1:0.75:1.5 using M30 including cost and Conveyance of all materials and labour charges

For Plinth beam	1	73.01	0.45	0.10	3.28
-----------------	---	-------	------	------	------

For Basement	1	13.15	8.39	0.10	11.03
--------------	---	-------	------	------	-------

-----  
14.31 CUM

Qty. 14.31CUM[505CFT]      Rate Rs. 65.00/ cft      **Rs. 32,825**

4. RCC 1:1:2 mix including cost and conveyance of all materials and labour charges etc complete.

For Lintel	1x1	73.01	0.23	0.23	3.86
------------	-----	-------	------	------	------

For Sunshade	1x8	1.82	0.60	0.076	0.66
--------------	-----	------	------	-------	------

Dome roof	1x1	[2πr <sup>2</sup> ]=100.48m <sup>2</sup>	0.38		38.18
-----------	-----	--	------	--	-------

-----  
42.7CUM

**Qty. 42.7CUM [1506CFT]      Rate Rs.110.00/cft      Rs. 1,65,660**

5.. Supplying and fabrication of steel including cost and conveyance of all materials cutting, bending, tying grills etc, complete.

Qty as per item no. 4 = 1506CFT x 3.00 kg/cft      = 4518

-----  
4518

**Qty 4518 kg      Rate Rs. 65.00/ kg      Rs. 2,93,670**

6.Brick work with CM 1:5 Mix using chamber burnt bricks including cost and conveyance of all materials and labour charges etc complete.

For Superstructure	1x1	73.01	0.23	3.96	Deduct for Doors	1x4	0.91	0.23	2.13
--------------------	-----	-------	------	------	------------------	-----	------	------	------

WINDOWS	1x8	1.2	0.23	1.2					
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Ventilator	1x21	2.1	0.23	0.76	For Parapet wall	1x143	0.8	0.23	0.91
------------	------	-----	------	------	------------------	-------	-----	------	------

**Qty: 105.73CUM[3731CFT]      Rate Rs. 75.00/cft**



66.4 (-) 1.78 (-) 2.69 (-) 0.42  
 44.22  
 -----105.73 CUM  
 -----Rs. 2,79,825

7. Wall plastering with CM 1:4 mix, 12mm thick including cost and conveyance of all materials and labour charges etc complete.

GUEST ROOM	1x1	16	-	3.04	48.64 Kit	1x1
	15.4	-	3.04	46.81 Bed	1x1	16 -
	3.04	48.64 BED	1x1	15.4	-	3.04 46.81 Outer
around	1x1	43.08	-	3.96	170.59	<b>Deductions as</b>
<b>per item no. 6</b>		(-) 4.89				
					-----356.6SQM -----	

**Qty 356.6SQM[3838SFT] Rate Rs. 18.00/sft Rs.69,084**

8. Supplying and fixing Country wood doors and windows with safety grills including cost and conveyance charges etc complete.

Door	1x4	0.91	-	2.13	7.75 Window	1x8
	1.21	-	1.21	11.71 V	1x2	1.21 -
	0.76		1.83			

-----21.29SQM -----

**Qty 21.29SQM[230SFT] Rate Rs.400.00 / sft Rs. 92,000**

9. Floor finishing with 2'x2' Vitrified Tiles Flooring Laying with Ordinary cement including cost and conveyance of all materials and labour charges etc complete.

Flooring	1x1	12.69	7.93
----------	-----	-------	------

**Qty 100.63SQM[1083SFT] Rate Rs. 80.00 / sft**

100.63 -----

100.63SQM -----

**Rs. 86,640**

-----Total Est. Rs. 9, 57,015/-

------(Rupees Nine lakhs fifty seven thousand and fifteen only)

#### IV. CONCLUSION

By leveraging innovative construction techniques and optimizing material use, Binishell structures provide a cost-effective alternative to conventional building methods. Their rapid construction, low maintenance, and versatile applications make them an attractive option for a wide range of projects, ensuring both economic and practical benefits. The combination of these factors demonstrates the significant potential of Binishell structures to deliver high-quality, affordable buildings that meet the needs of various stakeholders efficiently.

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# A Study on the Role of Social Media Marketing in Promoting Agricultural Products

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**ABSTRACT:** Social media is the new upcoming area in agricultural marketing that has blogs, micro blogs, pages, groups etc. This study adopted a descriptive research and the primary data collection tools were structured questionnaire and in depth interviews from farmers who uses social media.

From the analysis it is found that social media is very useful tool in agricultural marketing. It saves time and cost of the farmers for getting information. Face book is the most likely social media for pages and profiles. YouTube videos are most popular for information getting with applications. WhatsApp is the handy use of social media and mostly preferred for related groups.

Many officials are having their official pages, blogs, and groups on social media and it helps in getting information and solving the problems. Challenges were adoption of social media as tool of marketing. People are less trusted on e-buying, e-selling of agricultural commodity on social media.

**KEYWORDS:** Social media, Information and Communication Technology (ITC), Agricultural, Farmers.

## I. INTRODUCTION

The use of social media in agricultural marketing is increasing rapidly now days. Farmers are using social media because it has ability to connect with farmers, agribusiness, agri experts over a geographical distance. Up to certain extent social media in agricultural marketing provides solutions to the agricultural marketing problems. The main purpose of social media is sharing information and creating awareness. The most popular social media among farmers is Facebook, Twitter, YouTube, LinkedIn, WhatsApp etc. The users of social media are creating their own groups, pages, community, and blogs to share information.

### a) Definitions of Social Media-

A definition that focuses on the interpersonal networking dimensions (e.g. Facebook) “We define social network sites as web-based services that allow individuals to

- (1) construct a public or semi-public profile within a bounded system,
- (2) articulate a list of other users with whom they share a connection, and
- (3) view and traverse their list of connections and those made by others within the system.

### b) Challenges of Social Media use in Agricultural Marketing:-

1. Adoption of social media as a tool of agricultural marketing.
2. There is a limited access to social media because of data, network etc.
3. There is a need of training and education about use of social media in agril marketing.
4. People are less trusted on e-buying, e selling of agricultural commodity on social media.
5. All the activities are restricted by time, technology, networks etc.

## II. LITERATUREREVIEW

1.Ahluwalia & Arora: Social media marketing has become increasingly significant in the agricultural sector, offering unique opportunities for promoting agricultural products. Ahluwalia & Arora (2020) conducted a comprehensive review of the role of social media marketing in this domain. Their study highlighted the transformative impact of social media platforms on how agricultural businesses engage with consumers. By leveraging platforms such as Facebook, Instagram, and Twitter, agricultural enterprises can establish direct communication channels with consumers, share valuable content, and cultivate brand loyalty.

2.Dutta & Basak: In their study, Dutta & Basak (2019) explored the role of social media marketing in enhancing brand awareness and recognition within the agricultural industry. Their research underscored the significance of consistent and relevant content sharing in increasing visibility and attracting new customers. By adopting a strategic approach to





social media marketing, agricultural businesses can differentiate themselves from competitors and foster stronger connections with their target audience.

3. Gokarneshan & Nagarajan: Gokarneshan & Nagarajan (2019) delved into the emerging trend of influencer marketing in the agricultural sector. Their study focused on the role of agricultural influencers, such as farmers, agricultural experts, and industry influencers, in endorsing products and services on social media platforms. By leveraging the expertise and credibility of influencers, agricultural businesses can enhance consumer trust and influence purchasing decisions. Gokarneshan & Nagarajan highlighted the potential of influencer marketing to reach niche audiences and drive engagement within the agricultural community.

4. Sharma & Sharma: Sharma & Sharma (2018) investigated the effectiveness of content strategy and engagement in social media marketing for agricultural products. Their study emphasized the importance of visual content, user-generated content, and customer testimonials in enhancing brand credibility and driving consumer engagement. Sharma & Sharma underscored the need for agricultural businesses to develop compelling content that resonates with their target audience and encourages interaction on social media platforms.

5. Karami & Rezaei-Moghaddam: Karami & Rezaei-Moghaddam (2017) examined the challenges and opportunities associated with social media marketing in the agricultural sector. Their research highlighted issues such as content authenticity, regulatory compliance, and reaching rural audiences. Karami & Rezaei-Moghaddam emphasized the importance of innovative strategies and tailored approaches to overcome these challenges and fully leverage the potential of social media marketing in promoting agricultural products.

## **RESEARCH OBJECTIVES**

- To assess the effectiveness of social media platforms in promoting agricultural products and engaging with consumers.

## **III. RESEARCH DESIGN**

### **What is the study about?**

The study is about to provide valuable insights into the role of social media marketing in promoting agricultural products, with the goal of informing strategic decision-making and optimizing marketing efforts within the agricultural industry.

### **Why is the study being made?**

The study is being conducted to inform agricultural businesses about the potential benefits and challenges of utilizing social media marketing strategies and to provide insights into how these strategies can be effectively implemented to promote agricultural products.

### **What type of data is required?**

This study will require primary data and secondary data.

Data collection will be done by designing appropriate questionnaire, online survey among random people with a sample size of around 160 People.

### **TYPES OF DATA COLLECTION:-**

**Primary data:** - Primary data is that which is collected fresh and for the first time, primary data is also called original data/ basic data.

- Through online questionnaire survey.

**Secondary data:** - Secondary data refers to that data which has been used previously for any research and it is used for a second time.

- Through Google scholar
- Through online database

Total Population: - 160

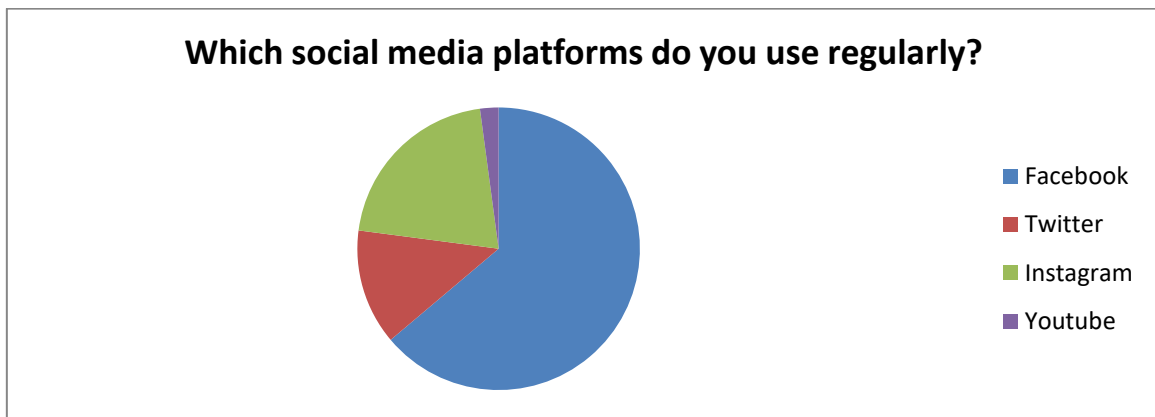
Sample Size: - 160

**Analysis Technique:** - Random sampling and questionnaire techniques selected by researcher to collect the data from the participants.

**Data Analysis and Interpretation:-**

**1. Which social media platforms do you use regularly?**

Response	Frequency	Percentage
Facebook	58	36.2
Twitter	12	7.5
Instagram	19	11.8
Youtube	71	44.3
<b>Total</b>	<b>160</b>	<b>100%</b>



└ Analysis

└ Facebook:

•Frequency: 58 respondents

•Percentage: 36.2%

└ Twitter:

•Frequency: 12 respondents

•Percentage: 7.5%

└ Instagram:

•Frequency: 19 respondents

•Percentage: 11.8%

└ Youtube:

•Frequency: 71 respondents

•Percentage: 44.3%

└ Interpretation

The majority of respondents reported using YouTube regularly (44.3%), followed by Facebook (36.2%), Instagram (11.8%), and Twitter (7.5%)

**Q2. What type of agricultural content do you find most engaging on social media?**

Response	Frequency	Percentage
Product promotions	32	20
Farming Tips / advice	74	46.2
Customer testimonials	12	7.5
Educational content	42	26.25
<b>Total</b>	<b>160</b>	<b>100 %</b>

### What type of agricultural content do you find most engaging on social media?



#### Analysis

##### Product promotions:

- Frequency: 32 respondents
- Percentage: 20%

##### Farming Tips / advice:

- Frequency: 74 respondents
- Percentage: 46.2%

##### Customer testimonials:

- Frequency: 12 respondents
- Percentage: 7.5%

##### Educational content:

- Frequency: 42 respondents
- Percentage: 26.25%

#### Interpretation

The data indicates that the majority of respondents find farming tips or advice (46.2%) to be the most engaging type of agricultural content on social media. Customer testimonials have the lowest level of engagement, with only 7.5% of respondents finding them engaging.

### IV. CONCLUSION

In conclusion, the research underscores the importance of social media marketing in promoting agricultural products and driving consumer engagement within the agricultural industry. By understanding consumer preferences, behaviors, and perceptions in the context of social media marketing, agricultural brands can develop more targeted and effective marketing strategies to reach and engage their target audience effectively. The use of social media in the marketing of agricultural products significantly influences cost reduction and hence efficiency in marketing as well as enhances turnover of farmers through increased demand for agricultural products.

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# Super Absorbent Polymer (SAP) Use in Concrete

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**ABSTRACT:** Super absorbent polymers (SAPs) have emerged as a ground-breaking additive in the development of high-performance concrete, significantly enhancing its properties and broadening its application spectrum. This paper explores the integration of SAPs into concrete, focusing on their impact on the material's workability, strength, durability, and self-healing capabilities. SAPs are known for their ability to absorb and retain large quantities of water, which they release gradually, thereby improving internal curing and reducing shrinkage. This study examines the microstructural changes and mechanical performance of SAP-modified concrete through a series of experimental tests and comparative analyses. The findings demonstrate that SAPs not only enhance the internal curing process but also contribute to increased compressive strength and reduced permeability, which are critical for the longevity and sustainability of concrete structures. The self-healing properties induced by SAPs address the challenges of micro-cracking, thereby extending the service life of concrete infrastructure. The integration of SAPs in concrete represents a significant advancement in construction materials, offering a sustainable solution that aligns with modern engineering demands

**KEYWORDS:** (Super absorbent polymers (SAP), Concrete durability, internal curing, reducing shrinkage, reduced permeability, compressive strength, sustainable solution, self-healing properties, Ability to absorb and retain)

## I. INTRODUCTION

Super absorbent polymers are a class of polymers capable of absorbing and retaining extremely large amounts of water relative to their own mass. These polymers can absorb water up to several hundred times their weight, swelling to form a gel-like substance. SAPs are primarily composed of cross-linked hydrophilic networks, which give them their remarkable water absorption properties. Originally developed for applications such as disposable diapers and agricultural water retention, SAPs have found a promising role in the construction industry, particularly in enhancing concrete properties

When added to a concrete mix, SAPs absorb a significant portion of the mixing water. This water is gradually released during the curing process, providing a continuous internal supply of moisture. This mechanism of internal curing is crucial because it mitigates the common problem of autogenous shrinkage, which occurs when the concrete dries out from the inside. Autogenous shrinkage can lead to micro-cracking and reduced durability. By ensuring adequate moisture availability, SAPs enhance the hydration process of cement, thereby improving the overall strength and durability of the concrete.

SAPs provide an internal source of water, which is essential for the hydration of cement particles, especially in high-performance concrete with low water-to-cement ratios. This internal curing reduces the risk of early-age cracking and improves the overall quality of the concrete.

By maintaining internal moisture, SAPs significantly reduce shrinkage. This is particularly beneficial for large concrete structures and pavements where shrinkage can lead to substantial cracking and maintenance issues.

The controlled release of water by SAPs helps to maintain a continuous hydration process, leading to a denser microstructure. This reduces the permeability of concrete, making it more resistant to ingress of harmful substances like chlorides and sulphates, thereby enhancing its durability.

One of the most remarkable benefits of SAPs in concrete is their contribution to self-healing. When micro-cracks form in the concrete, the SAPs within the crack can absorb water from the environment, swell, and then slowly release this water to aid in the hydration of hydrated cement particles around the crack, promoting autogenous healing. SAPs can improve the workability of fresh concrete. They act as internal reservoirs of water, which can be particularly advantageous in hot weather conditions where the risk of rapid moisture loss is high.

Incorporating SAPs requires adjustments in the mix design. The water-to-cement ratio, aggregate content, and other admixtures need to be carefully balanced to ensure the desired properties of the concrete are achieved.



Super absorbent polymers represent a significant advancement in concrete technology, offering solutions to some of the most persistent challenges in the construction industry. By enhancing internal curing, reducing shrinkage, and improving durability, SAP-modified concrete holds the potential to revolutionize how we design and build resilient infrastructure. As research and development in this field continue to progress, the widespread adoption of SAPs in concrete is likely to grow, driving the construction industry towards more sustainable and durable building practices.

## II. LITERATURE REVIEW

Mohammad Daoud: THE USE OF SUPER ABSORBENT POLYMER AS A SEALING AGENT IN PLAIN CONCRETE

The use of sodium polyacrylate as super absorbent polymer in concrete has promising potential to improve several properties of concrete including the water tightness. This property is very useful to prevent water leaks through the concrete mass making it a self-sealing concrete. This property improves with time if subjected to moisture for a properly designed concrete with adequate amount of SAP. The adequate amount of SAP to be used to prevent future water leak though the concrete mass is yet to be determined. Also the water pressure is another factor that plays a significant role in the water flow rate calculation. The increase in the water pressure increases the flow rate. Also the increase in the amount of SAP used in the concrete mix decreases the flow rate. Several other properties of concrete can be altered by using SAP as an admixture which in turn converts the liquid water into gel.

Parth C. Bhavsar: EXPERIMENTAL INVESTIGATION ON CONCRETE USING SUPER ABSORBING POLYMER

The optimum dosage of SAP for internal curing was found out to be 0.3% by weight of cement. If SAP adds as gel form in concrete, water content is increase and obviously strength of concrete will reduces as compare to powder form. Here also seen that SAP add 0.3% as gel form the strength of concrete is reducing in 7 days and it's gradually increase hydration and an achieving in 28 days. If SAP adds as powder form in concrete SAP absorbs water, then due to lowering water content strength of concrete increases

P.R. Chauhan: EXPERIMENTAL INVESTIGATION ON CONCRETE BY USING SUPER ABSORBING POLYMER

The optimum dosage of SAP for internal curing was found out to be 0.3% by weight of cement. There are observe two inverse effect in gel form pond and gunny bag curing SAP gives better result as compare toggle form without curing. In powder form pond curing gives lesser result as compare to powder form without curing. If SAP adds as gel form in concrete, water content is increase and strength of concrete will reduces as compare to powder form. One most important after 28 days SAP in gel form give higher result as compare to SAP in powder form due to maximum water contains available in swollen SAP. If SAP adds as powder form in concrete SAP absorbs water, then due to lowering water content strength of concrete obviously increases. Here also studied SAP adds as gel and powder form both are work best resulted. Powder form SAP best resulted for without curing

Ashish Kumar: EFFECT OF SUPER ABSORBENT POLYMER ON STRENGTH OF CONCRETE

The optimum dosage of SAP for M30 concrete is 0.3% for maximum Strength of concrete. Due to addition of SAP there is significant increase in Compressive, tensile and flexure strengths. The self-cured concrete in which SAP was used proved to be more economical than conventionally cured concrete. Self-curing concrete is reducing the improper curing problems

## III. METHODOLOGY

### 1. Literature Review

- A comprehensive literature review was conducted to understand the existing research and advancements in SAP Super Absorbent Polymer concrete. This included academic journals, conference papers, industry reports, and standards.

### 2. Material Selection

- Cement: Ordinary Portland Cement (OPC) was used as the primary binder.
- Aggregates: Fine and coarse aggregates conforming to standard specifications.
- SAP: Commercially available SAPs with known water absorption characteristics were selected.

### 3. Mix Design

- Various concrete mix designs were developed to incorporate different dosages of SAP. The control mix (without SAP) was compared with SAP-incorporated mixes.

### 4. Preparation of Samples





- Concrete samples were prepared by mixing the selected materials. SAP was added to the mix in dry form, and its water absorption capacity was accounted for in the total water content of the mix.
5. Curing
- The samples were cured under standard conditions (20°C and 95% relative humidity) for 28 days. Additional samples were subjected to accelerated curing methods to study the long-term effects.
6. Testing Procedures
- Compressive Strength-Tested using a universal testing machine (UTM) according to ASTM standards.
  - Flexural Strength -Measured using a third-point loading method.
  - -Durability Tests- Included freeze-thaw resistance, water permeability, and chloride penetration.
  - Microstructural Analysis- Scanning Electron Microscopy (SEM) was used to examine the distribution and interaction of SAP within the concrete matrix.

## **IV. RESULTS & DISCUSSION**

### **1. Mechanical Properties**

- Compressive Strength  
7-day Strength The compressive strength of SAP concrete was observed to be about 10-20% higher than the control mix due to good absorption of water by the SAP particles.

28-day Strength- The strength at 28 days was good pronounced, with only a 5-10% compared to the control mix. The internal curing provided by SAP improved the hydration process, partially compensating for the initial loss.

- Flexural Strength  
Initial Strength-Similar to compressive strength, early-age flexural strength was slightly higher (by about 10%)  
Durability Performance
- Water Permeability  
The incorporation of SAP reduced water permeability by approximately 30%. The internal curing effect and the refined pore structure contributed to this improvement.
- Chloride Ion Penetration  
SAP concrete demonstrated a reduction in chloride ion penetration depth by up to 25%, enhancing the potential for longer service life in marine or dicing salt environments.

### **2. Microstructural Analysis**

- Crack Analysis  
Micro-cracks in SAP concrete were fewer and smaller compared to the control mix. The SAP particles effectively acted as self-healing agents by releasing water into cracks, promoting further hydration and sealing.

### **3. Practical Considerations**

- Workability  
Adjustments in water content and the use of superplasticizers were necessary to maintain workability when using SAP. Optimal SAP dosage was critical to balance workability and mechanical properties.
- Economic Impact  
While the initial cost of SAP concrete is higher due to the price of SAP, the long-term benefits such as reduced maintenance costs and enhanced durability can offset the initial investment.
- Sustainability  
The improved durability and extended lifespan of SAP concrete structures contribute to sustainability by reducing the need for repairs and replacements, thus lowering the overall carbon footprint of construction activities.

## **V. DISCUSSION**

### **1. Effect on Mechanical Properties**

- Compressive Strength- The inclusion of SAP generally resulted in a reduction in early-age compressive strength due to the formation of voids. However, long-term strength showed improvements due to internal curing and enhanced hydration.
- Flexural Strength- Similar trends were observed in flexural strength, with initial reductions offset by long-term gains.



## 2. Durability Improvements

- Freeze-Thaw Resistance- SAP concrete showed superior freeze-thaw resistance. The SAP acted as internal reservoirs, releasing water during freezing, thus reducing internal stresses.
- Water Permeability- Reduced water permeability was observed due to the improved microstructure and the filling effect of the SAP.

## 3. Microstructural Changes

- Hydration Products- SEM analysis revealed a denser microstructure with more C-S-H (calcium silicate hydrate) formation in SAP concrete. The SAP particles provided nucleation sites for hydration products.
- Crack Bridging- SAP particles were effective in bridging micro cracks, thereby enhancing the toughness and ductility of the concrete.

## 4. Practical Implications

- Workability- The addition of SAP required adjustments in the mix design to maintain workability. Superplasticizers were often needed.
- Economic Considerations- Although SAPs are relatively expensive, the long-term durability benefits and potential reduction in maintenance costs can justify their use.
- Sustainability-SAP concrete contributes to sustainability by potentially reducing water usage and increasing the lifespan of concrete structures.

## 5. Future Research Directions

- Optimization of SAP Dosage- More research is needed to determine the optimal SAP content for different applications.
- Long-Term Performance-Further studies should focus on the long-term performance of SAP concrete in various environmental conditions.
- Cost-Benefit Analysis-A comprehensive cost-benefit analysis considering the lifecycle of SAP concrete structures.

**Table No-1: Conventional Concrete M35 Grade Test Result**

M35 Grade of Concrete			
Parameters	7 Days (Specimen)	14 Day(Specimen)	28 Day(Specimen)
Average Strength (mpa)	20.07	32.25	38.76

**Table No-2: M35 Grade concert with Added Superabsorbent polymer in it 5%**

M35 Grade of Concrete with Added (SAP) 5%			
Parameters	7 Days (Specimen)	14 Day(Specimen)	28 Day(Specimen)
Average Strength (mpa)	21.41	33.16	39.64



**Table No-3: M35 Grade concert with Added Superabsorbent polymer in it 10%**

<b>M35 Grade of Concrete with Added (SAP) 10%</b>			
Parameters	7 Days (Specimen)	14 Day(Specimen)	28 Day(Specimen)
Average Strength (mpa)	22.29	33.37	40.04

**Table No-4: M35 Grade concert with Added Superabsorbent polymer in it 15%**

<b>M35 Grade of Concrete with Added (SAP) 15%</b>			
Parameters	7 Days (Specimen)	14 Day(Specimen)	28 Day(Specimen)
Average Strength (mpa)	17.98	30.87	32.95

The compressive strength of SAP concrete 15 % was observed to be about 20-25% lower than the 1 To 10 % SAP Concrete due to the initial voids created by the absorption of water by the SAP particles.

## VI. CONCLUSION

- Superabsorbent polymers help in reducing water content in concrete mixes, leading to higher strength and durability.
- Superabsorbent polymer enhances the self-healing properties of concrete by reducing crack widths and increasing the lifespan of structures.
- Superabsorbent polymers can mitigate the effects of shrinkage in concrete, reducing the risk of cracks.
- Superabsorbent polymers contribute to the sustainability of concrete by reducing water consumption during mixing.
- These polymers aid in controlling bleeding and segregation in fresh concrete, ensuring uniformity in the mix.
- They enhance the rheological properties of concrete, making it easier to pump and place.
- Superabsorbent polymers can be used in lightweight concrete mixes to improve their performance.
- They are beneficial in reducing permeability in concrete, enhancing its resistance to chemical attacks.
- These polymers offer environmental benefits by promoting the use of recycled water in concrete production, reducing waste

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# Upgradation of National Highway to Double Tier Elevated Corridor for Efficient Traffic Management

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**ABSTRACT:** The upgradation of National Highway to a double-tier elevated corridor represents a transformative approach to enhancing traffic management and alleviating congestion in densely populated urban areas. This study explores the feasibility, design principles, and anticipated benefits of implementing a dual-level highway structure, specifically focusing on its potential to segregate fast-moving and local traffic. The upper tier is designed to accommodate long-distance, high-speed vehicles, while the lower tier serves local traffic, thereby optimizing traffic flow and reducing bottlenecks. The research employs traffic flow theory, urban planning principles, and advanced engineering techniques to assess the project's viability. Data from traffic surveys, demand forecasting, and simulation models provide a comprehensive understanding of current and projected traffic patterns. The findings suggest that such an infrastructure upgrade can significantly improve travel times, enhance safety, and promote sustainable urban development. Additionally, the integration of intelligent transportation systems (ITS) within the elevated corridor framework offers real-time traffic management capabilities, further augmenting efficiency. This study concludes that the double-tier elevated corridor is a viable solution for modernizing national highways and addressing the challenges of urban traffic congestion, ultimately contributing to more efficient and sustainable transportation networks. The study encompasses a multidisciplinary approach, incorporating traffic engineering, urban planning, environmental science, and stakeholder engagement.

**KEYWORDS:** Efficient traffic management, Urban infrastructure development, Traffic congestion solutions, Traffic flow optimization, Road safety, Elevated roadway systems.

## I. INTRODUCTION

Traffic congestion is one of the most visible, pervasive, and immediate transport problems plaguing not only India's but also most of the cities of the world on a daily basis. It affects all modes of transportation especially roads and all socioeconomic groups. Rapid population growth, increasing urbanization, inadequate/unplanned transport infrastructure, poor public transport systems and the rising number of personal vehicles are some of the primary causes of congestion. This article reviews the findings of studies based on road traffic congestion.

Traffic Congestion or traffic jams is one of the major issues in most metropolitan cities like Pune. As we know Pune city is a well-developed and popularly known for Oxford for east for its education many students come from different cities secondly many young people come for jobs because of booming IT companies. Due to this city has become densely populated. Today the Pune's population is around 35 lakhs. Registered vehicles are 36.2 lakh which is exceeding the human population. During the peak hours i.e. 09:00 to 11:00 in the morning and 6:00 to 8:00 in the evening traffic situation gets worst and chaotic. For the Increasing Traffic widening of road is not only the solution as there is land to be accrued in the cities. Land acquisition is a tedious and time consuming process which is not feasible in the cities as well as in the outskirts, so we have to find the sustainable solution for the increasing traffic i.e. Construction of Double Tier Elevated Highway Corridor including provision for metro (section from Pune to Shirur of NH- 753F (from Km. 0.000 to Km. 56.000)) in the State of Maharashtra.

The Starting Ch. 0+000 takes off near Wagholi Junction on Pune-Ahmednagar Road and Project end location to be considered at Shirur bypass end on Pune-Aurangabad Highway i.e. near at Bridge over Ghod River. Hence, the total length of the project corridor shall be 69.60Km. The findings suggest that such an infrastructure upgrade can significantly improve travel times, enhance safety, and promote sustainable urban development. Additionally, the integration of intelligent transportation systems (ITS) within the elevated corridor framework offers real-time traffic

management capabilities, further augmenting efficiency. This study concludes that the double-tier elevated corridor is a viable solution for modernizing national highways and addressing the challenges of urban traffic congestion, ultimately contributing to more efficient and sustainable transportation networks.

## II. RELATED WORK

In [1] This research tries to identify the factors responsible for the traffic and congestion problems in Pune, Lot of policy decisions that need to be taken by the government in terms of infrastructural development and law and order to curb this problem. In [2] According to the vehicle composition and lane distribution, there is the variation of travel time and congestion indices. It will analyze the influence of traffic congestion on the overall economy, environment including health. Majority of the people have suggested that the congestion can be minimized by Implementation of strict traffic law, controlling road side activities and adequate parking facilities. In [3] It is found that the main cause of traffic jams in Pune is road side parking which should be banned and penalized. Traffic jams can be improvised on various strategies such as road broadening, improved road infrastructures, penalty to the traffic law. To lessen the traffic problems there should be effective traffic management system and proper implication of traffic rules and system. In [4] It was found that urban road congestion charge is a system engineer involving government, public and industrial benefit. Charge plan should include charge purpose, charge tariff, charge region as well as charge method. Each item should be made clear and scientific and in accordance with the local transportation condition and financial situation. In [5] The prime cause of traffic jams in Pune is street parking which should be strictly banned. Traffic jams constraints can be improved by embarking on various strategies such as road capacity expansion, improved road infrastructures, restricting routes for Rickshaw, financial penalty to the traffic law breakers. In [6] At the Katraj intersection, it is found that the major traffic volume moves from Pune to Katraj; Pune to Mumbai Pune Expressway bypass; Mumbai Pune Expressway bypass to Kondhwa budruk; and from Katraj to Pune. At the Nal stop intersection, the major traffic flow occurs from Kothrud to Deccan; Deccan to Kothrud ; Kothrud to Mhatre bridge; and from mhatre bridge to Deccan. In [7] A good transport Network system is available in study area, which includes roads, Railway line, or Air transport network system. The important the major district road in the study area, which provides services in agricultural market, Education, commerce, Industrial and health sector. In this study [8] we see that the main reason of traffic jams in mundhwa chowk Pune is unauthorized and illegal road side parking and also road side construction. Traffic Jams make an improper negative impact on environment, Societies and as well as on development and economy of city.

## III. METHODOLOGY

**Collection of Literature Review papers and Study of Existing Research on Traffic Management and Double tier Highway.**

**Data collection of the selected corridor (Pune to Shirur).**

The data is to be collected such as names of the villages, chainage distance between the villages, roadmap of starting point to end point of survey, details of major built up locations.

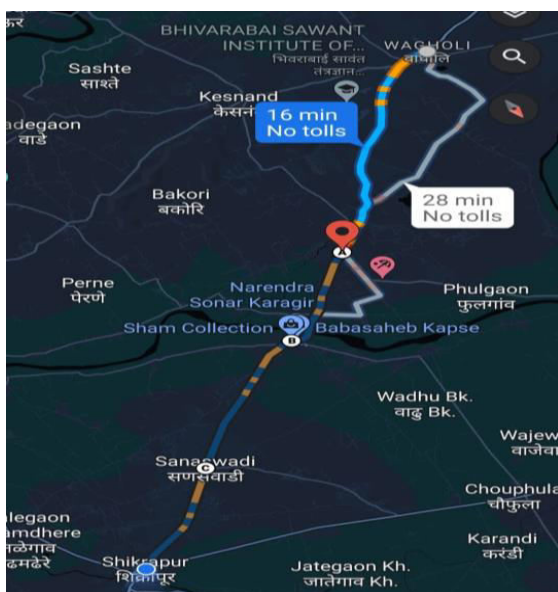


Figure.1

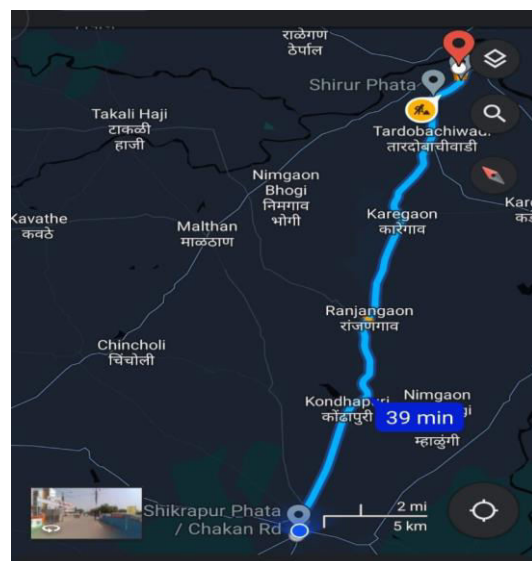


Figure.2





### Details of Major Built up locations.

The details such as the name of villages and their chainage is to be calculated

### Traffic volume calculation.

Traffic volume calculation is carried out to observe the traffic flow and estimate the hourly volume and average daily traffic.

Observe and note down the number of vehicles passes or come across the junction for the 5 min of time interval and this reading is to be taken for 10 min.

This number of vehicles are then classified in the form of passenger cars, motorcycles, light vans, medium lorries, heavy lorries, buses, three wheeler & others.

To calculate the volume of traffic per hour, the formulae which are used is given below:

1. Percentage of vehicle (%) = (No. of vehicle/total no of vehicle)\*100
2. No. of vehicles per hr (veh/hr) = No. of vehicle/(10min/60min)
3. Traffic volume in PCU = No. of vehicle\*PCU conversion factor
4. Traffic volume per hr (PCU/hr) = Traffic volume/(10min/60min)

By using above formulas the traffic volume is to be estimated for per hour

## IV. TRAFFIC ANALYSIS OF MAJOR JUNCTIONS

### ➤ Wagholi Chowk (15.9Km from Pune)

Table 1 Traffic Volume Calculation for Wagholi Location

Type of Vehicle	Percentage %	PCU converter	No. of vehicles	No. of vehicles per hour	Traffic Volume (PCU)	Traffic Volume PCU/HR
Passengers Cars	15.46	1	370	2220	370	2220
Motorcycles	69.91	0.75	1673	10038	1254.75	7528.5
Light Vans	3.09	2	74	444	148	888
Medium Lorries	1.04	2.5	25	150	62.5	375
Heavy Lorries	0.501	3	12	72	36	216
Buses	0.62	3	15	90	45	270
Three wheeler & other	9.36	1.2	224	1344	268.8	1612.8
Total	100		2393	14358	2185.05	13110.3

Hourly Estimated Volume = 14358 Vehicle/hr.

The total Traffic Volume per hour at location is = 13110.3 pcu/hr.



Graph.1

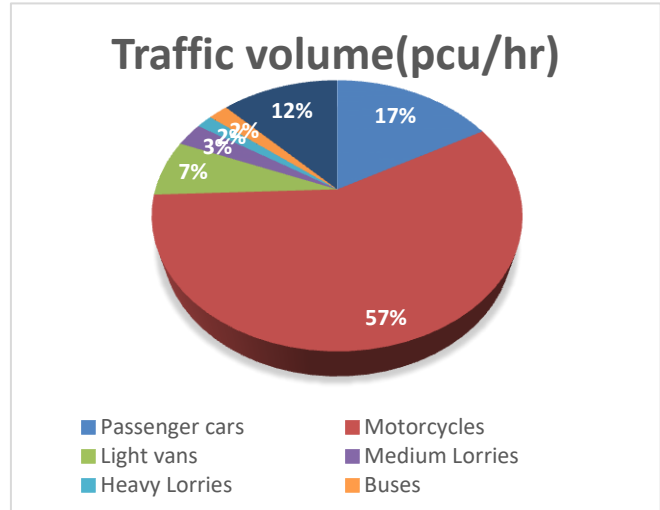


Figure.3

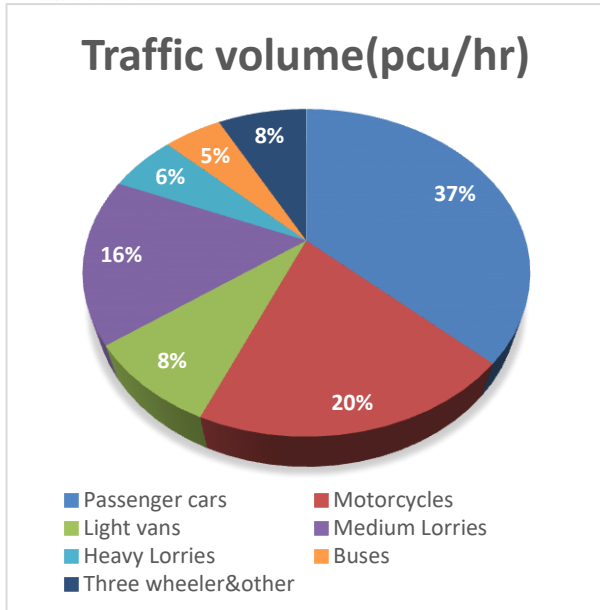
**Lonikand (8.2 Km from Wagholi)**

Table 2 Traffic Volume Calculation for Lonikand Location

Type of Vehicle	Percentage %	PCU converter	No. of vehicles	No. of vehicles per hour	Traffic Volume (PCU)	Traffic Volume PCU/HR
Passengers Cars	43.88	1	416	2496	416	2496
Motorcycles	31.22	0.75	296	1776	222	1332
Light Vans	5.06	2	48	288	96	576
Medium Lorries	7.80	2.5	74	444	185	1110
Heavy Lorries	2.32	3	22	132	66	396
Buses	2.00	3	19	114	57	342
Three wheeler & other	7.70	1.2	73	438	8706	525.6
Total	100		948	5688	1129.6	6777.6

Hourly Estimated Volume = 5688 Vehicle/hr.

The total Traffic Volume per hour at location is = 6777.6 pcu/hr.



Graph.2



Figure.4

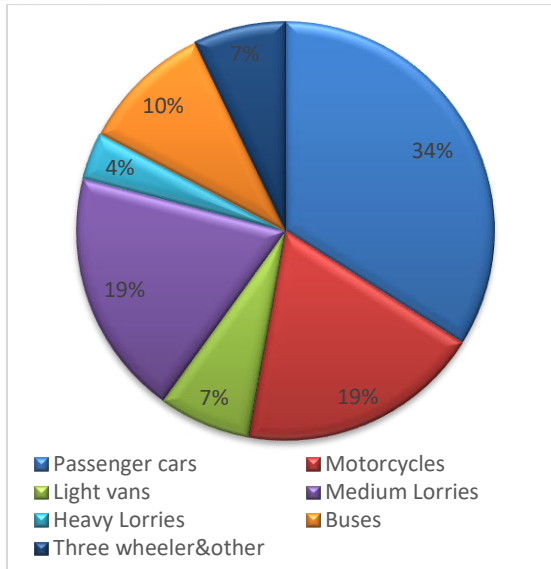
➤ **Bhima Koregaon (3.9 Km from Lonikand)**

Table.3 Traffic Volume Calculation for Bhima Koregaon Location

Type of Vehicle	Percentage %	PCU converter	No. of vehicles	No. of vehicles per hour	Traffic Volume (PCU)	Traffic Volume PCU/HR
Passengers Cars	42.02	1	419	2514	419	2514
Motorcycles	31.09	0.75	310	1860	232.5	1395
Light Vans	4.41	2	44	264	88	528
Medium Lorries	9.42	2.5	94	564	235	1410
Heavy Lorries	1.50	3	15	90	45	270
Buses	4.21	3	42	252	126	756
Three wheeler & other	7.32	1.2	73	438	87.6	525.6
Total	100		997	5982	1233.1	7398.6

Hourly Estimated Volume =5982 Vehicle/hr.

The total Traffic Volume per hour at location is = 7398.6 pcu/hr



Graph.3



Figure.5

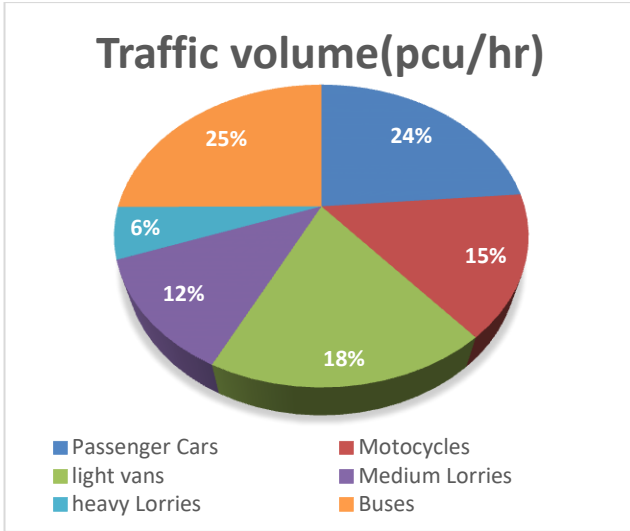
➤ **Sanaswadi (5.3 Km from Bhima koregaon)**

Table.4 Traffic Volume Calculation for Sanaswadi Location

Type of Vehicle	Percentage %	PCU converter	No. of vehicles	No. of vehicles per hour	Traffic Volume (PCU)	Traffic Volume PCU/HR
Passengers Cars	32.71	1	439	2634	439	2634
Motorcycles	28.01	0.75	376	2256	282	1692
Light Vans	12.74	2	171	1026	342	2052
Medium Lorries	6.70	2.5	90	540	225	1350
Heavy Lorries	2.53	3	34	204	102	612
Buses	11.54	3	155	930	465	2790
Three wheeler & other	5.73	1.2	77	462	92.4	554.4
Total	100		1342	8052	1947.4	11684.4

Hourly Estimated Volume = 8052 Vehicle/hr.

The total Traffic Volume per hour at location is = 11684.4 pcu/hr.



Graph.4



Figure.6

➤ **Shikrapur(4.1 Km from Sanaswadi)**

Table.5 Traffic Volume Calculation for Shikrapur Location

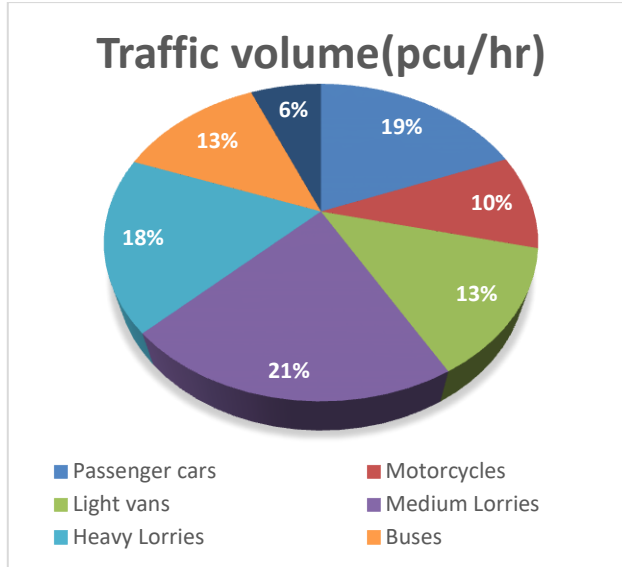
Type of Vehicle	Percentage %	PCU converter	No. of vehicles	No. of vehicles per hour	Traffic Volume (PCU)	Traffic Volume PCU/HR
Passengers Cars	32.80	1	583	3498	583	3498
Motorcycles	22.17	0.75	394	2364	295.5	1773
Light Vans	11.25	2	200	1200	400	2400
Medium Lorries	14.57	2.5	259	1554	647.5	3885
Heavy Lorries	10.18	3	181	1086	543	3258
Buses	7.48	3	133	798	399	2394
Three wheeler & other	1.51	1.2	27	162	194.4	1166.4
Total	100		1777	10662	3062.4	18374.4

Hourly Estimated Volume = 10662 Vehicle/hr.

The total Traffic Volume per hour at location is = 18374.4 pcu/hr.







Graph.5



Figure.7

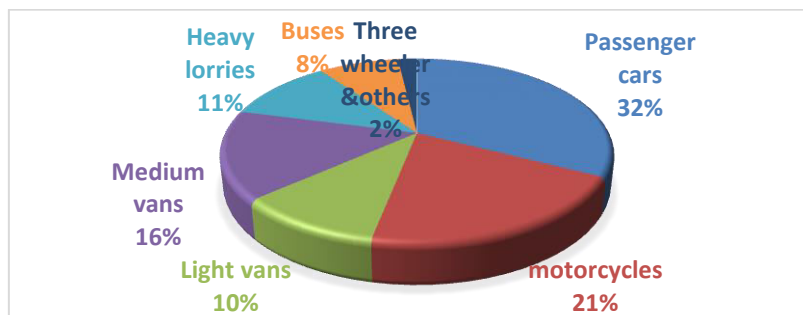
➤ **Ranjangaon(15 Km from Shikrapur)**

Table. 6 Traffic Volume Calculation for Ranjangaon Location

Type of Vehicle	Percentage %	PCU converter	No. of vehicles	No. of vehicles per hour	Traffic Volume (PCU)	Traffic Volume PCU/HR
Passengers Cars	32.51	1	529	3174	529	3174
Motorcycles	20.59	0.75	335	2010	251.25	1507.5
Light Vans	10.38	2	169	1014	338	2028
Medium Lorries	15.55	2.5	253	1578	632.5	3795
Heavy Lorries	11.06	3	180	1080	540	3240
Buses	7.99	3	130	780	390	2340
Three wheeler & other	1.90	1.2	31	186	37.2	223.2
Total	100		1627	9762	2717.95	16307.7

Hourly Estimated Volume = 9762 Vehicle/hr.

The total Traffic Volume per hour at location is = 16307.7 pcu/hr



Graph. 6



➤ **Karegaon(6.5 Km from Ranjangaon)**

Table. 7 Traffic Volume Calculation for Karegaon Location

Type of Vehicle	Percentage %	PCU converter	No. of vehicles	No. of vehicles per hour	Traffic Volume (PCU)	Traffic Volume PCU/HR
Passengers Cars	38.24	1	340	2040	340	2040
Motorcycles	34.30	0.75	305	1830	228.75	1372.5
Light Vans	4.38	2	39	234	78	468
Medium Lorries	8.88	2.5	79	474	197.5	1185
Heavy Lorries	2.13	3	19	114	57	342
Buses	4.49	3	40	240	120	720
Three wheeler & other	7.53	1.2	67	402	80.4	482.4
<b>Total</b>	<b>100</b>		<b>889</b>	<b>5334</b>	<b>1101.65</b>	<b>6609.9</b>

Hourly Estimated Volume = 5334 Vehicle/hr.

The total Traffic Volume per hour at location is = 6609.9pcu/hr

➤ **Shirur (11 Km from Shirur phata)**

Table.8 Traffic Volume Calculation for Shirur Location

Type of Vehicle	Percentage %	PCU converter	No. of vehicles	No. of vehicles per hour	Traffic Volume (PCU)	Traffic Volume PCU/HR
Passengers Cars	45.29	1	491	2946	491	2946
Motorcycles	24.81	0.75	269	1614	201.75	1210.5
Light Vans	15.49	2	168	1008	336	2016
Medium Lorries	2.12	2.5	23	138	57.5	345
Heavy Lorries	0.64	3	7	42	21	126
Buses	5.35	3	58	348	174	1044
Three wheeler & other	6.27	1.2	68	408	81.6	489.6
<b>Total</b>	<b>100</b>		<b>1084</b>	<b>6504</b>	<b>1362.85</b>	<b>8177.1</b>

Hourly Estimated Volume = 6504 Vehicle/hr.

The total Traffic Volume per hour at location is = 8177.1pcu/hr

**V. COST ANALYSIS**

**Estimated Total Cost:**

Per Kilometer Cost:- ₹150 crore to ₹200 crore

Total Length:- 69 kilometers

Estimated Total Cost=69Km×₹150 Crore/km to ₹200 Crore/km

**Estimated Total Cost=₹10,350 Crore to ₹13,800 Crore**



The upgradation of the national highway from Pune to Shirur into a double-tier elevated corridor with rigid pavement is estimated to cost between ₹10,350 crore to ₹13,800 crore. This comprehensive estimate encompasses various critical components, including design and planning, land acquisition, civil construction works, material and labour costs, safety and ancillary works, technology integration for traffic management, and a contingency fund to cover unforeseen expenses. The elevated corridor, designed to enhance traffic efficiency and safety over the 69-kilometer stretch, leverages the durability of rigid pavement and the advanced structure of a double-tier design.

## **VI. CONCLUSION**

In this paper, the in depth study of Traffic Survey Station, Location of Traffic Surveys, the study of the major & minor junction across the section of highway (i.e. Pune to Shirur Section) are studied.

It is found that the existing highway connected with huge nos. of junctions (Major and minor junctions as well) with a heavy traffic, which lead to the problem of traffic congestion issues.

It is observed that the limit for PCU/hr for the above mentioned locations is to be exceeded and this limit (5600-7000 PCU/hr) is suggested by Indian Roads Congress.

From the above traffic volume calculation of each junction, it is notice that there should be need for the reduction in traffic. Because the limit of all junction exceeds the value of PCU/hr limit.

On the basis of Traffic Survey of Existing highway, a sustainable and Economical solution for the development in infrastructure of our country is the upgradation of national highway to double tier elevated corridor for efficient traffic management. This concept tries to overcome the problems related to the environment, Land acquisition, impacts on human health issues, etc.

## **VII. SCOPE OF WORK**

The scope of work for the upgradation of a national highway to a double-tier elevated corridor for efficient traffic management encompasses several key phases. Initially, a comprehensive feasibility study will be conducted, including traffic surveys, environmental impact assessments, and economic analyses. This will be followed by the design development phase, involving the creation of preliminary and detailed engineering designs and the integration of smart traffic management systems.

There are also several points in scope of work such as traffic decongestion, enhanced safety, improved connectivity, reduced travel time, economic development, cost and funding, etc.

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# Experimental Study on Recycled Asphalt Material

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**ABSTRACT:** A Recycling of used asphalt and other waste mixtures as replacements for virgin aggregate is on the increase worldwide. specification for reused asphalt into new base course mixtures from 35% to 50%. All recycling processes fall into one of four possible categories as follows: Hot recycling, Cold recycling, in-situ recycling and in-plant recycling. The results of measuring British and European testing procedures throughout the Process of flexible road construction are relied on for guidance. Decisions are Based on the data generated at virtually every stage of the operation, including initial Investigation, cost estimation, production control, installation, acceptance and Assessment of performance. This can be achieved by ensuring sufficient care has been taken by Skilful, knowledgeable individuals during sampling and testing to produce reliable Result. Errors can lead to costly, false assumptions being made about the quality of Materials and products. The present investigation consisted of experimental and theoretical studies of using Various % of Recycled Asphalt Pavement aggregate in three different mixtures. The aggregates used have been Recycled from bituminous mixtures.

**KEYWORDS:** Recycled Asphalt Pavement, Construction and demolition West, bitumen mixture, Indian standard recommended.

## I. INTRODUCTION

Bituminous mixtures used to roads nowadays were evolved from dry stone mixtures Developed by two pioneers Telford and Macadam. These inventors introduced individually dry bound mixtures for pavements, which were subsequently sprayed with a sealing tar blend to bind the aggregates together and provide a medium with good water proofing properties. These composite mixtures relied on stone interlocking for their strength. In 1909, the UK parliament introduced the Road Board to advise Local Authorities on the best way to repave and repair damaged roads and the government provided grants to carry out this task More recently, increased awareness of the environment and, in particular, the concern over guaranteeing sustainable development, and the pressing need to organise waste management have all contributed to enhancing the image of recycling as an important and even priority instrument for solving the problem of waste materials. Environmental awareness has also awakened recognition of the possible economic value of recyclable wastes through recycling into secondary raw materials. To move towards sustainable development the amount of waste produced from road surface and industry in general must be reduced and the amount of waste recovered should be increased.

In simple terms, we must deal with our wastes in our time and ensure that any sites used for recovery or disposal of waste are properly Managed, comprehensively monitored and responsibly restored so that future Generations are not lumbered with the economic and environmental cost of cleaning up After us (Environmental Protection Agency (EPA) Ireland1998). Engineers need to be at the fore in relation to environmental concerns and treat these issues with as equal importance as health and safety issues. They should lead the way in developing new materials and ways of reusing existing ones. They should be innovative, and actively involved in promoting the concept of sustainable development.

## II. LITERATURE REVIEW

### (A) Ahmad M Abu Abdo Liwa College Dec 2017

Topic: Utilizing Reclaimed Asphalt Pavement (RAP) Materials in New Pavements – A Review

Recently, prices of asphalt pavement materials have been increasing tremendously, which led to attempts to find alternative cheap materials. In addition, more concerns are directed to reserving natural resources and reducing environmental impacts of using virgin asphalt binders, thus more attention is focused on the use of recycled materials in pavement designs

### (B) Yanmei YANG School of River and Ocean Engineering, Chongqing Jiao tong University, Chongqing, P.R. China

Topic: Recycling of Abandoned Concrete and Waste Asphalt in Road Construction



They studied the Recycled asphalt production equipment combines original batch asphalt mixing machine and equipment of crushing and heating for old asphalt additionally. Original equipment is used for heating and measurement of new mineral aggregates and new asphalt, while new equipment is for heating and measurement of old asphalt and regenerant (Xinyu Shi, 2008).

**(C) VAKKALAGADDA ANUSHA2CH.PRAVEEN BABU, M. Tech (Transportation Engineering), Department of Civil Engineering, MVR College of Engineering and Technology, Paritala, Krishna District, Vijayawada, Andhra Pradesh, India.**

Topic: RECYCLED ASPHALT PAVEMENT MIXTURES FOR ROAD CONSTRUCTION

As can be seen throughout the results, the 100% RAP at the optimum binder content tended to perform well. The 100% RAP without any virgin binder had worse mix design results

Recycling of bituminous mixtures has been carried out for several years but most of this Material has been used as a lower-class material such as a fill or blinding material in the Construction of new roads and other paved areas. Recycled Asphalt Pavement is most commonly used as an aggregate and virgin asphalt binder substitute in recycled Asphalt paving, but it is also used as a granular base or sub-base, stabilized base aggregate, and Embankment or fill material. It can also be used in other construction applications. Recycled Asphalt Pavement is a Valuable, high-quality material that can replace more expensive virgin aggregates and binders.

#### **OBJECTIVE:**

1. To minimize waste.
2. To Conservation of National Resources.
3. Environmental impact reduction.

### **III. PROBLEM STETMENT**

Currently, due to the end up of its design life and traffic loads, asphalt pavements may badly deteriorate. The reconstruction of the pavement may become an economical and feasible solution. Reconstruction of a pavement requires removal of pavement surfaces. Waste asphalt removed from a failed pavement surface is a mixture of aggregate coated with bitumen and is collected from failed asphalt pavement surfaces and has been used as flexible layer construction material. Successive road improvement and expansion of road network play the crucial role in economic development and to maintain sustainable development of our country. The most common type of pavement structure used for highway construction is flexible pavement. The quality of These pavement structures largely depends on aggregate materials which are the main Components of pavement structural layers use of RAP in surface, base, and sub-base courses is Not common, and large quantities of RAP aggregate remain unused in our country. While currently there are many roads are past their design life or feasible to reconstruct. RAP will Reduce the cost of highway construction and haul, and reduce exploitation of local natural Resources. One attractive option is to use the Recycle Asphalt Pavement material as a base course with thin overlay. However, the hardness of bitumen in Recycle Asphalt Pavement, brittles of age asphalt and fines that may be the Problem associated with RAP.

### **IV. METHODOLOGY**

#### **Collection Of Material**

The Asphalt Pavement Road constructed from location is Dr. D.Y Patil Road or pride city road. This study conducted on sample that be collected from One location ..These collected such as sample different stages involved to determine physical and mechanicals laboratory experiments Or test.

#### **Manual Extraction**

Bitumen Extraction Test is used to determine the percentage of bitumen content present in the asphaltic pavement by cold solvent extraction. The properties of flexible pavement such as durability, compatibility, and resistance from Defects bleeding, ravelling, and aging of flexible pavement are majorly dependent on the Percentage of bitumen used with the aggregate to lay the pavement. The aggregate are extracted to use of Benzene Pure -99% laboratory regents fine chemicals company. Bitumen extraction used equipment is centrifugal extractor are used to extraction test for aggregate separate to bitumen and used to other experiments or test.

#### **Oven dry the Materials**

The sample after extraction to take the Oven to 110° temperature for 24 hours to sample are testing purpose to ready the sample. The aggregate is tested to sieve analysis method and collect to retained or passed sample.





## Testing On Material

**1.Sieve analysis** - is a technique used to determine the particle size distribution of aggregates. It involves passing a sample of the aggregate through a series of sieves with progressively smaller openings and measuring the amount of material retained on each sieve. This information helps in assessing the suitability of the aggregate for various construction applications.

**2. Shape test (flakiness and Elongation)**-The particle shape of aggregate is determined by the percentages of flaky and elongated particles contained in it. In case of gravel, it is determined by its Angularity Number. Flakiness and Elongation tests are conducted on coarse aggregates to assess the shape of aggregates. Aggregates which are flaky or elongated are detrimental to the higher workability and stability of mixes. They are not conducive to good interlocking and hence the mixes with an excess of such particles are difficult to compact to the required degree.

**3.Impact Test**- Toughness is the property of a material to easiest impact. Due to moving loads the aggregates are subjected to pounding action or impact and there is possibility of stones breaking into smaller pieces. Therefore, a test designed to evaluate the toughness of stones i.e., the resistance of the stones to fracture under repeated impacts may be called Impact test on aggregates. The test can also be carried on cylindrical stone specimen known as Page Impact test. The aggregate Impact test has been standardized by Indian Standard Institution. The aggregate impact test is conducted as per IS-2386 Part IV.

**4.Crushing value test** -Aggregate is inert material that imparts the strength of concrete. It is the resistance of aggregate to compressive forces. The strength Asphalt or concrete cannot exceed that of the bulk of aggregate contained therein. If the aggregate is having low crushing strength, its use will affect adversely the strength of concrete. The aggregate crushing strength value acts as a powerful tool to know the behaviour of aggregates when subjected to wear. Hence it is to be performed to know the sustainability of aggregate before using it in the concrete or Bitumen mix.

**5.Specific gravity of aggregate** -The specific gravity of an aggregate refers to its density relative to the density of water. It's typically used in construction to determine the volume occupied by the aggregate in various mixtures. To find the specific gravity of an aggregate, you would typically weigh a certain volume of the aggregate and divide that weight by the weight of an equal volume of water.

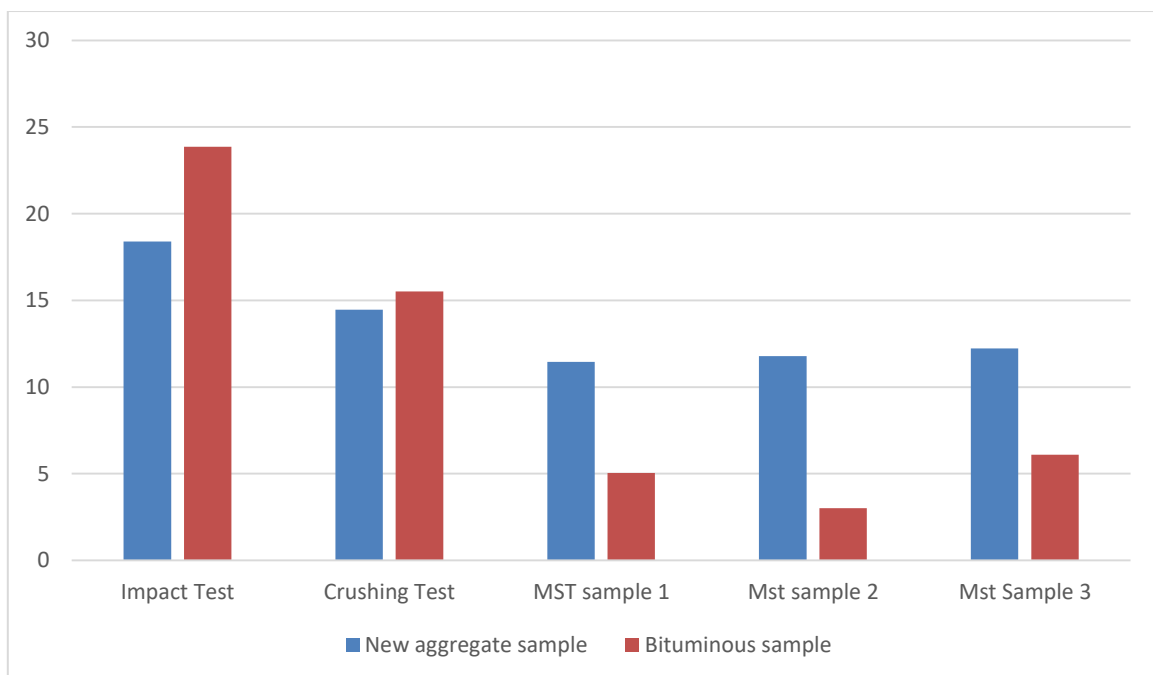
**6.The Marshall Bitumen mix test** - test is a common method used to measure the stability and flow properties of bituminous mixtures (asphalt mixtures) under different conditions. It helps in evaluating the quality of asphalt mixtures for road construction by determining key properties such as stability, flow, and density. This test to make a specimen of used aggregate and bitumen mixture.



### V. RESULT AND DISCUSSION

we conducted above test on aggregates in lab. after we have completed test on bituminous (Recycled) new aggregate sample. These tests play a crucial role in assessing the quality of construction materials. By comparing the test results with specification standards, we've ensured that the aggregates meet the necessary criteria for reuse. This is essential for maintaining construction standards and ensuring the integrity of structures.

Sr. No.	Test Name	New aggregate sample Result	Bituminous Sample result	Criteria	Test Method
1	Specific Gravity	0.95%	1.62%	-	IS:2386 Part III
2	Flakiness and Elongation	37.91% & 6.64%	13.93% & 13.93%	Maximum 40%	IS: 2386 Part I
3	Crushing Value	14.46%	15.51%	Maximum 30%	IS: 2386 Part IV
4	Impact Value	18.40%	23.87%	Maximum 30%	IS: 2386 Part IV
5	Marshall Stability Test				As per Morth Specification.
	1 <sup>st</sup> Sample	11.46 KN	5.05 KN	9.70 KN	ASTMD 1569 & IRC: 111-2009
	2 <sup>nd</sup> Sample	11.78 KN	3.01 KN	9.70 KN	
	3 <sup>rd</sup> Sample	12.23 KN	6.09 KN	9.70 KN	





## **VI. CONCLUSION**

We Have Completed all tests on Recycled aggregates. We analysed the outcomes of the tests and it can be used for various purposes. The Recycled aggregate wastage, can be minimised up to 40% to 50 % of total waste. so it can widely useful for minimisation of the waste. A lot of waste asphalt mixture can lead to serious environmental pollution problems. These Aggregates can be used in sub base in road construction, which not only solved the problem of environmental pollution but also achieves resource recycling to reduce waste of resource and energy. The aggregate can help conserve natural resources by reducing the need for virgin materials. By recycling existing pavement materials, we can extend the lifespan of valuable resources while also minimizing energy consumption. Embracing RAP aggregate contributes to a more sustainable and resource-efficient infrastructure development approach, aligning with long-term environmental goals. These aggregates can be used for providing drainage & pipe bedding.

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# Water Hyacinth Conversion into Activated Carbon for Water Purification

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**ABSTRACT:** This study delves into the consequences of water overgrowth, in the Indrayani River using it as a focal point for broader conversations on managing urban water systems and controlling invasive species in Indrayani River in Pune. It outlines the traits of water hyacinth, how it adapts to Pune's tropical climate. By examining water quality metrics, biodiversity indicators and the overall well-being of the river ecosystem the research aims to uncover the effects of water hyacinth, on the Indrayani river. Furthermore, the research examines how well current management approaches are working and highlights efforts to control the growth of water hyacinth. In this research, we have also focused on how this collected water hyacinth biomass from the river surface can be utilized and used for the purification of water and determining its efficiency. By combining these results, the study not only provides information, about the complex nature of invasive species in city water systems but also suggests useful suggestions for maintaining water resources sustainably. Using Indrayani river as the source for research purpose, this study showcases the methodology and efficiency of using water hyacinth biomass as activated carbon for water purification while addressing the problem of increasing its habitat on the river surface.

**KEYWORDS:** Water Hyacinth, Aquatic weed, Indrayani River, Pyrolysis, Biochar.

## I. INTRODUCTION

In Pune, the known Indrayani River is facing an issue due, to the increasing presence of water hyacinth. This invasive water plant, scientifically known as *Eichhornia crassipes* and originally from the Amazon basin has adapted to Pune's climate. Its quick expansion in the Indrayani River poses a challenge as the city aims to maintain a harmonious balance, between urban growth and safeguarding its natural water bodies. The existence of water hyacinth, in the Indrayani River goes beyond an event; it poses a challenging ecological mystery. This invasive plant not only alters the rivers beauty but also disrupts the intricate harmony of the aquatic environment. The waters of the Indrayani now grapple with green mats floating on the surface disturbing the natural habitats of local flora and fauna. This study aims to understand the details of the water invasion, in the Indrayani River. It examines the difficulties presented by this plant in this river taking into account aspects like water quality, biodiversity and the general well-being of the river ecosystem. Additionally, the research looks into the efforts and plans implemented to control the overgrowth of water hyacinth in the Indrayani river and also using the removed water hyacinth for the purification purposes by converting it into activated carbon by burning through pyrolysis process. This study adds to the discussion, on waterways the control of invasive species like water hyacinth and the balance between urban development and environmental protection in Pune by examining the impact of water hyacinth, on the Indrayani River.

### Problems caused by growth of Water Hyacinth:

- Water hyacinth is a naturally occurring weed that proliferates rapidly in aquatic ecosystems.
- Its aggressive growth can lead to eutrophication, disrupting the balance of nutrients and oxygen in water bodies.
- Water hyacinth mats can block sunlight, affecting other aquatic life and impeding water flow.
- It can lead to the death of submerged native plants due to shading, deplete dissolved oxygen in the water leading to fish kills, and make boat travel impossible with severe infestations.



A. Accumulation of water hyacinth on the surface of Indrayani River

Water hyacinth can be removed from the water body through manual or mechanical removal methods depending on the scale of work. Nets and boats can be used to manually collect water hyacinth biomass from water surface whereas in mechanical removal method, machines equipped with cutting blades or conveyor systems can be used. Water hyacinths can be removed directly from the water surface and collected for further drying process.

Just simply removing the water hyacinth from the water surface doesn't solve the problem completely since it might accumulate again on the water surface in less amount of time. Thus, it needs to be removed from time to time to eliminate its overgrowth and this collected water hyacinth can be utilized further for the landfill or water purification process after removal by converting it into biochar. Preparation of biochar from water hyacinth is a comparatively better approach for utilization of removed water hyacinth biomass which also assists in purification of water by removing concentration of heavy metals present in the water.

## II. RELATED WORK

Research on the conversion of water hyacinth into activated carbon for water purification has gained significant attention due to the environmental issues caused by water hyacinth infestations in water bodies and the need for sustainable water treatment solutions.

In this research, we have referred to the work done by Jeevitnadi Foundation on Mula-Mutha Rivers for removal of water hyacinth and process of filtration of water through filter media prepared from water hyacinth biochar.

Mula-Mutha rivers face the problem of rapidly increasing water hyacinth habitat and clogging of water due to its presence on water surface. This water hyacinth biomass is collected by manual or mechanical means and allowed for drying after which it is processed further for burning by pyrolysis method to obtain biochar.

## III. METHODOLOGY

### 1. Collection of Water Hyacinth Biomass for converting into activated carbon:

- Harvest water hyacinth from affected water bodies.
- Dry and process the biomass to create biochar through pyrolysis process.
- Biochar derived from water hyacinth retains its adsorption properties.
- The obtained water hyacinth biochar can be used as an adsorbent for removal of heavy metals present in the water.

### 2. Screening/cleaning of collected Water Hyacinth biomass for further pyrolysis process:

- Remove impurities such as sand, debris, and other organic matter from the collected biomass.
- Ensure that the biomass is clean and ready for pyrolysis.
- The biomass undergoes drying to remove moisture content, then it is processed through techniques like pyrolysis to convert the biomass into useful energy form i.e. to convert it into activated carbon.
- The biomass is also oven dried at 110 °C for half an hour for moisture removal before being placed in the pyrolizer.



### 3. Selection of additives to be used in the purification process:

- Various types of additives can be used along with the water hyacinth in the purification process to obtain greater degree of purification. These additives assist in improving the extent of removal of heavy metals and other impurities.
- Following types of additives can be used with water hyacinth in the filtration process:
- Cow dung
- Wood ash
- Rice husk ash
- Coconut shell ash

### 1. Use of Water Hyacinth as adsorbent for water purification:



B. Filter Unit prepared from Biochar

### 2. Biochar prepared by burning water hyacinth through pyrolysis process

- Water hyacinth biochar has remarkable adsorption properties due to its porous structure.
- It can effectively remove pollutants such as heavy metals, organic compounds, and nutrients from water.
- Its adsorption capacity and mechanisms need to be studied thoroughly to optimize its use and efficiency.

### 3. Design of adsorbent and filtration system:

- Develop a system that incorporates water hyacinth biochar as an adsorbent.
- Consider factors such as flow rate, contact time, and adsorbent dosage.
- Design a filtration setup (e.g., columns, filters, or tanks) to allow water to pass through the biochar bed.
- The design of the adsorbent and filtration system would depend on the specific requirements of the water to be treated.

### 4. Extent of treatment received:

- Monitor the water treatment process using water hyacinth biochar.
- Measure parameters such as pH, turbidity, and pollutant concentrations.
- Assess the effectiveness of biochar in removing contaminants.
- The extent of treatment received would depend on the specific conditions of the treatment process, including temperature, pH, amount, nature and properties of additives added, and contact duration.

### 5. Study of amount of impurities removed from water after the purification process:

- Analyse water samples before and after treatment.
- Quantify the reduction in impurities (e.g., heavy metals, nutrients, and organic pollutants).
- Evaluate the overall purification efficiency.

## IV. EXPERIMENTAL RESULTS

Following tables show the results obtained by testing the water sample from Indrayani River before and after carrying out the filtration of water sample through prepared filter media from water hyacinth and other additives such as rice husk and coconut shell ash. In this research, we have studied 12 parameters of the collected water sample from the Indrayani river as follows.



Following are the test results obtained from the collected water sample from Indrayani river before the filtration process:

Test results obtained after passing the water sample through prepared filter media from water hyacinth biochar are as follows:

Sr. No.	Tests	Results	Unit	Acceptable Limits as per 10500:2012	Test Method
01	Total Arsenic (As)	0.018	mg/l	0.01,Max	APHA (3114C)
02	Cadmium (Cd)	0.014	mg/l	0.003,Max	APHA (3111B)
03	Iron (Fe)	<0.1	mg/l	1.0,Max	APHA (3111B)
04	Lead (Pb)	0.044	mg/l	0.01,Max	APHA (3111B)
05	Mercury (Hg)	Nil	mg/l	0.001,Max	IS 3025 (Part 48)
06	Copper (Cu)	0.11	mg/l	0.05,Max	APHA -3111-B
07	Nickel (Ni)	0.10	mg/l	0.02,Max	APHA (3113B)
08	Nitrate (NO <sub>3</sub> )	0.24	mg/l	45,Max	APHA (4500-NO <sub>3</sub> -B)
09	Total Dissolved Solid	790.0	mg/l	500,Max	IS 3025 (Part 16)
10	pH	7.80	mg/l	6.5 to 8.5	IS 3025 (Part 11)
11	Chlorides	76.07	mg/l	250,Max	IS 3025 (Part 32)
12	Sulphate (SO <sub>4</sub> )	28.94	mg/l	200,Max	IS 3025 (Part 24)

Sr. No.	Tests	Results	Unit	Acceptable Limits as per 10500:2012	Test Method
01	Total Arsenic (As)	0.013	mg/l	0.01,Max	APHA (3114C)
02	Cadmium (Cd)	<0.1	mg/l	0.003,Max	APHA (3111B)
03	Iron (Fe)	<0.1	mg/l	1.0,Max	APHA (3111B)
04	Lead (Pb)	0.018	mg/l	0.01,Max	APHA (3111B)
05	Mercury (Hg)	Nil	mg/l	0.001,Max	IS 3025 (Part 48)
06	Copper (Cu)	0.07	mg/l	0.05,Max	APHA -3111-B
07	Nickel (Ni)	0.09	mg/l	0.02,Max	APHA (3113B)
08	Nitrate (NO <sub>3</sub> )	0.043	mg/l	45,Max	APHA (4500-NO <sub>3</sub> -B)
09	Total Dissolved Solid	486	mg/l	500,Max	IS 3025 (Part 16)
10	pH	7.65	mg/l	6.5 to 8.5	IS 3025 (Part 11)
11	Chlorides	62.09	mg/l	250,Max	IS 3025 (Part 32)
12	Sulphate (SO <sub>4</sub> )	9.22	mg/l	200,Max	IS 3025 (Part 24)

## V. CONCLUSION

This study addresses the problem of rapidly growing water hyacinth habitats on the Indrayani river water and ill effects caused by it while stating its utilization in process of purification of water by converting water hyacinth into activated carbon and preparing filter media by coupling the prepared water hyacinth biochar with suitable additives to assist in removal or reducing the concentration of heavy metals present in water.

Water hyacinth biochar offers a sustainable and cost-effective solution for water purification. Its adsorption capacity, coupled with proper system design and monitoring, can significantly improve water quality and mitigate the environmental impact of water hyacinth growth. The effectiveness of water hyacinth in water treatment can vary depending on a variety of factors, including the specific conditions of the treatment process and the nature of the water being treated. The efficiency of purification achieved also depends on the additives used along with water hyacinth biochar.

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# Comparative Analysis of Precast Construction Technique with Respect to Cast-In-Situ Method

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**ABSTRACT:** Precast construction technique is a method that involves the use of premade moulds or forms for casting of concrete, which is cured in a controlled environment. The elements casted are then transported to the site and erected with help of cranes. In this paper, a detailed study is carried out on the viability of precast construction technique and its potential in improving efficiency in construction sector. A direct comparative analysis of precast construction is done with respect to cast-in-situ method of construction for a residential building and their time and cost differences were analyzed by methods of direct cost comparison and As-Built-Schedule respectively.

**KEYWORDS:** Precast, efficiency, Comparative analysis, As-Built-Schedule

## I.INTRODUCTION

Precast concrete is widely used for constructing highways, bridges, commercial complexes, and mass concrete projects where quality is of utmost importance. As precast concrete is casted in controlled environment (precast plant), it allows workers/plant supervisors to maintain high quality standards as it is closely monitored. Using precast construction technique offers many significant advantages over traditional onsite casting. Precast concrete production can be performed on ground level, which maximizes safety in its casting. The Moulds constructed in precast construction can be used for hundreds-thousands time, which make them very cost effective for repetitive works reducing shuttering materials and wastages.

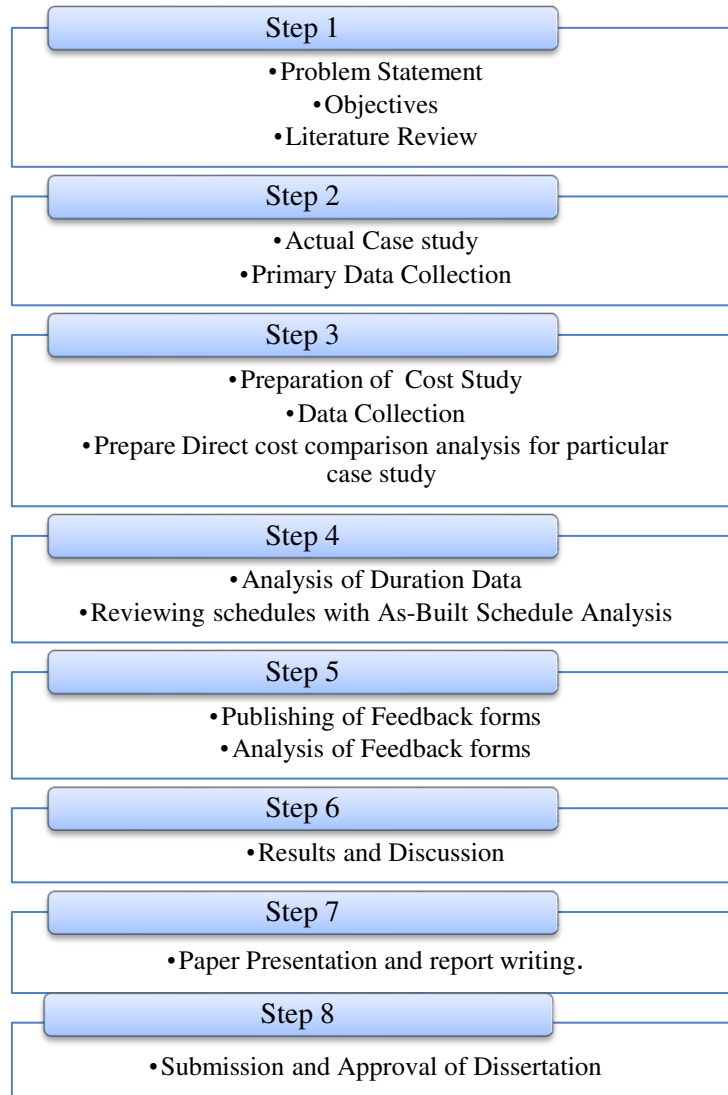
India's construction market is valued around USD 639 billion in the current year and is poised to grow at CAGR of over 6% reaching USD 1 Trillion by 2030. The residential construction market contributes to about USD 189.80 billion currently. Indian construction sector largely follows traditional cast-in-situ techniques of construction for its residential structures. On the other hand Countries leading in construction sector have embraced precast construction techniques for increasing efficiency in projects and also reduce completion time and project costs.

This study aims to find out the reasons contributing to viability of precast construction and also draw out reasons for its lesser preference than regular cast-in-situ construction. Comparison of the two methods is done by Direct Cost Comparison and As-Built-in Schedule methods. Also feedbacks from engineers, contractors as well as homeowners were taken to understand the public and industry preferences.

## II. METHODOLOGY

### Methodology Flow Chart

The following methodology was adopted.



## III. COMPARISONS IN COST AND TIME

Table 01 – Comparative study of Precast vs. Cast-in-Situ

	<b>PRECAST</b>	<b>CAST-IN-SITU</b>
Quality Control	Provides much better quality control	It is hard to control quality on site due to weather conditions, unskilled labours or due to improper supervision.
Labour Required	Number of labours required is less due to it being a controlled process inside factory.	Number of labours required is more.
Shape	It is quite easy to make same size precast products due to reusable mold. This provides cost-savings and improves efficiency.	Any required shape can be provided according to plan requirements.
Cost	Precast concrete is very efficient in reducing cost of construction of elements when the required	It is costlier than precast construction but it provides





	construction quantity is large enough to subdue the cost for construction of factory if needed.	flexibility in design.
Manufacturing Conditions	Controlled conditions are provided during manufacturing, temperature and all factors are monitored carefully.	Site conditions cannot be fully monitored, there are variations in construction efficiency due to temperature, humidity etc.
Speed of construction	The speed of construction is fast in precast technique. Also erection speed is rapid.	The speed of construction is comparatively slow as time is required for shuttering, concreting on site, deshuttering and other various activities.

### Building Description:

The building is constructed using cast-in-situ method from the foundation to 1<sup>st</sup> floor. This ensured strong base which provided suitable platform for the remaining 22 floors. Suitable provisions were made on the slabs, beams and columns of the first floor so that regular precast elements could be erected above systematically. The precast components include Hollow core slabs (HCS) , Structural pods, load bearing and non load bearing walls (LB , NLB).

### 3.1 DURATION COMPARISON

The main advantages of incorporating precast construction technique is saving of construction time. Precast elements can be constructed at a rapid pace and then erected as per project deadline requirements. The daily production capacity of the factory as well the lead distance for precast elements is an important factor influencing construction speed/duration in this technique. The factory carrying out production for the concerned project had a max production output of 850m<sup>3</sup> concrete per day and the lead distance is about 2 kms.

The following table consists of the difference in duration times for different processes in precast and cast-in-situ method,

Table 02 – Comparison of time required for different activities in Precast and Cast-in-situ construction

Sr. No.	TYPE OF CONSTRUCTION	STAGES	TIME REQUIRED TO FINISH WORK	DATES	TYPE OF WORK DONE ACCORDING TO STAGES	RESULT
1	PRECAST CONSTRUCTION	Precast production planning	1 Day		Detailed design and planning of the precast element required for the second floor	Total time for second floor in precast construction is 20 days
		Manufacturing of precast element	2 Days		Production of all single floor elements for the second floor within two days	
		Site preparation	2 Days		Preparation of the site for installation of the precast element	
		Installation and grouting of precast elements	10 Days		Including transportation and installation of precast elements of the second floor	
		Finishing work	5 Days		Completion of finishing work such as offset and excessive grout and	



					grinding	
2	MIVAN CONSTRUCTION	Construction planning	2 Days		Detailed planning and design of the formwork for the 2 <sup>nd</sup> floor.	Total Time for 2nd Floor in Mivan Construction: Approximately 6weeks
		Site preparation	2 Days		Preparation of the site for formwork erection	
		Formwork erection and concrete pouring	7 Days		Erection of formwork and pouring of concrete for the 2 <sup>nd</sup> floor slab and walls	
		Curing and striking	14 Days		Curing of concrete and removal of formwork	
		Finishing work	14 Days		Completion of finishing works for the 2 <sup>nd</sup> floor	

### 3.2 Cost Comparison of selected building

The selected building was also analyzed for cost comparison by using direct cost analysis method. The cost difference in precast construction and cast-in-situ is influenced by a variety of factors. The crucial ones being the cost of factory setup and the distance of factory from site of construction. For the concerned building, the factory was at about a 2 km distance which was same as that of the RMC Plant supplying concrete for regular construction.

Also the cost for excavation, p.c.c., and construction of footings was neglected as both the buildings employed cast-in-situ construction up to 1<sup>st</sup> floor. Hence comparison was done for the total 2<sup>nd</sup> floor having an area of 12,976.56 Sqft or 1206 Sqm.

Table 03 – Comparison of cost of construction by precast and cast-in-situ construction

Sr. No.	PRECAST CONCRETE CONSTRUCTION		CAST IN PLACE CONSTRUCTION (MIVAN)	
	Parameters	Cost	Parameters	Cost
1	Precast walls	4816665 /-	Steel	4754880 /-
2	Beam, Landing & staircase	1993434 /-	Concrete M40	4225000 /-
3	Non-structural walls	1022770 /-	Shuttering	5796000/-
4	HCS	611425 /-	Concrete Pouring	325000/-
5	Erection cost	3567885 /-	Crane Charges	534000/-
6	Transportation	375000 /-		



	cost				
7	Plant & machinery cost	1866561 /-			
<b>Total cost for precast concrete construction is = 1,42,53,740/-</b>		<b>Total cost of cast in place construction (mivan) is = 1,56,34,880/-</b>			

Hence, after completing the direct cost comparison of floors constructed by cast-in-situ and precast technique, it can be observed that that the precast construction technique is economical. The cost difference is found out to be 13.81 lakhs for every floor. The main factors influencing precast need to be kept in mind although which are distance of site from factory, total quantity of construction etc. The installation of a factory nearby site for huge construction works is very beneficial and if provided better execution will revolutionalize large scale products.

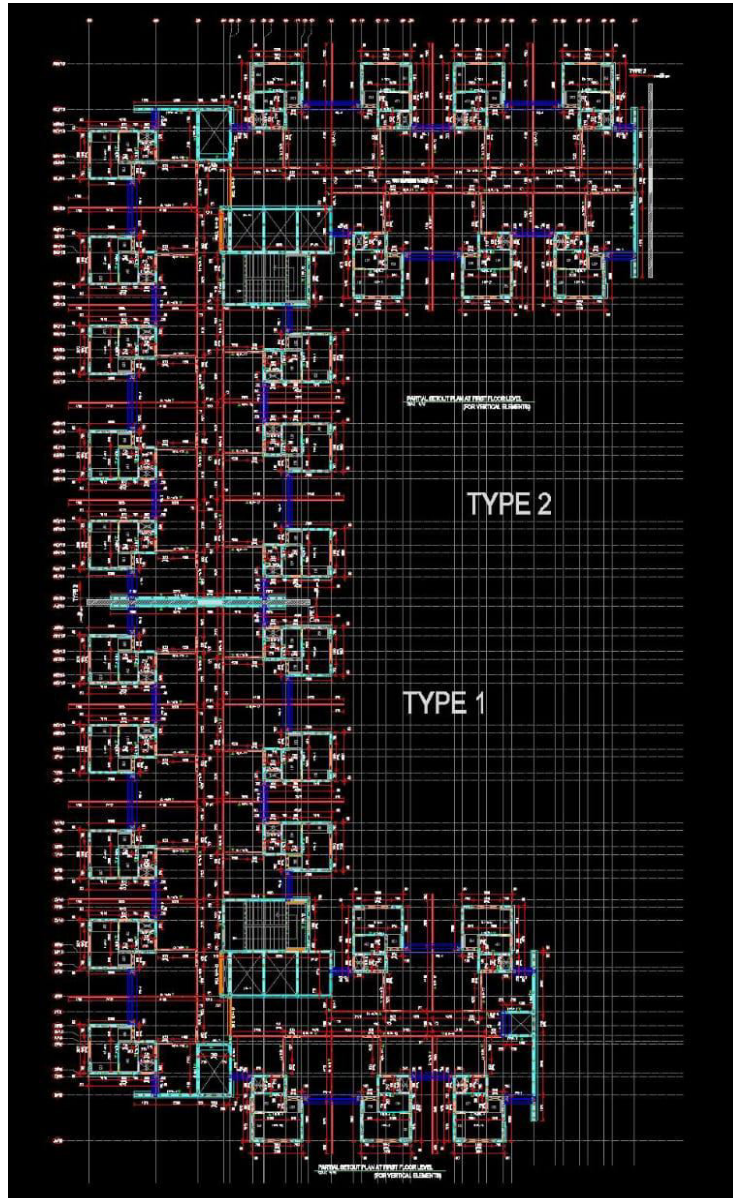
#### IV.CONCLUSION

As we have seen from the above study and previous case studies, it is observed that profitability of Precast construction technique depends upon various factors such as cost of setting up factory, total quantity of construction or the scope of project, distance of site from manufacturing factory. We studied the same building which was constructed by precast technique and cast-in-situ technique and carried out As-Built-in schedule time analysis and direct cost analysis. The results showed that by employing precast construction technique the time of construction of project can be significantly reduced and also cost of construction is reduced greatly.

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### ANEXURE – 1





# Survey Paper on Mobile Ad-hoc Network using Different Routing Protocol

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**ABSTRACT:** Mobile ad-hoc network (MANET) has got tremendous success and attention due to its self-maintenance and self-configuration properties or behavior. Based on wired and wireless networks, the network topology of MANETs changes rapidly by means of routing attacks. Hence, providing security to this infrastructure-less network is a major issue. The routing protocols for ad-hoc networks cope well with the dynamically changing topology but are not designed to accommodate defense against malicious attacker. Malicious nodes have opportunities to modify or discard routing information or advertise fake routes to attract user data to go through themselves. In this article, we discuss a hybrid technique using anonymity, one-way trapdoor protocol, hash functions, and elliptic curve cryptographic to mitigate attacks in the MANET. The flooding procedure is used in the route discovery process and produces a storm of the broadcast, leading to an increase in packet loss and control overhead. In this work we study and evaluate the quality of services parameters for different routing protocol.

**KEYWORDS:** Mobile Ad-hoc network, Wireless sensor network, Cognitive radio network, Performance parameter, Quality of services

## I. INTRODUCTION

WSNs are systems of internationally spread and customized systems that detect and collect atmospheric factors and transmit the data to a centralised location. WSNs may detect warmth, sounds, particulate emissions, moisture, and weather, between other factors. In order to communicate sensor data electronically, these systems are comparable to mobile ad hoc networking include that the rely on mobile connections and spontaneously system development. WSNs detect external atmospheric parameters such as warmth [1-4], vibration, and humidity. Wired versions are reversible, collecting information and permitting management of sensing action. The construction of those connections was spurred by tactical applications such as combat surveillance. Such systems are used in both corporate and commercial purposes, such as processes industry measurement and controlling and equipment condition checking [5].

A WSN is comprised of "modules," which may amount anywhere between a some to hundreds or even thousands and are all connected to different detectors. A wireless transponder with only an internally and externally antennae, a CPU, an electronic circuits for interfacing with the sensing, and a power provider, usually a batteries or an incorporated form of harvested power, are all typical elements of similar networks [6]. A node in the network might be the length of a shoebox to (conceivably) a grains of powder, notwithstanding the fact that minuscule sizes that has yet to be reached. Pricing for sensing nodes range from the few bucks to billions of millions, dependent on the network node sophistication. Height and budget constraints constrain power, capacity, computation performance, and telecommunications capacity. The design of a wirelessly node may vary from a simple ring topology to a complicated multi-hop wirelessly meshes networking. Dissemination may be accomplished by routed or inundation. Figure 1 shows the Wireless Network Sensor [7].

Computer networks micro sensors technologies is a critical leading innovation. In November 1999, Economic Magazine called it one of the 21 most important innovations for the 21st millennium. Inexpensive, intelligent devices with a slew of on-board instruments, connected using Wi-Fi networks and the World wide web, and extensively implemented, enable new ways to instruments and manage households, organizations, and the ecosystem [9-12]. In addition, interconnected micro sensors provide the capability for a variety of missile defences, offering new powers in espionage, monitoring, as well as other operational purposes. Cameras are often used to gather knowledge for rescue operations, power administration, patient observation, and stock asset tracking. If sensors are to empower, secured communications techniques must be devised to protect the system and its consumers [13].



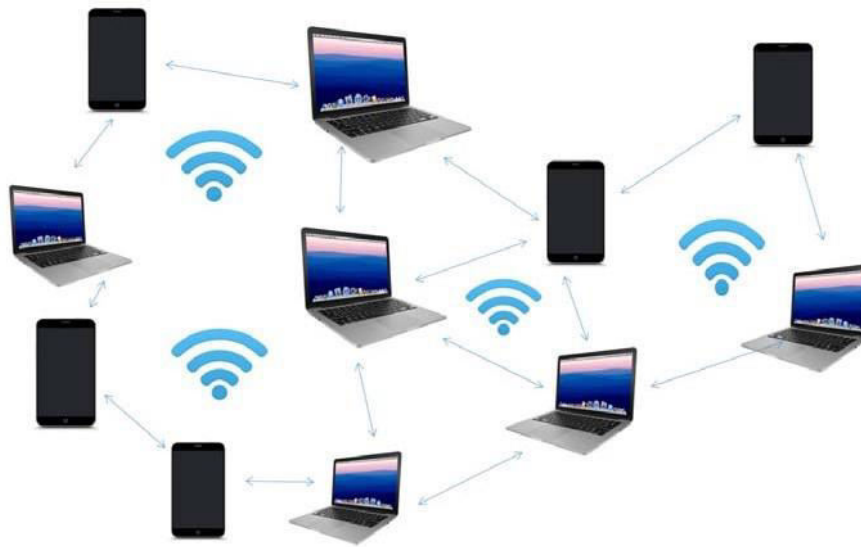


Figure 1: Example of mobile ad hoc network (MANET) structure [2].

## II. LITERATURE REVIEW

Two kinds of MANET protocols are dominantly used: proactive and reactive protocols. While proactive protocols, such as optimized link state routing (OLSR), construct the routing table in advance, reactive protocols, such as ad-hoc on-demand distance vector routing (AODV), process route search whenever a packet delivery is required.

Mobile ad-hoc wireless networks give us the high probability and high properties to create networks, without any central management or infrastructure, independent and temporary network, that is means wide ubiquitous networks. The intermediate nodes should be able to communicate between them to send and receive the data with ability using at anytime and anywhere, the mobility of the intermediate node between the source and destination gives us unstable topology maybe the connection between the nodes will be breakoften. Therefore, the strategies to design any wireless depend on path routing and protocol selection. In this paper they study and evaluate the effect of mobility on the routing protocols DSDV, AODV and DSR in two different scenarios, the density of nodes and different area in NS2.35 simulation by using threeperformance metrics in the evaluating the routing protocols are Average Throughput, Packet Delivery Ratio and Average End-to-End Delay.

Mobile Ad-hoc Networks (MANETs) are self-sufficient networks that can work without the need for centralized controls, pre-configuration to the routes or advance infrastructures. The nodes of a MANET are autonomously controlled, which allow them to act freely in a random manner within the MANET. The nodes can leave their MANET and join other MANETs at any time. These characteristics, however, might negatively affect the performance of the routing protocols and the overall topology of the networks. Subsequently, MANETs comprise specially designed routing protocols that reactively and proactively perform the routing. This paper evaluates and compares the performance of two routing protocols which are Ad-Hoc On-Demand Distance Vector (AODV) and Optimized Link State Routing (OLSR) in MANET environment. The study includes implementing a simulation to examine the performance of the routing protocols based on the variables of the nodes' number and network size. The evaluation results show that the AODV outperforms the OLSR in most of the simulated cases. The results further show that the number of nodes and network size has a great impact on the Throughput (TH), Packet Delivery Ratio (PDR), and End-to-End delay (E2E) of the network.

A mobile ad-hoc network is a collection of mobile nodes that goatherd to exchange data and information from source to destination. Typically, MANET has no infrastructure, which can call it an infrastructure-less network. The node in the network communicates directly with the neighbor nodes that are already within the wireless range of that node. MANET has several types of routing protocols that can be used to establish links between nodes. These routing protocols are different in their mechanisms, which are AODV and DSR. in this paper this simulation study carries out two routing protocols to evaluate their performance and quality of service in terms of energy consumption and packet delivery ratio. The comparison study was carried out using the NS2 simulator. The results of the simulations show better performance of DSR over AODV in different scenarios.



VANET is a branch of MANETS, where each vehicle is a node, and a wireless router will run. The vehicles are similar to each other will interact with a wide range of nodes or vehicles and establish a network. VANETs provide us with the infrastructure to build new solutions for improving safety and comfort for drivers and passengers. There are several routing protocols proposed and evaluated for improving VANET's performance. The simulator is preferred over external experience because it is easy, simple, and inexpensive. In this paper, we choose AODV protocol, DSDV protocol, and DSR protocol with five different nodes density. For each protocol, as regards specific parameters like (throughput, packet delivery ratio, and end- to- end delay). On simulators that allow users to build real-time navigation models of simulations using VANET. Tools (SUMO, MOVE, and NS-2) were used for this paper, then graphs were plotted for evaluation using Trace-graph. The results showed the DSR is much higher than AODV and DSDV, In terms of throughput. While DSDV is the best choice because of the low average end to end delay. From the above, we conclude that each strategy has its own negative and positive aspects that make it ideally suited to a particular scenario than other scenarios.

The most important experiences we discovered from several disasters are that cellular networks were vulnerable, and the loss of the communication system may have a catastrophic consequence. Mobile ad-hoc networks (MANETs) play a significant role in the construction of campus, resident, battlefield and search/rescue region. MANET is an appropriate network for supporting a communication where is no permanent infrastructure. MANET is an effective network that uses to establishing urgent communication between rescue members in critical situations like, disaster or natural calamities. The sending and receiving data in MANET is depending on the routing protocols to adapt the dynamic topology and maintain the routing information. Consequently, This paper evaluates the performance of three routing protocols in MANET: ad-hoc on-demand distance vector (AODV), destination sequenced distance vector (DSDV), and ad-hoc on-demand multipath distance vector (AOMDV). These protocols are inherent from different types of routing protocols: single-path, multi-path, reactive and proactive mechanisms. The NS2 simulator is utilized to evaluate the quality of these protocols. Several metrics are used to assess the performance of these protocols such: packet delivery ratio (PDR), packet loss ratios (PLR), throughput (TP), and end-to-end delay (E2E delay). The outcomes reveal the AOMDV is the most suitable protocol for time-critical events of search and rescue missions.

The existing network infrastructure may not work well in a disaster environment caused by a fire or an earthquake. Instead of relying on the existing infrastructure, communicating through a mobile ad hoc network (MANET) is recommended because MANET can configure a network without an infrastructure communication system. In addition, firefighters conducting emergency activities in harsh environments surrounded by flames and smoke need a communication system to assist their rapid firefighting operations. Existing work is not suitable for indoor firefighters communications because they did not consider the indoor disaster environment well. In this proposed scheme, dual channels (i.e., 2.4 GHz and sub-GHz bands) are used for an efficient routing table configuration. Data frame and HELLO message are exchanged through the 2.4 GHz band, while the neighbor list of each node is exchanged through the sub-GHz band. Each node can configure the routing table based on the exchanged neighbor list. A performance evaluation is conducted to compare the proposed technique with enhanced versions of optimized link state routing (OLSR) and destination-sequenced distance vector routing (DSDV). The results show that the proposed scheme outperforms the other two MANET routing algorithms (i.e., OLSR-mod and DSDV-mod) in terms of the packet delivery ratio (PDR), end-to-end delay, and initial routing table configuration time approximately 27.8%, 4.7%, and 166.7%, respectively.

Disasters could cause communication systems to partially or completely down. In such a case, relief operations need a rapidly deployed communication system to save lives. Exchanging information among the rescue team is a vital factor to make important decisions. Communication system required to be robust to failures, rapidly deployable, easily maintainable to provide better services. Wireless ad-hoc networks could be the choice of establishing communication with the aid of existing infrastructure in a post-disaster case. To optimize mobile ad-hoc network performance, address the challenges that could lead to unreliable performance is required. One and the most crucial key challenge is routing information from a sender to a receiver. Due to the characteristics of a disaster environment such as signal attenuation, communication links exist between rescue crew is short-lived, suffer from frequent route breakage, and may result in unreliable end-to-end services. Many routing protocols have been proposed and evaluated in different network environments. This paper presents the basic taxonomy of Mobile Ad Hoc Networks and the state of the art in routing categorizes (Proactive, Reactive, Geographic-aware and Delay tolerant Networks (DTN)).

### **III. ROUTING PROTOCOL**

Routing in the wireless networks are categorized into 3 types based on the structure of the network. They are Flat routing, Hierarchical Routing and Location Based Routing [4]. In flat routing, all the nodes of the network perform the same functionality and work together to collect/generate the data and routing to the destination. The Sensor Protocols for Information via Negotiation (SPIN) protocol and Directed Diffusion protocol belong to flat network routing. In the

hierarchical routing, the entire network is divided into many clusters to improve the scalability and utilize the energy of the nodes efficiently. For Example LEACH (Low Energy Adaptive Cluster Hierarchy) routing protocol [5]. In Location based routing, location details of each node are monitored continuously to find the routing path for the communication. Global Positioning System (GPS) devices are used along with network nodes. For example: Geographic and Energy Aware Routing (GEAR). Figure 1 shows the classification of routing protocols based on the network structure.

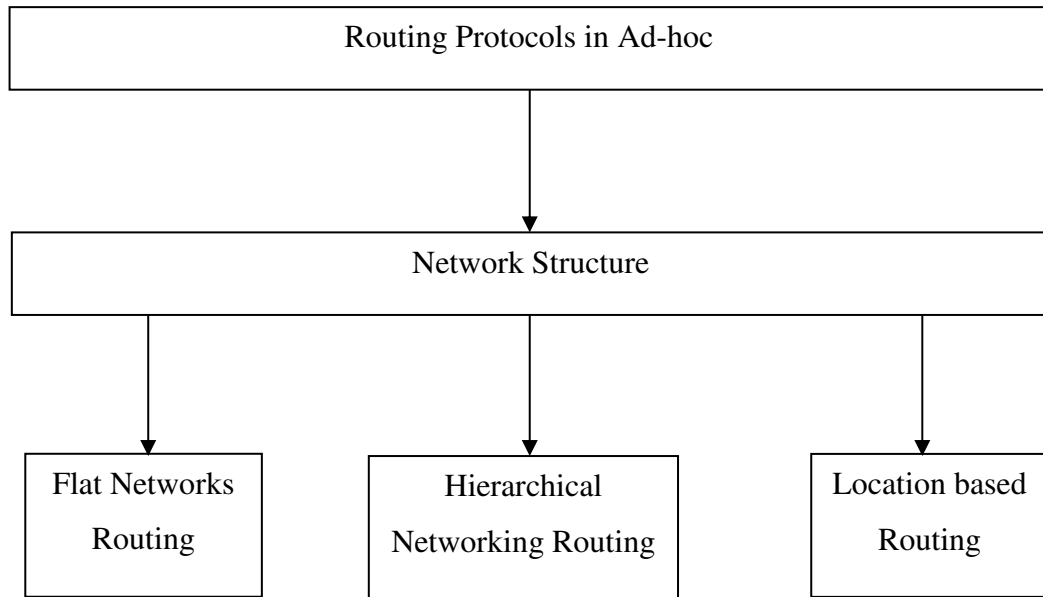


Figure 2: Classification of routing protocols in WSN

In Clustered Architecture, the sensor nodes are logically organized into several clusters depending on the nodes' geographic proximity or other parameters considered by the clustering algorithms [6]. Each cluster is governed by the cluster head node which is yet another sensor node but probably with more energy.

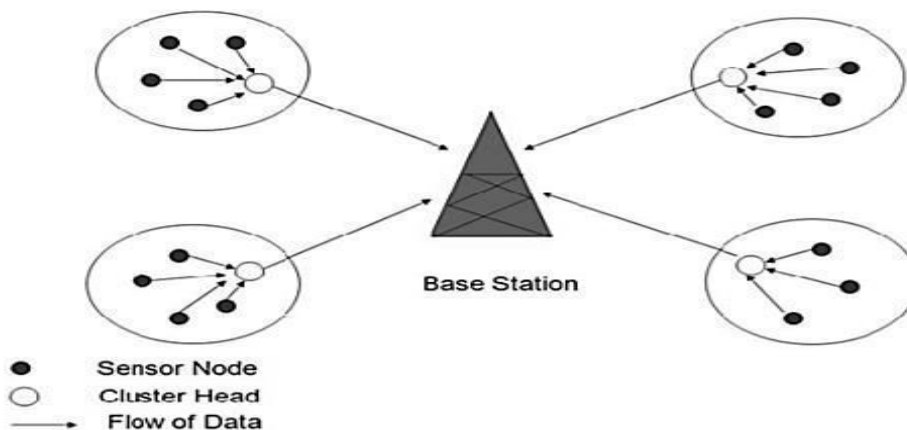


Figure 3: Clustered architecture of wireless sensor network

The data communication happens in hierarchical fashion, for example, from cluster member node to respective cluster head node and then from a cluster head node to the Base Station either directly or through some other cluster head nodes.

The advantage of such network architecture is that the overall energy expenditure for data communication is minimized. Moreover the network remains stable while it is scaled up in terms of number of nodes. Figure 2 shows a Clustered Architecture of wireless sensor network.



#### **IV. DESIGN ISSUE OF ROUTING PROTOCOL**

Routing protocols of MANETs have many design issues due to MANETS characteristics like node mobility, power limitations of the node, hidden and exposed terminal problem etc. Other issues to be taken into consideration are security, quality of services, reliability, channel utilization [18]. A brief discussion on various issues is given below.

**Node Mobility:** The major challenge that the routing protocol has to face is highly dynamic network topology due to the mobility of nodes. Random speed and direction of motion of nodes result in frequent breaks in preconsidered network topologies and end to end paths.

**Power Limitations of Node:** Nodes in MANETs are battery operated. The number of transmission attempts consumes considerable battery power. The routing protocol must account the available battery power of node while selecting as an intermediate node in a path.

**Hidden and Exposed Terminal Problem:** Hidden terminal problem refers to a collision of packets due to simultaneous transmission from two nodes which are not in the direct transmission range of each other but in the transmission range of a receiver. The collision occurs when both nodes transmit data without knowing each others status of the activity. Exposed terminal problem refers to inability of the node to transmit because neighbor node occupies the channel. Due to this an effective channel utilization is affected.

**Radio channel:** Link capacity and link error probability have time-varying characteristics in MANETs. This makes routing protocol to find alternate good quality links continuously [19]. This problem becomes more complex because of retransmissions due to collisions of data packets. Therefore routing protocol must find an efficient route with less congestion.

**Bandwidth:** Radio channel in a wireless network is band limited and therefore data rate offered is less compared to wired channels like an optical fiber. The routing protocol must limit the generation of the control packet to save bandwidth. It is possible when there is a limitation on sharing topological information among the nodes.

**Security:** Security is one of the important concern in wireless networks compared to fixed networks. Wireless networks are more prone to physical threats at the link level. The routing protocol must embed some sort of encryption to data being transmitted to ensure secure transmission of data.

#### **V. CONCLUSION**

Mobile Ad Hoc Networks have evolved rapidly and are finding numerous applications in the areas of self-creating, self-organizing and self-administering wireless networks. The present paper describes use of and comparison of three routing protocols. The parameters used for comparison are throughput and delay in response by varying the number of mobile nodes. A random waypoint mobility model was used for fixing the mobile nodes. In this paper we study different research work using different protocol, In future we also increase the performance for these quality of services parameters, there are some parameters are network overhead, end to end delay, throughput and packet delivery ratio.

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# Study on Analysis and Design of Cost-Effective Binishell with Shotcrete

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**ABSTRACT:** This study focuses on analysis and design of Binishell construction, aiming to enhance cost-effectiveness while maintaining structural integrity. The research involves a comprehensive analysis of key factors influencing the cost of Binishell structure, including material, labour, and construction methodologies. Through systematic examination of various construction parameters, this study aims to identify opportunities for cost reduction without compromising on quality and performance of final structure.

Binishell construction, known for its innovative approach to creating thin-shell structures using pneumatic forming techniques, is investigated for its potential to achieve structural efficiency and economic viability through the application of shotcrete. Shotcrete, a versatile and adaptable construction material, is employed as both formwork and reinforcement, synergizing with the Binishell construction method. The study also addresses environmental considerations and sustainability aspects associated with the proposed construction method.

**KEYWORDS:** Analysis and design, Pneumofom Material, Shotcrete Application, Construction Efficiency, Material Optimization, Life cycle cost Analysis. Innovation and construction.

## I. INTRODUCTION

In this innovative construction methods, Binishell stands out as a unique and sustainable approach known for its architectural form and structural efficiency. This study delves into the detail interplay of design and cost-effectiveness within the context of Binishell construction, with a specific focus on the integration of shotcrete as a key component in the construction process. The construction industry is continuously evolving, with a growing emphasis on innovative and sustainable building methods. Binishell construction, characterized by its unique shell-like structures, has gained importance for its architectural and environmentally friendly attributes. This study focuses on the on the complex relationship between design considerations and cost-effectiveness in Binishell construction, with a specific exploration of the integration of shotcrete as a construction material. Keeping the necessity of project in mind, the cost estimate of structure is carried out.

- To prepare a plan for low cost Binishell concrete dome.
- To Study a low-cost housing in India.
- To carry out Analysis and Design of a proposed plan.
- To achieve more Sustainability

The project is initiated with the collection of information from existing journals, papers called literature review. After collecting the relevant information, the projected is started. A computational approach to realize this goal was developed and is listed in the following steps:

1. Selecting the site that is most prone to earthquakes.
2. Planning the dome structure keeping in view the necessity of the project.
3. Analyzing and designing the dome to check its structural stability based on the given loading conditions.
4. Comparing the dome structure with a similar size conventional building by means of cost estimation.

## II. METHODOLOGY

### Ring Beam Footing:

Continuous reinforcing bars are embedded in the ring beam foundation. These rebar dowels securely connect the dome to its footing. The ring beam creates a solid base to construct the dome on. Rebar is bent over so that the Air form can be slid over the rebar and attached to the footing.



**Figure.1- construction of foundation**

### **Procedure for Construction Of Binishell**

Monolithic construction process demands an Air form. The Monolithic Air form is a balloon like, inflatable structure that determines the shape and size of a dome. It's made of PVC-coated nylon or polyester fabric.. The Air form is a highly engineered fabric structure that should be handled with great care.

#### **a. Site Preparation:**

Choose a suitable location for the Binishell structure, considering factors such as soil type, drainage, and accessibility.

- Conduct a survey to determine the exact dimensions and layout of the Binishell.
- Excavate the marked area to the required depth, considering the thickness of the foundation slab and any additional requirements.
- Ensure that the formwork is securely anchored and aligned according to the Binishell design.
- If necessary, install utilities such as plumbing or electrical conduits in the foundation area before pouring concrete.

#### **b. Formwork and Layout:**

- Prepare a solid foundation slab that serves as the base for the Binishell structure. The slab should be designed to support the weight of the structure and provide a stable surface for the formwork.
- Define the desired shape and dimensions of the Binishell structure. Use layout tools such as strings, stakes, and measuring equipment to mark key points and outline the formwork area on the foundation slab.
- Position the deflated pneumoform (inflatable membrane) on the layout according to the predetermined shape. The placement should align with the marked layout, ensuring accuracy in the final structure.

#### **c. Anchor Pneumoform to Slab:**

- Position the inflated pneumoform onto the slab, aligning it with the desired location and orientation of the Binishell structure.
- Make any necessary adjustments to ensure the pneumoform is centred and aligned according to the design.
- Insert anchor bolts or dowels into the drilled holes. The length of the anchors should be sufficient to provide a secure connection to the pneumoform.
- Carefully position the pneumoform over the anchor bolts or dowels.
- Securely attach the pneumoform to the anchor bolts or dowels. This can be done using nuts and washers, tightening them to ensure a firm connection.

#### d. Inflate Pneumoform:

- Ensure proper alignment and orientation according to the Binishell design.
- Anchor the edges of the pneumoform securely to the foundation slab.
- Use temporary fixtures or restraints to prevent movement during inflation.
- Connect the pneumoform to the air supply system, which could be an air compressor or another pneumatic device.
- Ensure a secure and airtight connection.



Figure.2- Reinforced bar

#### a. Add reinforcement/Rebar

Types of rebars used in the construction of Binishell domes

##### a) Hoop Rebar:

Rebar that actually does the most good to hold the dome up is hoop rebar that goes around the dome. Hoop rebar performs somewhat like the hoops on a barrel. Hence, they should be located as far toward the outside as is practical. As pressure is applied to the Binishell Dome, the dome will try to dimple immediately under the pressure.

##### b) Vertical Rebar

The vertical layer of rebar is laid against the hoops. For Binishell Domes requiring thicker shells, rebar should still be placed to the outside.

#### b. Shotcrete:

- Shotcrete is a mixed mortar of cement, sand, 3/8 minus aggregate, and water projected at high velocity onto a surface. The force of the jet impacting on the surface compacts the material. A relatively dry mixture is used so that the material supports itself minimizing sagging or sloughing, even when used for vertical and overhead applications. The cement, sand, aggregate, and water are mixed by suitable means, and then pumped through a hose by a specially designed mortar pump.
- **Basic Steps for Applying Shotcrete to a Binishell Dome**
- **Layer One**
- The shotcrete is started at the bottom of the dome. First, a thick, tapered layer of shotcrete should be applied around the entire circumference of the dome, at the base, up to about one foot high. This ensures the concrete on the footing is good concrete and not rebound shotcrete. A 1/2" to 1" layer is then sprayed on the surface from ground level up to about 6' high. From 6' high on up to the top third of the dome, a 1/2" layer is applied. The top third of the dome is covered with 1/4" to 1/2" of shotcrete.
- **Layer Two**
- Second layer is usually applied on the second day. Up to a 1" layer is applied from ground level to approximately

8". From 8" to the top, a 1/2" layer is then applied.

- **Layer Three**
- The third layer is an exact duplicate of the second layer, except that dome will support more weight and the layers can go on thicker and higher. The concrete around the base of the dome will be strong enough to support additional concrete if it is needed for extra thickness.
- **Layer Four**
- Layer four is a repeat of the third. The base should be worked for smoothness. Particular attention should be given to the depth gauges.
- **Final Layer**
- The final layer should be relatively thin (about 1/4" to 1/2") to permit a smooth finish. Before spraying this last layer, depth is checked. If adequate thickness is not reached by this time, it is necessary to spray additional layers as needed. The finishing layer of concrete should be sprayed from the top down. It seems easier to make a nice finish if the final concrete layer starts at the top.



Figure.3- Shotcrete

This project is a structural design project and during the course of the project we will gain useful knowledge in: •

Design of Structural elements

- Design of dome structure as per stresses and loads
- Design of ring beam for foundation.

#### Software / Equipment used

Various software which will be used in this project are

- Auto CAD
- STAAD.Pro

### III. RESULT

#### Analysis

The analysis was done using Staad.Pro software. The loads given for the analysis

Self weight of dome

- i) Live load due to wind, snow Total wt. (w)
- ii) Dead load
- iii) Seismic load





iv) Wind load

$$= \text{thickness} \times \text{wt. of concrete} = 0.1 \text{ m} \times 25 \text{ kN/m}^3$$

$$= 2.5 \text{ kN/m}^2$$

$$= 1.5 \text{ kN/m}^2 = 4 \text{ kN/m}^2$$

$$= 1.5 \times 4 = 6 \text{ kN/m}^2 = \text{medium soil}$$

$$= 250 \text{ km/hr (based on the Extreme Weather Events over India in the last 100 years)}$$

**Table 1 – Absolute Stress BEAM FORCE DETAILS**

	Dead load				Live load			
	Plane center stress		Plate corner stress		Plane center stress		Plate corner stress	
Shear	SQX (local) kN/m <sup>2</sup>	SQY (local) kN/m <sup>2</sup>	SQX (local) kN/m <sup>2</sup>	SQY (local) kN/m <sup>2</sup>	SQX (local) kN/m <sup>2</sup>	SQY (local) kN/m <sup>2</sup>	SQX (local) kN/m <sup>2</sup>	SQY (local) kN/m <sup>2</sup>
	0.001	1.341	0.13	1.388	0.001	0.804	0.221	0.862
Membrane	SX (local) kN/m <sup>2</sup>	SY (local) kN/m <sup>2</sup>	SX (local) kN/m <sup>2</sup>	SY (local) kN/m <sup>2</sup>	SX (local) kN/m <sup>2</sup>	SY (local) kN/m <sup>2</sup>	SX (local) kN/m <sup>2</sup>	SY (local) kN/m <sup>2</sup>
	-86.515	-349.833	-56.562	-347.698	-102.23	-284.135	-31.245	-292.399
Bending Moment	Mx kg-m/m	My kg-m/m	Mx kg-m/m	My kg-m/m	Mx kg-m/m	My kg-m/m	Mx kg-m/m	My kg-m/m
	5.247	39.896	3.753	24.029	9.557	72.904	24.334	41.616

Seismic load			
Plane center stress		Plate corner stress	
SQX (local) kN/m <sup>2</sup>	SQY (local) kN/m <sup>2</sup>	SQX (local) kN/m <sup>2</sup>	SQY (local) kN/m <sup>2</sup>
0.157	0.358	0.157	0.362
SX (local) kN/m <sup>2</sup>	SY (local) kN/m <sup>2</sup>	SX (local) kN/m <sup>2</sup>	SY (local) kN/m <sup>2</sup>
20.637	8.794	21.171	9.336
Mx kg-m/m	My kg-m/m	Mx kg-m/m	My kg-m/m
0.866	5.07	16.718	2.146



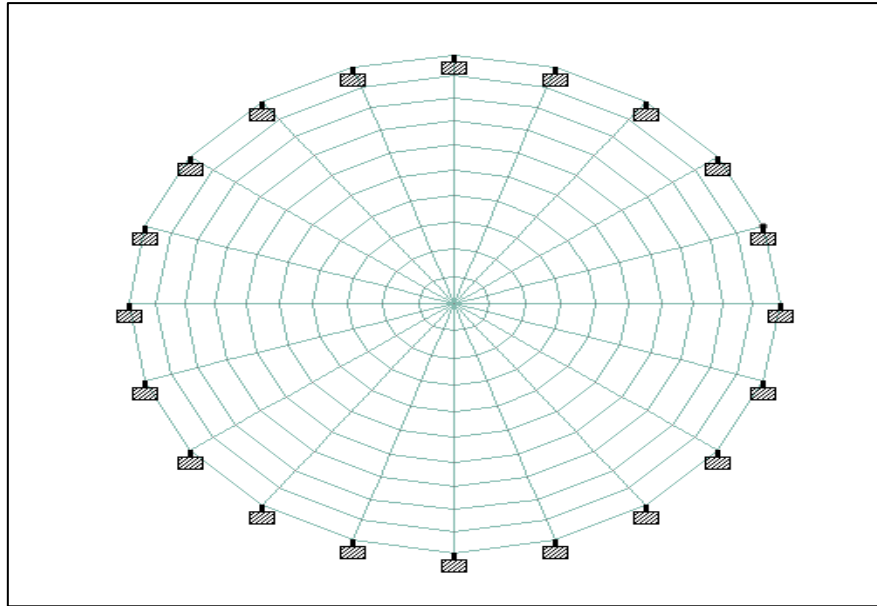


Figure. 4– Displacement due to Loads

### Design

• Inside diameter of room = 11m • Rise of dome = 4.5m  
 Let the radius of the dome be 'r', the diameter of the dome be 11m and rise is 4.5 m.  $(2r - \text{height of dome}) \times \text{height of dome} = (\text{diameter} \div 2)^2$

$$(2r - 4.5) \times 4.5 = (11 \div 2)^2 \quad r = 5.61$$

$$\cos \phi = (r - \text{height of dome}) / r$$

$$\cos \phi = 0.1978$$

$$\phi = 78^\circ 59' > 51^\circ 49' 38''$$

$$\sin \phi = (\text{diameter} / 2r) \quad \cos \phi = (5.61 - 4.5) / 5.61 \quad \sin \phi = 11 / (2 \times 5.61)$$

$$\sin \phi = 0.9804$$

$$\phi = 78^\circ 59' > 51^\circ 49' 38''$$

The circle of latitude at which the angle  $\phi = 51^\circ 49' 38''$ , the hoop stress is 0. If the angle is greater, then hoop compression will be developed while for the portion below this plane, hoop tension will be developed and will go increasing further towards the base of the dome.

### Load calculation

There is no opening at crown. Let us assume the thickness of the dome be 100 mm. i) Self weight of dome = thickness  $\times$  wt. of concrete

$$= 0.1 \text{ m} \times 25 \text{ kN/m}^3 = 2.5 \text{ kN/m}^2$$

$$\text{ii) Live load due to wind, snow} = 1.5 \text{ kN/m}^2 \quad \text{Total wt. (w)} = 4 \text{ kN/m}^2$$

$$\text{Dead load} = 1.5 \times 4 = 6 \text{ kN/m}^2 \quad \text{Total load (W)} = 4 + 6 = 10 \text{ kN/m}^2$$

**Calculation of stresses due to combined load** There are two types of stresses are induced in dome.

1. Meridional thrust (T) along the direction of meridian.
2. Hoop stress (H) along the latitudes.

The stress at any horizontal plane will be equal to the algebraic sum of stresses due to the two loading and the dome will be designed for the maximum of these stresses.

$$\text{Total meridional stress (T)} = [wr(1 - \cos \phi) \div t \times \sin^2 \phi] + [W \div (2\pi r t \times \sin^2 \phi)]$$

$$= [4 \times 5.61(1 - \cos 78^\circ 59') \div (0.1 \times \sin^2 78^\circ 59')] + [10 \div (2\pi \times 5.61 \times 0.1 \times \sin^2 78^\circ 59')] \text{ kN/m}^2$$

$$= 191.3425 \times 10^{-3} \text{ N/mm}^2 \quad \mathbf{T = 0.1913 \text{ N/mm}^2}$$

$$\text{Hoop stress (H)} = (wr \div t)[(\cos^2 \theta + \cos \theta - 1) \div (1 + \cos \theta)] - [(W \div 2\pi r t) \times (1 \div \sin^2 \theta)]$$

$$= (4 \times 5.61 \div 0.1)[(\cos^2 78^\circ 59' + \cos 78^\circ 59' - 1) \div (1 + \cos 78^\circ 59')] - [(10 \div 2\pi \times 5.61 \times 0.1) \times (1 \div \sin^2 78^\circ 59')] \text{ kN/m}^2$$

$$= -149.46 \times 10^{-3} \text{ N/mm}^2$$



### $H = -0.1495 \times 10^{-3} \text{ N/mm}^2$ Hoopstress in absence of live load

Hoop stress should also be found in absence of live load. This will increase the tensile stresses in the upper portion of the dome, especially near the periphery of the opening. However, meridional thrust will not increase by omitting the live load.  $w = 0.1 \times 25000 = 2500 \text{ N} = 2.5 \text{ kN}$

Wt. of lantern (W) =  $10 \times 2.5 = 7.5 \text{ kN}$

Thus the hoop stresses due to  $w$  calculated above will be decreased in the ratio of  $(250 \div 400) = 0.625$  while the hoop stresses due to  $w$  will be increased by a ratio of  $(10 \div 7.5) = 1.333$ .

The maximum hoop tension at the opening has been increased from  $0.098 \text{ N/mm}^2$  to  $0.195 \text{ N/mm}^2$

**Provision of reinforcement** Max. Compressive stress Max. hoop tensile stress

Max. hoop tension per metre length of meridian Area of steel

$$= 0.354 \text{ N/mm}^2 \text{ [safe]} = 0.195 \text{ N/mm}^2$$

$$= 0.195 \times 100 \times 1000 = 19500 \text{ N} = 19500 / 140 = 139 \text{ mm}^2$$

Reinforcement for temp etc = 0.15% of thickness

$$= (0.15/100) \times 100 \times 1000 = 150 \text{ mm}^2/\text{m}$$

Total reinforcement =  $139 + 150 = 289 \text{ mm}^2$  Using 8mm  $\Phi$  bars, spacing =  $(1000 \times 50) \div 289 = 173 \text{ mm}$  However **provide 8mm bars @ 160mm c/c** where hoop tension is developed.

In the portion where no hoop tension is developed, minimum area of steel @ 0.15% will be  $150 \text{ mm}^2$ . Hence **provide 8mm  $\Phi$  bars @ 300mm c/c**.

### Design of ring beam

Meridional thrust per metre length of the dome at its base =  $0.19 \times 100 \times 1000 = 19000 \text{ N/m}$ .

Horizontal component T per metre length =  $9000 \times \cos 78^\circ 59' = 3630.80 \text{ N/m}$ . Hoop tension, trying to rupture the beam =  $3630.80 \times (11/2) = 19969.38 \text{ N}$ . Area of steel reqd. =  $19969.38 / 140$

=  $142.63 \text{ mm}^2$  Using 10mm  $\Phi$  bars, No. of rings =  $(142.63 / 78.53)$

= 1.8 ~ 2 nos. (approx) Hence **provide 2 rings of 10mm  $\Phi$  bars**.

Equivalent area of composite section of beam of area of cross-section A. =  $A + (m-1) \times A_{st}$

$$= A + 18 \times 78.53 \times 2 = A + 2827.08$$

Allowing tensile stress of  $1.2 \text{ N/mm}^2$  in the composite section, we have  $19969.38 / (A + 2827.08) = 1.2$

From which  $A = 13814.07 \text{ mm}^2$

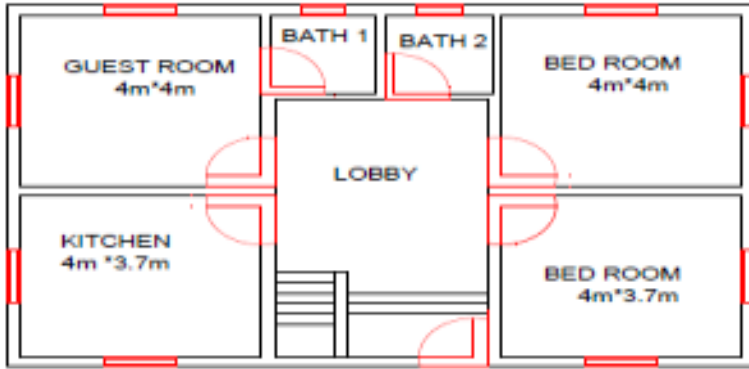
However, provide a ring beam of  $200 \text{ mm} \times 200 \text{ mm}$ . Provide 6mm  $\Phi$  Striups @ 160mm c/c to tie the rings in the ring beam.

## IV. COST ESTIMATION

The detailed cost estimation of normal conventional building and monolithic concrete dome housing of same size are compared below



Normal conventional building



REFERENCE  
 D 1.20 X 2.10  
 W 1.50 X 1.50  
 V 0.60 X 0.60  
 ALL DIMENSIONS  
 ARE IN METERS

PLAN

Figure18 – Plan of the conventional one story house

Estimation of normal conventional house

1 .Earth work Excavation for foundation in Hard Gravel soil including 10m lead and lift etc complete. DESCRIPTION

	NO'S	L[M]	B[M]	D[M]	QTY[M <sup>3</sup> ]
For Columns	1x12	1.2	For Plinth Beam	1x1	73.01

Qty 38.65 CUM [ 1364CFT]

1.2 1.82 0.45 0.23

Rate Rs.6.00/cft

31.10 7.55

-----38.65 CUM

Rs. 8,184



2. Sand filling for foundation and basement including cost and conveyance of all materials and labour charges etc complete.

For Column 1x12 For Plinth beam 1x1 For Basement 1x1  
Qty. 107.90 CUM [3807 CFT]

1.2 1.2 73.01 0.45 13.15 8.39

Rate Rs. 45.00/ cft

0.15M 0.15M 0.91M

**Rs. 1,71,315**

2.592 4.92 100.39  
-----107.90 CUM  
-----

3. Cement concrete 1:5:10 using 40 mm size ISS HBG metal including cost and Conveyance of all materials and labour charges Etc complete.

For Column 1x12 1.2 1.2 0.15M 2.592 For Plinth beam 1x1  
73.01 0.45 0.10M 3.28 For Basement 1x1 13.15  
8.39 0.10M 11.03

-----16.902 CUM

-----Qty. 16.902 CUM [597 CFT] Rate Rs. 65.00/ cft **Rs. 38,805**

4. RCC 1:2:4 mix using 20 mm size ISS HBG metal including cost and conveyance of all materials and labour charges etc complete.

For Columns 1x12 0.23 0.23 3.96 2.51 For Lintel 1x1 73.01 0.23  
0.23 3.86 For Sunshade 1x8 1.82 0.60 0.076 0.66

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For Loft 1x4 3.04 0.60 0.076 0.55 Roof slab 1x1 13.15 8.39  
0.38 41.92  
-----49.5 CUM -----

**Qty. 49.5 CUM [1747 CFT] Rate Rs. 110.00/ cft Rs. 1,92,170**

5..Supplying and fabrication of steel including cost and conveyance of all materials cutting, bending, tying grills etc, complete.

Qty as per item no. 4 = 1747 CFT x 3.00 kg/cft = 5241

-----5241

-----Qty 5241 kg Rate Rs. 65.00/ kg **Rs. 3,40,665**

6. Brick work with CM 1:5 Mix using chamber burnt bricks including cost and conveyance of all materials and labour charges etc complete.



	For Superstructure	1x1	73.01	0.23	3.96	Deduct for Doors	1x4	0.91	0.23	2.13
WINDOWS		1x8	1.2	0.23	1.2	Ventilator	1x2	1.21	0.23	0.76
Parapet wall		1x1	43.08	0.23	0.91					

**Qty: 105.73CUM[3731CFT] Rate Rs. 75.00/cft**

66.4 (-) 1.78 (-) 2.69 (-) 0.42  
44.22

-----105.73 CUM  
-----**Rs. 2,79,825**

7.Ceiling plastering with CM 1:3 mix 10mm thick including cost and conveyance of all materials and labour charges etc complete.

Ceiling	1x1	1.69	7.93	-100.63	Sunshades 1x8	1.82	0.68	-
9.9 Loft Bottom	2x2	3.04	0.60	-7.2				

-----117.73SQM  
-----**Qty 117.73SQM[1267SFT] Rate Rs. 18.00/sft Rs.22,806**

8. Wall plastering with CM 1:4 mix, 12mm thick including cost and conveyance of all materials and labour charges etc complete.

GUEST ROOM	1x1	16	-	3.04	48.64	Kit		
1x1		15.4	-	3.04	46.81	Bed	1x1	16
		-	3.04	48.64	BED		1x1	15.4
		3.04	46.81	Outer alround	1x1	43.08	-	3.96

170.59 Deductions

as per item no. 6

(-) 4.89

-----356.6SQM -----  
**Qty 356.6SQM[3838SFT] Rate Rs. 18.00/sft**

**Rs. 69,084**

9. Supplying and fixing Country wood doors and windows with safety grills including cost and conveyance charges etc complete.

Door	1x4	0.91	-	2.13	7.75	Window
1x8		1.21	-	1.21	11.71	Ventilation
		1.21	-	0.76	1.83	1x2

-----21.29SQM

-----**Qty 21.29SQM[230SFT] Rate Rs.400.00 / sft Rs. 92,000**

10.Floor finishing with 2'x2' Vitrified Tiles Flooring Laying with Ordinary cement including cost and conveyance of all materials and labour charges etc complete.

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Flooring	1x1	12.69	7.93
----------	-----	-------	------

**Qty 100.63SQM[1083SFT] Rate Rs. 80.00 / sft**

100.63 -----  
100.63SQM -----  
**Rs. 86,640**





11. Weathering coarse with brick bats and lime powder and top finished with pressed tiles in cm 1:4 mix including all charges etc complete.

For Terrace	1x1	13.15	8.39	110.32
-----110.32SQM				
-----Qty: 110.32SQM[1182SFT]		Rate Rs. 55.00/sft Rs. 65,010		

12. Provision of staircase arrangements LS

**Total Est.**

**(Rupees Thirteen Lakhs and eighty six Thousands and six hundred only)**

**Rs. 20,000 -----**

**Rs.13, 86,600/-----**

**Estimation of concrete dome housing**

1 .Earth work Excavation for foundation in Hard Gravel soil including 10m lead and lift etc complete. DESCRIPTION

NO'S	L[M]	B[M]	D[M]	QTY[M <sup>3</sup> ]
For Plinth Beam 1x1	73.01	0.23	2	33.58
-----33.58 CUM -----				
Qty 33.58 CUM [ 1185CFT]	Rate Rs.6.00/cft		<b>Rs. 7,110</b>	

2 . Sand filling for foundation and basement including cost and conveyance of all materials and labour charges etc complete.

For Plinth beam 1x1	73.01	0.45	0.15M	4.92 For Basement	1x1	13.15
	8.39	0.91M	100.39			
-----105.31CUM -----						
Qty.105.31CUM[3716CFT]	Rate Rs.45.00/ cft		<b>Rs.1,67,220</b>			

3. Cement concrete 1:5:10 using 40 mm size ISS HBG metal including cost and Conveyance of all materials and labour charges Etc complete.

For Plinth beam 1x1 For Basement 1x1

Qty. 14.31CUM[505CFT]

73.01 13.15

Rate Rs. 65.00/ cft

0.45 0.10 3.28 8.39 0.10 11.03

-----14.31 CUM -----

**Rs. 32,825**

4. RCC 1:2:4 mix using 20 mm size ISS HBG metal including cost and conveyance of all materials and labour charges etc complete.

For Lintel	1x1	73.01	0.23	0.23	3.86 For Sunshade
	1x8	1.82	0.60	0.076	0.66 Dome roof
	1x1	$[2\pi r^2]=100.48m^2$	0.38		38.18
-----42.7CUM					
-----Qty. 42.7CUM[1506CFT]		Rate Rs.110.00/cft		<b>Rs. 1,65,660</b>	

5..Supplying and fabrication of steel including cost and conveyance of all materials cutting, bending, tying grills etc, complete. Qty as per item no. 4 = 1506CFT x 3.00 kg/cft = 4518

-----4518

-----





-----**(Rupees Nine lakhs fifty seven thousand and fifteen only)**

## **V. CONCLUSIONS**

- The implementation of this project will play a key role in bringing awareness about the construction of MCD's and their use as residential buildings in the earthquake prone areas for the people with median house hold income.
- The project also encompasses various aspects of the constructions of concrete domes which include cost efficiency, disaster resistant nature, earthquake resistant nature and energy efficiency.
- we have analyzed and designed Monolithic Concrete Domes. The structure was designed as per mentioned standards. The design was done in accordance with the codal provisions as provided in the design of reinforced concrete structures.

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# **Comparative Study on Effect of Sugarcane Bagasse Ash and Wheat Straw Ash on Properties of Concrete**

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**ABSTRACT:** The paper presents the effect of using wheat straw ash and sugarcane bagasse ash as a partial replacement material of cement in concrete mixes [1]. The wheat straw ash and sugarcane bagasse ash is the remains left after open burning of wheat straw and sugarcane bagasse [1]. In this study, ash prepared from uncontrolled burning of wheat straw and sugarcane bagasse is evaluated for its suitability as partial replacement of cement in concrete [1]. The strength parameters i.e. compressive strength and workability of concrete blended with wheat straw ash cement are evaluated & studied by replacing cement by 15%, 20% by weight to OPC. Slump test was carried out on fresh concrete and compressive strength test and flexural strength was carried out on hardened concrete. Several cubes were tested at 7, 14 & 28 days. The result shows that wheat straw ash and sugarcane bagasse ash is not a good replacement material with  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Fe}_2\text{O}_3$ . The compressive strength also decreased with increase of WSA.

**KEYWORDS:** Sugarcane Bagasse ash, Wheat straw ash, IS: 10262-2009, slump test, Cement replacement

## **I. INTRODUCTION**

Concrete is an artificial material used extensively and globally for a long time. Concrete is a composite of fine and coarse aggregate combined with hydraulic paste of cement and water [2]. It is the indispensable building construction material, and also important in other projects of infrastructure around the globe. It is experienced as the second material far and wide used by mankind. In fact, the utilization of natural resources i.e. natural aggregates as coarse and fine, cement as binding material for the production of concrete has caused a lot of degradation in the natural resources [3]. From an ecological point of view, creation of concrete is mostly responsible for the release of greenhouse gases. It is reported that yearly production of concrete is about 1.6 billion tons worldwide, which discharges 7% of the global carbon dioxide into the atmosphere [4]. Keeping in view these concerns of environment, cost of materials for construction, shortage of raw materials and higher demand of energy, practice of utilizing alternate solid waste material is becoming a common concern of the globe [5]. Many researchers have conducted experimental studies that focused on finding possibilities for alternatives to be used as cement substituting materials, that are of less worth which include industrial and agricultural wastes, whose potential benefits can be appreciated through recycling, reutilizing and renewing processes. Hence, scholars have been exploring the effective and practical use of waste materials which are pozzolanic in nature as a cement substitute [6]. It is suggested by researchers that consumption of supplementary cementitious materials in concrete helps to reduce the adverse environmental effects related to the manufacturing process of cement or concrete [7]. With utilization of these wastes as supplementary and replacement materials there is considerable energy conservation and reduction in the consumption of cement which aids in the reduction of release of carbon dioxide in the environment [8]. Moreover, there could be considerable improvement in the strength and durability properties with use of supplementary cementing materials in concrete. Therefore, wide-range research has been carried out on number of supplementary materials, like rice husk ash, metakaolin ash, sewage sludge ash, palm shale ash, etc [9]. A major agricultural by-product obtained from cereal production is wheat straw waste and sugarcane bagasse, which encourages environmental pollution because the farmers burn it in open fields. However, when wheat straw waste and sugarcane bagasse is properly burnt under controlled situation results in a material that has cementing properties and that can be used in concrete as supplementary cementing material [10]. The resulting ash has higher percentage of silica present, also higher fineness compared to cement, therefore the wheat straw ash and sugarcane bagasse is considered as the possible source of supplementary cementing material [12].



## **II.OBJECTIVE**

- The main goal of this study is to explore the influence of WSA and SCBA on the characteristics of concrete of M25 grade when it is used as partial replacement of Cement.
- To test and compare the workability (Slump test) of M25 grade concrete with and without WSA, SCBA.
- To test and compare compressive strength, and flexural strength of M25 grade concrete with and without WSA, SCBA.
- To ensure optimum use of domestic and industrial waste & reduce carbon footprints.

## **III. LITERATURE REVIEW**

**Hardik Dhull, M.Tech. (CIVIL), M.D. University, Rohtak ,Haryana, India (2017)** Started, The paper presents the effect of using wheat straw ash as a partial replacement material of cement in concrete mines. The wheat straw ash is the remains left after open burning of wheat straw. In this study, wheat straw ash prepared from uncontrolled burning of wheat straw is evaluated for its suitability as partial replacement of cement in concrete. The strength parameters i.e. compressive strength and workability of concrete blended wheat straw ash cement are evaluated & studied by replacing cement by 15%, 20%, 30% & 40% by weight to OPC. Slump test was carried out on fresh concrete and compressive strength test was carried out on hardened concrete. Several cubes were tested at 7&28 days. The result shows that wheat straw ash is good replacement material with SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, Fe<sub>2</sub>O<sub>2</sub> of about 75%. The slump value decreased with increase in wheat straw ash. The compressive strength also decreased with increase of WSA.

**Irfan Ali Shar, Dr. Fareed Ahmed Memon, Noranda's Bheel, Zubair Hussain Shaikh, (2019).** Started, the alternatives include industrial and agricultural wastes, whose potential benefits can be appreciated through recycling, reutilizing and renewing processes. With utilization of these wastes as supplementary and replacement materials there is considerable energy conservation and reduction in the consumption of cement which aids in the reduction of release of carbon dioxide in the environment. The replacement of cement with WSA in concrete enhances the compressive strength of concrete, while reduces workability of concrete, due to the fineness of WSA particles as compared to cement particles.

**Faizan ul Haq, and Ashish Sharma, M. Tech Scholar, Department of Highway and Transport Engineering, RIMT University, Punjab, India. (2022).** The impact of employing wheat straw ash as a partial substitute material for cement in concrete mining is presented in this research. Wheat straw ash is the residue left over after open burning wheat straw. The appropriateness of wheat straw ash obtained from uncontrolled burning of wheat straw as a partial replacement for cement in concrete is investigated in this study. The compressive strength and workability of concrete blended wheat straw ash cement are examined and investigated by substituting cement by 15%, 20%, 25%, and 30% by weight to OPC. Slump tests were performed on new concrete, and compressive strength tests were performed on hardened concrete. Several cubes were evaluated after 7 and 28 days. The results demonstrate that wheat straw ash is a decent replacement material. The slump value dropped as wheat straw ash increased. The compressive strength decreased as WSA increased. As the percentage of WSA in the concrete increases, more water is required to make the mix more workable, indicating that WSA has a high-water demand. It will tackle the problem of wheat straw disposal while also being environmentally beneficial.

**Shubham Patidar, Dr. H.K. Mahyar, M.E Transportation Engineering, S.G.S Institute of Technology and Science Indore (M.P), India9(2021).** There have been numerous experiments in recent years to improve the properties of concrete in terms of strength and durability, particularly in severe conditions. For a durable and hard structure, high-strength concrete appears to be the preferable option. Industries generate a considerable number of by-products or wastes, such as fly-ash, copper slag, silica fume, wheat straw ash etc., which cause environmental and health hazards due to dumping and disposal. When silica fume, wheat straw is added to concrete, this improves the concrete's mechanical and durability properties. This paper presents literature review on replacement of Cement by Wheat Straw Ash along with silica fumes and steel fibers which includes current and future trends of research. The replacement of cement with Wheat straw ash by small quantity (upto 15%) in concrete may enhance the properties (compressive strength, split tensile strength & flexural strength) of concrete. Adding wheat straw ash lowers workability of the concrete, due to the fineness of wheat straw ash particles as compared to cement particles.



#### IV. MATERIAL & METHODOLOGY

##### A. Material Used

For the casting process, various construction materials are used like Wheat Straw ash, Sugarcane Bagasse ash, cement, Water, admixture, fine aggregates and coarse aggregates.

##### B. Wheat Straw

Local farmers in Pune region, provided the wheat straw utilized in the study. After drying, it was open burned, and the leftover ash was filtered through a No. 200 BS test sieve.

Oxide	% (by weight)
SiO <sub>2</sub>	8.8
Al <sub>2</sub> O <sub>3</sub>	1.4
Fe <sub>2</sub> O <sub>3</sub>	1.2
MgO	1.9
CaO	4.2

Table 1 is showing the properties of WSA in which the percentage of different oxide are shown as per the weight.

##### C. Sugarcane bagasse ash

Local farmers in Pune region, provided the sugarcane bagasse utilized in the study. After drying, it was open burned, and the leftover ash was filtered through a No. 200 BS test sieve.

oxide	% (by weight)
SiO <sub>2</sub>	74.14
Al <sub>2</sub> O <sub>3</sub>	2.32
Fe <sub>2</sub> O <sub>3</sub>	1.73
K <sub>2</sub> O	5.67
Other oxides	16.14

Table 2 is showing the properties of SCBA in which the percentage of different oxide are shown as per the weight.

##### D. Cement

The cement utilized was purchased from a local Cement Vendor and is of OPC 43 grade with a consistency (P) of 28%. With a specific gravity of 3.15, the Initial setting time is 37 minutes and the final setting time is 581 minutes. The cement was tested for various qualities, and the measurements have been made precisely while keeping in mind the restrictions established by IS: 8112-1989.

##### E. Aggregates

The coarse total where 12-20 mm in size brought from a nearby Crusher Plant in Pune, and fine total stream sand purchased from a neighbourhood merchant from a similar spot with fineness modulus 2.389 affirming to Zone II.

##### F. Water

The water used for testing and curing was drawn from a nearby faucet. The w/c proportion utilized in this venture is kept at 0.44, 0.55.

##### G. Admixture

ASTM C494 Admixtures for Concrete, particularly Types F (high-range water-reducing)

##### H. Methodology

The strength parameters of concrete blended wheat straw ash cement, namely compressive strength and workability, are tested and examined by substituting cement by 15% and 20% by weight to OPC.

The compressive strength of cubic samples with dimensions of 150\*150\*150 mm was studied. They were loaded after 7, 14 and 28 days. The force was applied perpendicular to the cube's upper face, and the compressive testing equipment's loading speed was 5 mm/min.

The testing instrument's loading capability was approximately 3000 kN. For this study, three concrete cubes with dimensions of 150 x 150 x 150mm were cast for each mix to test compressive strength with varying WSA and SCBA percentages after 7, 14 and 28 days.

Additionally, Flexure strength test was performed and the outcomes were investigated as needs be with the substitution of WSA and SCBA.

For Flexure strength, examples 400 mm x 100 mm x 100 mm were casted and for Split ductile chamber of breadth 150mm and level of 300 mm were appropriately restored for 28 days prior to testing.

### Stages:

1. Process of waste burning
2. Performing properties test on concrete ingredients
3. Planning of mix proportion
4. Preparing concrete cubes and Performing tests on fresh concrete
5. Curing
6. Performing test on harden concrete

### Stage 1. Process of waste burning

**Sugarcane Bagasse Ash:** The bagasse was obtained from juice extractors factories, where the sugarcane bagasse waste is washed in a tank with water and then dried by placing it in the sun. Then, it was left to burn completely in air up to 600 °C until it is converted totally to ashes; then, the ashes were placed in an oven and heated up to 200 °C; then, the temperature was maintained for 2 h to get rid of the remaining organic matters (carbon). After the ash was taken out of the oven, it was ground in a grinder to obtain finer particles.



Fig 1. Burning Process Of SCBA

**Wheat Straw Ash:** The open burning of biomass residue constitutes a major portion of biomass burning and leads to air pollution, smog, and health hazards. When wheat straw, an agricultural product, is burned, it is very rich in SiO<sub>2</sub>, which has a pozzolanic character. However, the pozzolanic character is sensitive to calcination temperature and grinding conditions

### Stage 2. Performing properties test on concrete ingredients

Specific Gravity Test and water absorption test

Specific Gravity is the ratio of density of a material to the density of standard or reference substance.

**Specific gravity =  $W_3 / (W_3 - (W_1 - W_2))$**

**Water absorption =  $((W_3 - W_4) / W_4) \times 100$**

**Specific gravity of fine aggregate = 2.7**

**Specific gravity of coarse aggregate = 2.81**

**Water absorption of fine aggregate = 4.27%**

**Water absorption of coarse aggregate = 1.013%**



**Fig 2. Specific Gravity Test / Water Absorption Test**

Sieve Analysis Test

Table 3: Shows the sieve analysis results that we got during the test. We can see the percentage of soil retained and passed from the table.

Co-efficient of curvature  $C_c = (D_{30})^2 / (D_{10} \times D_{60}) = 0.94$

Co-efficient of uniformity  $C_u = D_{60} / D_{10} = 3.94$



**Fig 3. Sieve Analysis Test**

Weight of Sample 2 kg

Sieve	Weight (kg)	Cumulative Wt. Retain	% Cumulative Wt. Retain	% Passing
4.75	0.001	0.001	0.05	99.95
2.36	0.198	0.199	9.95	90.05
1.18	0.780	0.979	48.95	51.05
600	0.313	1.292	64.6	35.40
300	0.202	1.494	74.7	25.30
150	0.201	1.695	84.75	15.25
Pan	0.300	1.995	99.75	0.25

**Table 3: Shows the sieve analysis results**

**Initial and Final Setting of Cement**

It is the period passed between the addition of water to the cement and the beginning of the paste's plasticity. OPC cement should not be less than 30 minutes. The period at which cement totally loses its flexibility and becomes hard is known as the cement's ultimate setting time.

- Initial setting time for normal cement = 75 min.**
- Initial setting time for cement with 15% of composite ash. = 4.30 hrs.**
- Initial setting time for cement with 20% of composite ash. = 79 min.**
- Final setting time for normal cement. = 4.13 hrs.**
- Final setting time for cement with 15% of composite ash. = 83 min.**
- Final setting time for cement with 20% of composite ash. = 4.16 hrs.**

Fineness test and consistency test on cement.

- Fineness of cement = 1.33**
- Consistency of cement (P) = 34%**
- Consistency of cement containing 15% of composite ash (P1) = 40%**
- Consistency of cement containing 20% of composite ash (P2) = 47%**

**Crushing values and impact values test**

The aggregate crushing value provides a relative measure of an aggregate's resistance to crushing under a progressively applied compressive stress. When the aggregate crushing value is 30 or greater, the result may be abnormal, and the ten percent fines value should be computed instead.

- Crushing value of aggregate = 8.84%**
- Impact value of aggregate = 3.76%**



**Fig 4. Crushing values and impact values test.**

**Stage 3. Planning of mix design**

**Mix proportion M25 (15% Ash) (10% Tolerance)**

Sr	Materials	Calculations	Quantity (KG)
1	Cement	1.1 x 8.97	9.86
2	Admixture	1.1 x 0.10	110ml
3	Sugarcane Ash	1.1 x 0.871	0.958
4	Wheet Straw Ash	1.1 x 0.871	0.958
5	Fine Agg	1.1 x 20.16	22.176
6	Coarse Agg	1.1 x 39.03	42.933
7	Water	1.1 x 4.65	5.115

**Table No :4 Mix proportion M25 (15% Ash) (10% Tolerance)**

**Mix proportion M25 (20% Ash) (20% Tolerance)**

Sr	Materials	Calculations	Quantity (KG)
1	Cement	1.12 x 8.7	10.44
2	Admixture	1.12 x 0.11	132ml
3	Sugarcane Ash	1.12 x 1.075	1.29

4	Wheet Straw Ash	1.12 x 1.075	1.29
5	Fine Agg	1.12 x 16.31	18.26
6	Coarse Agg	1.12 x 34.65	41.58
7	Water	1.12 x 4.731	5.68

Table No :5 Mix proportion M25 (20% Ash) (20% Tolerance)

- **Mix proportion M25 (10% Tolerance)**

Sr	Materials	Calculations	Quantity (KG)
1	Cement	1.1 x 10.71	11.77
2	Admixture	1.1 x 0.10	110
3	Fine Agg	1.1 x 20.16	22.176
4	Coarse Agg	1.1 x 39.03	42.933
5	Water	1.1 x 4.65	5.115

Table No: 6 Mix proportion M25 (10% Tolerance)

#### Stage 4. Preparing concrete cubes and monitoring

Preparing and testing fresh concrete is an essential part of the construction process, ensuring the material's quality and suitability for its intended use. The preparation begins with mixing cement, water, aggregates, and any necessary admixtures to create a homogeneous mixture. Once mixed, the fresh concrete's workability is assessed, often through a slump test, to determine its ease of handling and placement. Temperature checks are conducted to ensure the mix is within optimal curing ranges, while air content tests are performed to evaluate the concrete's potential durability and resistance to freeze-thaw cycles. Unit weight measurements help ascertain the concrete's density, affecting its strength and stability.

#### Test results on fresh concrete

1. Slump cone test:

**Slump of normal concrete = 80mm**

**Slump of concrete with 15% composite ash = 130mm**

**Slump of concrete with 20% composite ash = 160mm**



Fig 5. Slump cone test.

#### Stage 5. Curing

Curing concrete cubes is an essential process to ensure that they reach the required strength for testing. Proper curing helps in achieving accurate and reliable test results, which reflect the potential strength and durability of the concrete used in actual construction.





Keep the cubes fully immersed in water for the entire curing period, typically 7, 14, or 28 days.

## Stage 6. Performing test on harden concrete

### 1. Compression test

Total 27 cubes of size 150\*150\*150mm of design mix M25grade were evaluated for this investigation where 9 cubes were made of normal concrete and remaining 18 were made up of 15% and 20% of composite ash respectively. The specimens were evaluated after 7, 14 and 28 days of cure. The first 9 regular concrete cubes were compared to partial cement substitution with wheat straw ash and Sugarcane bagasse ash. Wheat straw ash and sugarcane bagasse ash was employed in varied quantities of 15% and 20%, as a replacement for cement, and 9 cubes were cast for each percentage.

Table 7 shows the compressive strengths after curing in MPA after 7, 14 and 28 days of nominal concrete.

Table 7: Compressive Strengths after 7, 14 and 28, days of curing. (Nominal concrete)

TEST RESULTS	LOAD (KN)	COMP. STRENGTH [N/mm <sup>2</sup> ]
DAY 7	460	20.44
DAY 14	526.66	23.40
DAY 28	603.33	26.81

Table 8 shows the compressive strengths after curing in MPA after 7, 14 and 28 days of 15% composite ash concrete.

TEST RESULTS	LOAD (KN)	COMP. STRENGTH [N/mm <sup>2</sup> ]
DAY 7	546.66	24.29
DAY 14	673.33	29.92
DAY 28	706.666	31.40

Table 8: Compressive Strengths after 7, 14 and 28, days of curing. (15% composite ash concrete)

Table 9 shows the compressive strengths after curing in MPA after 7, 14 and 28 days of 20% composite ash concrete.

Table 9: Compressive Strengths after 7, 14 and 28, days of curing. (20% composite ash concrete)

TEST RESULTS	LOAD (KN)	COMP. STRENGTH [N/mm <sup>2</sup> ]
DAY 7	943.33	41.92
DAY 14	1276.66	56.74
DAY 28	1266.66	56.29



Fig 6. Compression test

Flexural strength test [For 28 Days]

Sample No	Flexural Strength (Normal)	Flexural Strength (20% Ash Mix)
1	3.18	1.98
2	2.75	1.3
3	3.46	2.03

Table No: 10 Comparison Between Normal Concrete & 20% ash Mix

V. RESULTS

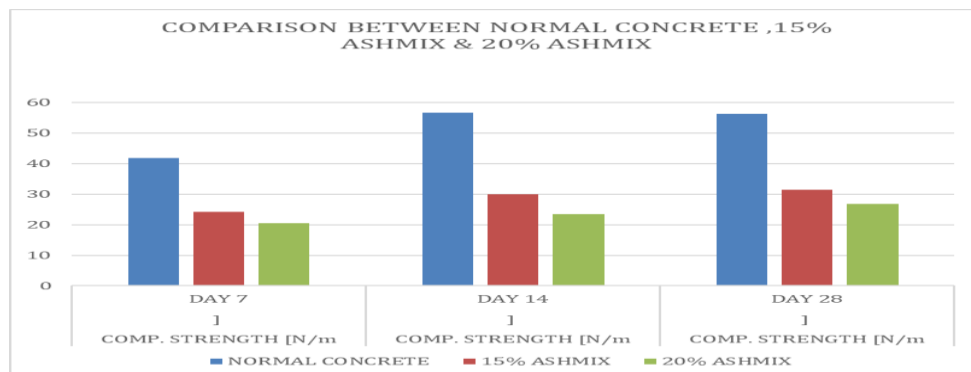
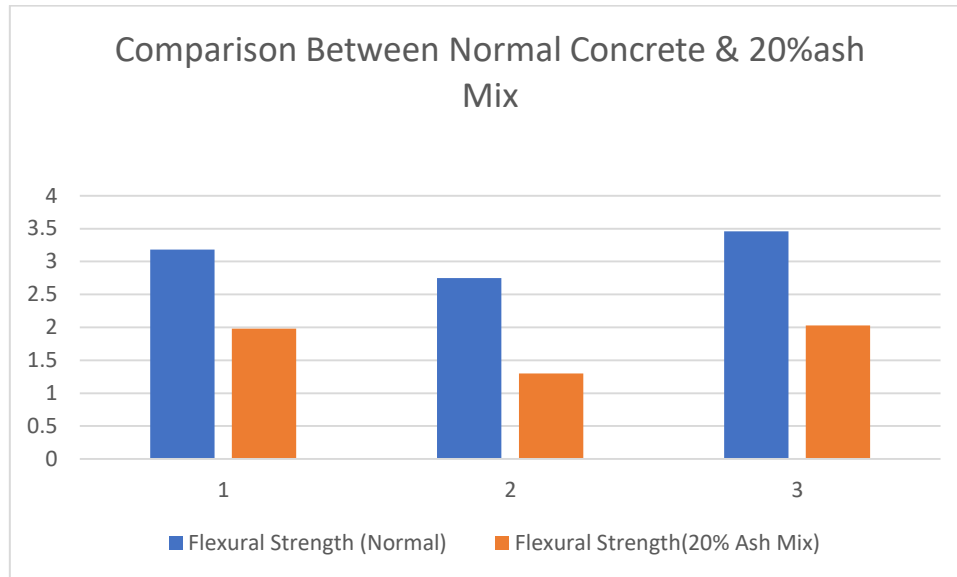


Chart 1. Comparison between nominal concrete and 15%, 20% composite ash concrete

Chart 1. shows the comparison of compressive strengths after curing graphically in MPA after 7, 14 and 28 days when we replace cement with WSA and SCBA by 15%, 20% and without replacement. From the above graph we can see that at 15% replacement of WSA and SCBA gives **42.04%**, **47.25%** and **44.18%** decrease in compressive strength at 7, 14 & 28 days respectively

From the above graph we can see that at 20% replacement of WSA and SCBA gives **51.23%**, **58.74%** and **52.39%** decrease in compressive strength at 7, 14 & 28 days respectively



**Chart 2. Comparison between nominal concrete and 20% composite ash concrete**

Chart 2. shows the comparison of flexural strengths after curing graphically in MPA after 28 days when we replace cement with WSA and SCBA by 20% and without replacement. From the above graph we can see that at 20% replacement of WSA and SCBA gives **37.77%**, **52.72%** and **41.4%** decrease in compressive strength at 28 days respectively

## VI. CONCLUSION

From the test carried out and design following this can be concluded:

- We can see that at 15% replacement of WSA and SCBA gives **42.04%**, **47.25%** and **44.18%** decrease in compressive strength at 7, 14 & 28 days respectively
- We can see that at 20% replacement of WSA and SCBA gives **51.23%**, **58.74%** and **52.39%** decrease in compressive strength at 7, 14 & 28 days respectively
- We can see that at 20% replacement of WSA and SCBA gives **37.77%**, **52.72%** and **41.4%** decrease in flexural strength at 7, 14 & 28 days respectively
- As the percentage of WSA and SCBA in the concrete increases, more water is required to make the mix more workable, indicating that WSA has a high-water demand.
- As it is a waste and free of charge, using WSA and SCBA might be cost effective.
- WSA and SCBA will conserve resources, notably cement, making the building sector more sustainable.
- It will tackle the problem of wheat straw and sugarcane bagasse disposal while also being environmentally beneficial.

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