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Concrete Using Waste Material – Plastic Straw

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ABSTRACT: The utilization of fibers in concrete applications has now become a widely accepted practice, driven in part by the advancements made in enhancing concrete's ductility and crack control. An additional benefit can be attained if these fibers are sourced from waste materials, leading to a significant reduction in environmental pollution and eliminating the need for additional landfill space. This paper marks the initial phase of an extensive investigation on the incorporation of waste plastic fibers into concrete applications. The primary objective of this research is to promote sustainability and address environmental concerns by producing fibers from discarded plastic straws, which will then be incorporated into plain concrete to enhance its strength and ductility. The experimental work conducted in this study aimed to evaluate the impact of incorporating waste plastic fibers on the properties of concrete. With modern living standards and technological advancements, there has been a substantial increase in both the volume and types of waste generated, resulting in a pressing waste management crisis. This study aims to address this issue by utilizing waste materials that would otherwise end up polluting our environment.

KEYWORDS: Fibers, Strength, Sustainability, Plastic straw, Waste

I. INTRODUCTION

Plastic straws are almost always used only once before being disposed of. Further, they really are non-essential. Plastic straws are single-use, lightweight, and made from Polypropylene, a material that isn't easily recycled and degrades slowly. As a result, the negative environmental impact of plastic straws is disproportionate compared to volume.[1] One problem plaguing the environment is the difficulty of recycling plastic straws, which often end up in landfills or oceans. To combat this issue, some researchers have put forth an innovative solution – using plastic straws as raw materials to create fiber-reinforced polymer (FRP) composites. These composites can then be utilized as a strengthening agent for concrete, effectively reducing plastic waste while also improving concrete's mechanical properties such as tensile strength and ductility. This paper aims to examine existing literature on the use of plastic straw FRP composites for confining concrete and present the findings from our own experimental investigation into its performance under varying conditions.

II. IMPORTANCE

Our Waste Management Solution proposes using recycling plastic waste as construction materials to effectively manage plastic waste from households/ Coconut Vendors. By repurposing plastic straws, we can create fibre-reinforced polymer composites that can be incorporated into concrete. This innovative method of utilizing plastic waste can significantly contribute to the strengthening of concrete structures.

Specifically, incorporating plastic straw fibre-reinforced polymer composites in concrete has been proven to enhance its mechanical properties. These composites have demonstrated acceptable levels of strength and ductility, making them ideal for concrete strengthening purposes. Not only do they improve the overall strength of concrete, but they also increase its ductility performance.

Recent research has also shown that the addition of plastic, including plastic straws, in reinforced concrete yields

better strength compared to traditional methods. This finding highlights the effectiveness and reliability of using plastic mixed reinforced concrete in various applications. Additionally, extensive investigations have been conducted on the behaviour of compression members with different proportions of plastic waste.

In conclusion, our revolutionary Waste Management Solution offers a sustainable approach to managing plastic waste while simultaneously enhancing the strength and durability of concrete structures. The incorporation of plastic straws into fibre-reinforced polymer composites proves to be a promising solution for improving the overall performance of concrete and reducing environmental impact.

III. PROBLEM IDENTIFICATION

Street and coconut vendors play a crucial role in our daily lives, serving as a vital link between affordability and necessity. However, these hardworking individuals are often unfairly blamed for the plastic waste in our country. Despite making up just 2.5% of the urban population, they cater to the daily needs of over 377 million Indians in urban areas. Despite their significant contributions, street vendors face numerous challenges such as encroachment, littering, and lack of social security.

The recently implemented single-use plastic (SUP) ban on July 1st, 2022 disproportionately affects these street vendors while favouring larger businesses. The ban only covers 19 specific items including disposable plastic food ware, plastic sticks and flags, sweet box covers, earbuds, thin plastic carry bags, and straws.

Despite the implementation still there is use of above items which leads to polluting our environment.



Fig.1. Scattered Plastic Straws Near Vendor.

The use of plastic straw is been practiced after the ban. So, the waste generated from the above issues will be used in concrete, minimize the plastic pollution.

IV. LITERATURE SURVEY

Kandasamy and Murugesan (2011) used plastic cups as fiber. Two mixes were considered; a normal mix without fiber, and a mix with 0.5% of added fibers by weight of cement. It was found that there is enhancement in both compressive strength and tensile strength in the presence of fibers.[2]

Batayneh et al. (2006) evaluated the possibility of using waste plastic bottles and granulated plastic waste in concrete. The fiber addition ranged from 0% to 2% by volume of concrete. The results show that there is a decrease in slump and compaction factor when fibers are present in the concrete. The higher the content of the fiber the larger the reduction in slump and compaction factors.[3]

Belarbi and Acun (2013) examined the effect of incorporating fibers on the compressive and tensile strength of concrete. The reading was noted at the time of first crack and at the time of failure. The required quantity of ingredients was weighed and were prepared cylinders with the help of molds and cured for 7 days and 28 days. It is found that the compressive strength is increased while placing only the fiber. The split tensile strength has been increased while using plastic fiber sheet at the outer side of the specimen.[4]

Ahmed et al. (2016) studied the effect of different addition of waste plastic fibers addition on the strength properties of concrete. Generally, the compressive, tensile and flexural strength were found to increase as the percentage of fibers increased from 0% to 3%. The increase in compressive strength was about 13% whereas the increase in tensile strength and flexural strength was 38% and 68% respectively when adding more fibers to the concrete.[5]

Jones (1974) compared the compressive and flexural strength of concrete with and without asbestos fibers at different curing periods. They found that increasing the number of fibers up to a certain level led to an increase in both compressive and flexural strength at all curing ages. However, beyond that level, no further increase in strength was noticed.

V. EXPERIMENTAL WORK

A. Mix Design

Two trial mixes (Normal without fibre & with fibre) were prepared in this experiment as an attempt to get on the perfect mixture with good workability and compressive strength equal to (20) MPa at 28 days. The mix proportions of the chosen mixture are (1:1.5:3) by weight, where the water-cement ratio (W/C) is 0.45. The specific gravity of coarse and fine aggregate were 1700 kg /m³ and 2650 kg /m³ respectively. Plastic straws were cut to a size of 3mm as shown in Figure (2). The admixture used is a superplasticizer (Fosroc Auramix 400) as shown in Figure (3), added in the mix of concrete having fibre. So, using the single percentage and along with the comparison of single percentage with the control mix that does not contain any fibers will allow us to compare in a very detailed way. All the data are listed in Table (1).

Table 1: Mixing quantities of the fibre concrete sample.

Sr. No	Cement (Kg)	Sand (Kg)	Water (Kg)	Gravel (Kg)	Straw (Kg)	Admixture (Kg)
1	11.916	32.6	7.440	44.095	0	0
2	11.916	32.6	7.440	44.095	.120	.096



Fig.2. Fosroc Auramix 400



Fig.3. Straw Cuts

B. Mixing Procedure

After preparing all the quantities needed, mix concrete in a suitable mixer as shown in Figure (4), or by hand in batches of such size as to leave about 10 % excess after molding the test specimens. The mixing procedure will be

as required by (IS 456: 2000). The cubes of 15 cm in size were cast in three layers. Each layer was compacted 35 times using a tamping rod, by hand. The slump value of the control mix (i.e. 0% fibers) was 1.1 cm. This value decreased to 1 cm for mixes with 0.1%. 9 cube samples were cast and tested under compressive strength at 7, 14 & 28 days respectively. Curing of concrete is done in the control of moisture content and temperature of concrete. Which is maintained by providing it with water from external sources as shown in Figure (7).



Fig.4. Concrete Mixer



Fig.5. Compacting Using Tamping Rod



Fig.6. Cube Samples in Mold



Fig.7. Curing the samples

C. Compressive Strength test on Concrete

The compressive strength of concrete cubes is determined according to the Indian Standard of Testing Materials by applying a compressive axial load until failure occurs (IS 516:Part 1/Sec-1 :2021). The test is conducted on a compression-testing machine.



Fig.8. Sample Under Compressive Strength test

D. Result and Discussion

Figure 8 shows that using Straws as fibers in concrete mixes of its compressive strength some what same in its initial 7 & 14 days and at 28 days there is slightly decreased strength compared to the sample which does not contain straws. We achieve the 28 days strength required to M20 grade concrete. Figures 10 and 11 shows the damaged cubes for both sample 1 and sample 2 respectively.

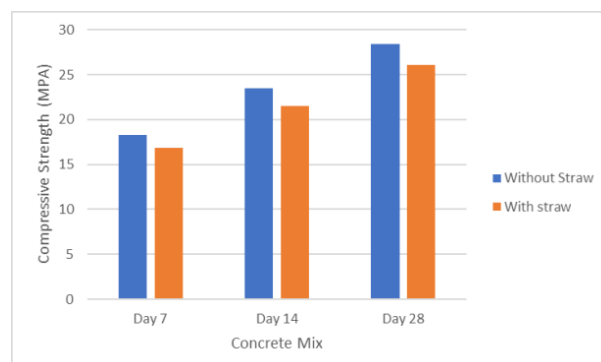


Fig.9. Compressive Strength of Sample 1 & Sample 2



Fig.10. Damaged Cube (Sample 1)



Fig.11. Damaged Cube (Sample 2)

Table 2: Compressive Strength of two samples in MPA

Age (Days)	Sample 1 (Without Straw)	Sample 2 (With Straw)
7	18.31	16.86
14	23.50	21.53
28	28.46	26.10

E. Conclusion

This study aimed to use the waste plastic straw in concrete and effectively dispose of the straw waste or the plastic waste. Though the awareness has been created still use of plastic straw is in practice, even it is ban still local vendors are using and other related business are in practice. To overcome the issues of plastic waste (straw), we tried to dispose the waste in concrete and performed the procedure on it. We found out that the compressive strength has been achieved as per IS on the 28 days with the straws used in the concrete. In small quantity but large impact will be seen if this process is carried for road concrete projects.

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