

Praxis Natural Fiber for Enhancing Concrete Properties: Coconut Fiber

Ms. Sakshi Nagesh Kanade¹, Ms. Pranali Prabhakar Keni², Ms. Priya Pramod Mhatre³,
Ms. Pradnya Prakash Jadhav⁴, Prof. Khultej Hiralal Gurav⁵, Prof. Padmakar Jagannathrao Salunke⁶
U.G. Student, Department of Civil Engineering, MGM CET, Kamothe, Navi Mumbai, India^{1,2,3,4}
Assistant Professor, Department of Civil Engineering, MGM CET, Kamothe, Navi Mumbai, India⁵
Head of Department, Department of Civil Engineering, MGM CET, Kamothe, Navi Mumbai India⁶

ABSTRACT: In this 21st century concrete with higher mechanical properties plays an important role, which is need to use various kind of fibre like steel, glass, carbon, etc. There are few natural fibres available on which studies has shown enhancement of concrete properties. In this paper we have used natural fibre that is Coconut Fibre. To study the effect of optimum dosage on concrete properties in economical point of view we have casted 90 numbers of specimen and performed Compressive, Split tensile, & Flexural test for 3,7 & 28 days using 2%, 2.5%, 3%, 3.5%, & 4% of coconut fibre by addition according to cementitious material.

It is found that with the increase in percentage of fibre the strength also increases. The optimum dosage lies between 2.5% to 3.5%. To achieve the constant slump for all the mixes the admixture dosage was increased by 0.05% with every addition of 0.5% of coconut fibre whereas the compressive strength with the optimum dosage increase the strength by 10-13%, split tensile strength by 25-50% & flexural strength by 30-40% at 28 days.

KEYWORDS: Natural fiber, coconut fiber, fiber reinforced concrete etc.

I. INTRODUCTION

Fibre is a thread or filament which is used to enhance the properties of concrete. Fibre can be distinguished in two types that are Artificial and Natural fibre. The artificial fibre is steel, glass, asbestos, polypropylene, carbon, etc & the natural fibre are sugarcane, banana, sisal, coconut, etc which are now-a-days used for study to enhance the concrete property. Coconut fibre is a natural fibre extracted from outer husk of coconut which is thick and coarse but durable. Though coconut fibre is a waste material which can be utilized as fibre in fibre reinforced concrete with the use of coconut fibre the wastage will be reduced and also it is economical and non-degradable. The coconut fibre has various applications like insulation, erosion control, agricultural, netting, matting, etc. Composite material consisting of mixture of cement, mortar or concrete. The formation of intrinsic cracking in concrete thus ensuring a most durable concrete construction can be inhabits and control by fiber.

According to official website of International Year for Natural Fiber approximately, 500000 tonnes of coconut fiber are produced annually worldwide, mainly in India and Sri Lanka. India and Sri Lanka are also the main exporters, followed by Thailand, Vietnam, the Philippines and Indonesia. Around half of the coconut fiber produced is exported in the form of raw fiber.

There are many general advantages of coconut fiber. e.g. they are moth-proof, resistant to fungi and rot, provide excellent insulation against temperature and sound, not easily combustible, flame-retardant, unaffected by moisture and dampness, tough and durable, resilient, springs back to shape even after constant use, totally static free and easy to clean^[1]

From last two decades the researches are done on artificial fibre and only few studies have been done on natural fibre that is coconut fibre thus we have selected a coconut fibre because it enhances the engineering property^[6]. Different type of artificial and natural fiber classification and the images of various fiber showing in Fig. 1. (a) and (b).

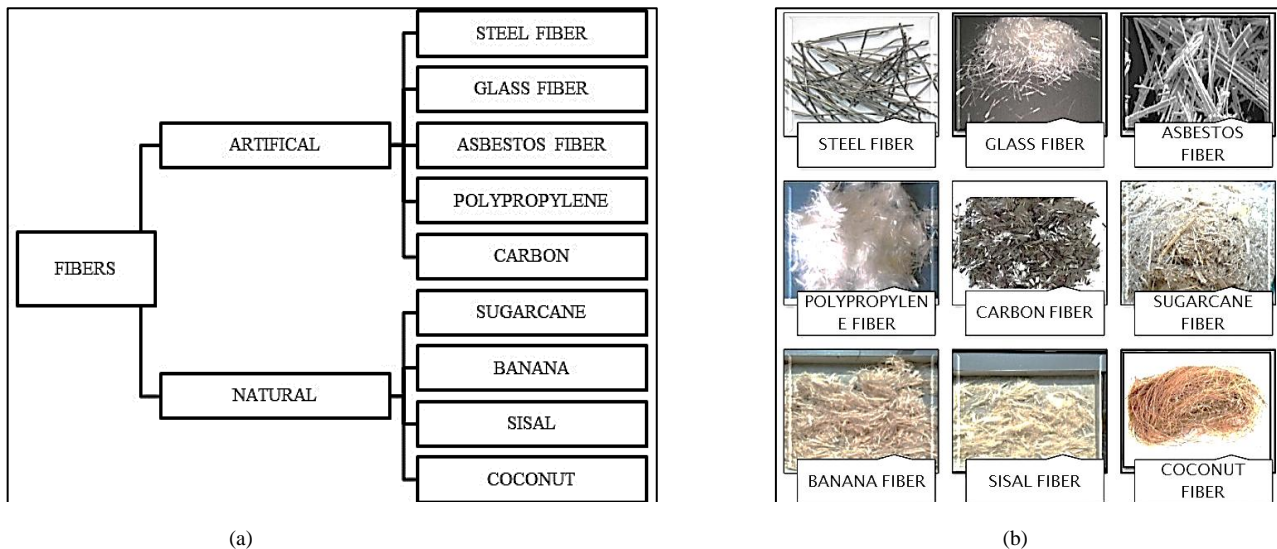


Fig 1 : (a) Classification of fiber (b) Types of fiber

II. LITERATURE SURVEY

Total 25 research papers were studied for knowing the application scenario of different type of fiber used in concrete out of which few literature observations and summary is mentioned below accordingly the methodology is fixed for conducting further studies for this project.

1. M.A.OthumanMydin, *et. al.* (2014)- These researchers describes experimental studies on the use of coconut coir fiber as mechanical properties enhancement of foamed concrete which focuses on three parameters which are compressive strength, flexural strength, splitting tensile strength with different percentage of coconut fiber (0, 0.2, 0.4). Light weight foamed concrete mix added with 0.4% CF shows the highest strength compared to other mixes. They have also conducted SEM analysis for 0.4% CF which shows the small size and number of pores that increase the bonding in cement paste.
2. J. Sahaya Ruben, *et. al.* (2014)- In their experimental study 28 days the compressive strength and split tensile strength are carried out using different coir length of 20mm, 25mm, 30mm respectively of different percentage as 0.5%, 0.75%, 1%. The strength gradually increased upto 0.75% of coir fiber than the strength is decreased. The maximum compressive strength is achieved using 25mm length fiber with 0.75% addition of fiber length.
3. Rajan Shikha, *et. al.* (2015)- These researchers describe the behavioural study of coconut fiber in concrete structure. Addition of coconut fiber improves the various engineering properties like compressive strength, flexural strength, split tensile strength of concrete and also improves good binding property. Coir fiber is treated as natural latex before using it. So that it is not affected by moisture in concrete. Their study found optimum fiber content to be 1%, 2%, 3% (by weight of cement). 27 cubes were casted of M25 and M30 grade concrete and kept for 7, 14, 28 days curing. They found that flexural strength increases in case of 3% fiber mix. Since 1% and 3% do not show favourable results. They have concluded that fiber content should not be used beyond 3%.
4. SoumenSantra, *et. al.* (2016)- In their experimental study the influence of 1%, 2%, 3% fiber content by mass of cement and fiber lengths of 2.5, 5, 7.5 is investigated. The addition of coconut fiber improved the flexural strength of concrete by about 12%, they also formed good bonding in concrete. The study found the optimum fiber content to be 3%. It was found that the result does not improve by addition of fibers beyond 5% of the weight of cement in the mix. Hence the optimum increase in the strength of the concrete by addition of fibers lies between 0% and 3% of the weight of cement in the mix.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 2, February 2020

- Ajay Kumar, *et. al*, (2018)- In their experimental investigation natural sand is replaced by foundry sand. This material has been used as replacement in 20%, 30%, 40% initially. They had also added 3% of coconut fiber by the weight of cement in each mix. Their research describes experimental studies on the use of coconut fiber to enhance the tensile property in concrete. Concrete acquires increase in compressive strength at 30% replacement of mix M4 (70% Natural Sand+30% Foundry Sand) and M5 (70% Natural Sand+30% Foundry Sand+3% Coconut Fiber) by 0%, 2% at 7 days and 28 days. In flexural strength increases at 40% replacement for mix M6 (60% Natural Sand+40% Foundry Sand) and M7 (60% Natural Sand+40% Foundry Sand+3% Coconut fiber) at 7 days and 28 days.

The literature studies are summarized as follows.

- In the all research paper it is found that optimum % of fiber used to be 3%-4% by the weight of cement
- It is observed that beyond 3% of addition of coconut fibre the concrete properties gradually decreased
- Coconut fiber is added in concrete without any replacement of concrete material i.e. cement and aggregate.
- In all, flexure strength is increased more by 30-40%; split tensile strength is also increased as compared to compressive strength

III. METHODOLOGY

This paper consist of experimental work in which 5 combination and one conventional mix is performed. Table no 3 indicate the code and percentage of fibers used in concrete. Overall 90 numbers of specimens was casted in which 54 numbers of cubes (150mmx150mmx150mm), 18 numbers of cylinder(150mmx300mm), 18 numbers of beams(150mmx150mmx700mm) tested for compressive strength (3days, 7days and 28days), split tensile strength (28 days) an flexural strength (28 days) respectively.

Coconut fiber is different from the other natural fiber because of the following physical and chemical properties mentioned in table no 1 and table no 2 respectively. Following are the properties of material used for fiber reinforced concrete:

- Cement : OPC 53 (Ambuja Cements Ltd.)
- Flyash : Dirk India Pvt Ltd,
- Fine Aggregate : Zone 1, Sp.gr 2.7
- Coarse Aggregate : 20mm, Sp.gr 2.72

Parameter	Values	Unit
Length	150-200	mm
Density	1.45	gm/cc
Tenacity	10	gm/Tex
Breaking Elongation	30-35	%
Diameter	0.15 - 1.25	mm
Rigidity of modulus	1.905	dyne/cm ²
Swelling in water	5-7	%
Moisture at 65% of RH	10-13%	%

Table no 1: Physical properties of coconut fiber

Name of Compound	Percentage (%)
Lignin	48.37
cellulose	44.93
Hemicellulose	0.3
Pectin and related to compound	0.35
Water soluble	5-10
Ash	2.3

Table no 2: Chemical properties of coconut fiber

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 2, February 2020

code	CM	CF2	CF2.5	CF3	CF3.5	CF4
Coconut Fiber %	0	2	2.5	3	3.5	4

Table no 3: code and percentage of fibers used in concrete

Indian standard method (IS 10262:2019) was adopted to find the proportion of concrete ingredients for M20 grade of concrete. Table no 4 shows the quantity of concrete ingredients per cum for all combinations.

CODE	CM	CF2	CF2.5	CF3	CF3.5	CF4
OPC	320.00	320.00	320.00	320.00	320.00	320.00
FLYASH	80.00	80.00	80.00	80.00	80.00	80.00
COCONUT FIBER	0.00	8.00	10.00	12.00	14.00	16.00
FINE AGG.	736.00	736.00	736.00	736.00	736.00	736.00
CAI	515.20	515.20	515.20	515.20	515.20	515.20
CAII	588.80	588.80	588.80	588.80	588.80	588.80
WATER	180.00	180.00	180.00	180.00	180.00	180.00
ADMIXTURE	4.00	4.40	4.60	4.80	5.00	5.20

Table no 4:Quantity of material per cum



Fig. 2.(a) Preparation of fiber(b) Weighing of fiber(c) Slump cone test(d) Testing of cube (e) soaking of fiber (f) measuring slump cone (g) measuring the slump cone (h) casting of cubes

IV. EXPERIMENTAL RESULTS AND DISCUSSION

Results obtained from concrete testing are represented in graphical format in following graphical figures.

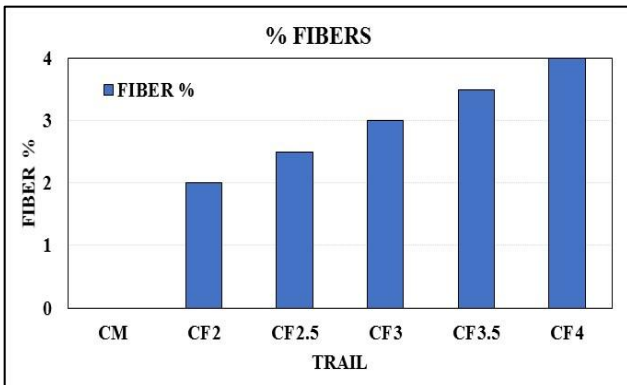


Fig. 2. Percentage of Coconut Fiber

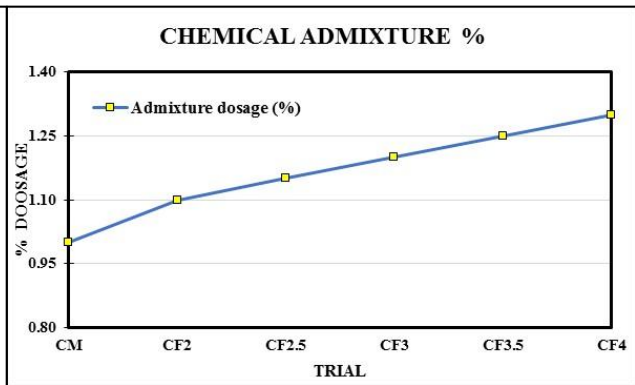


Fig. 3. Dosage of chemical admixture

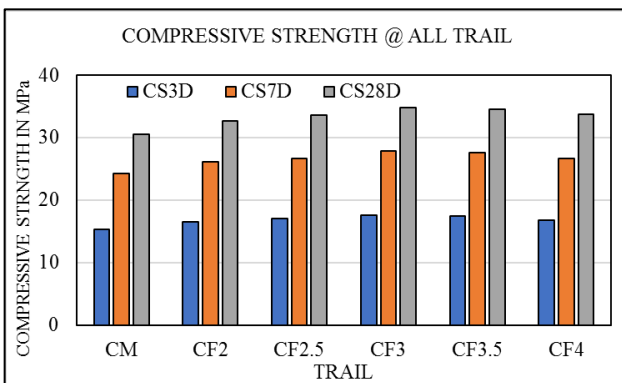


Fig. 4. Compressive strength at all trails

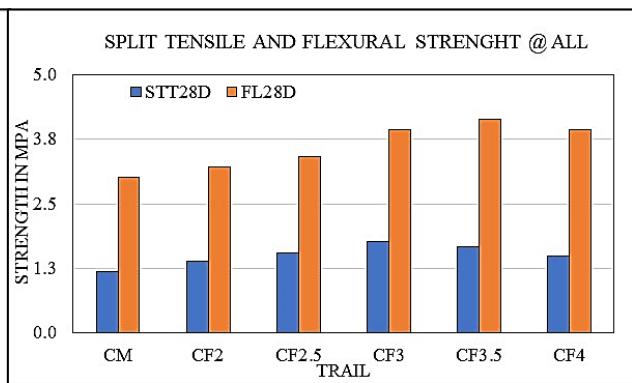


Fig. 5. Split tensile and flexure strength at all trails

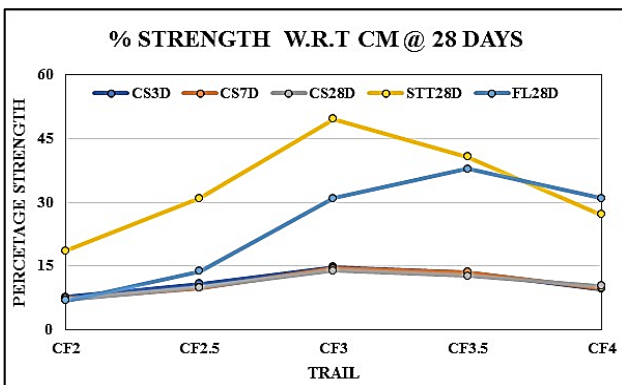


Fig. 6. Percentage w.r.t conventional mix at 28 days

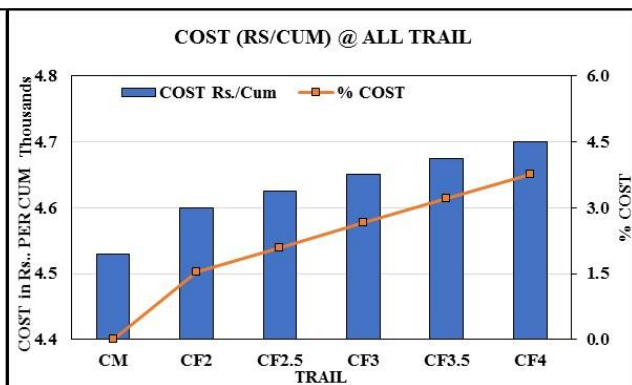


Fig. 7. Cost (RS/CUM) at all trails

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 2, February 2020

A. COMPRESSIVE STRENGTH 3 DAYS

From Fig no. 4. and Fig no. 6

- With the use of 2%, 2.5%, 3%, 3.5% & 4% fibres, the compressive strength of concrete found to be increased by 7.7%, 10.8%, 14.9%, 13.6% & 9.7% respectively when compared with conventional mix
- The strength found to be 15.3, 16.5, 17, 17.6, 17.4 & 16.8 MPa with the addition of 0%, 2%, 2.5%, 3%, 3.5% & 4%.
- The addition of 3% fibre the maximum compressive strength found to be 17.6 MPa at 3 days.
- With the 3% of fibre strength development is better while at 4%, strength dropped about 5.2% compared to 3% of addition of fibre.

B. COMPRESSIVE STRENGTH 7 DAYS

From Fig no. 4. and Fig no. 6

- With the use of 2%, 2.5%, 3%, 3.5% & 4% fibres, the compressive strength of concrete found to be increased by 5.9%, 10%, 12.6%, 14.3% & 12.4% respectively when compared with conventional mix
- The strength achieved is 24.3, 25.7, 26.7, 27.4, 27.8, 27.3 MPa with the addition of 0%, 2%, 2.5%, 3%, 3.5% & 4%.
- The addition of 3.5% fibre gives maximum compressive strength which found to be 27.8 MPa at 7 days.
- At the 3.5% of fibre concrete strength is increased and reduces at 4% about 3.7% when compared with 3% of addition of fibre.

C. COMPRESSIVE STRENGTH 28 DAYS

From Fig no.4. and Fig no. 6

- With the use of 0%, 2%, 2.5%, 3%, 3.5% & 4% of fiber the strength increased by 7.0% 9.9%, 13.9%, 12.7%, and 10.3% of fiber when compared with conventional mix.
- The strength found to be 30.6, 32.7, 33.6, 34.8, 34.5, 33.7 MPa with the addition of 0%, 2%, 2.5%, 3%, 3.5% & 4% of coconut fiber.
- At 28 days the maximum strength is 34.8 MPa with addition of 3% fiber was observed.
- At 3% fiber concrete strength is increased by 13.9% and at 4% it is decreased by 10.3% when compared with 3%.

D. SPLIT TENSILE STRENGTH 28 DAYS

From Fig no. 5. and Fig no. 6

- With the use of 2%, 2.5%, 3%, 3.5% & 4% of fiber the split tensile strength was found to be 1.2, 1.4, 1.5, 1.8, 1.7, 1.5 MPa respectively at 28 days.
- With the use of 2%, 2.5%, 3%, 3.5% & 4% fibres, the tensile strength of concrete found to be increased by 18.3%, 30.7%, 49.4%, 40.6% & 26.7%, respectively when compared with conventional concrete.
- It was found that the split tensile strength is highest with addition of 3% fiber i.e. 1.8 MPa.
- At 4% the strength is 1.5 MPa & at 3% it is 1.8 MPa, thus it is observed that at 4% the split tensile strength has reduced by 22.7% compared to 3% addition of fiber.

E. FLEXURE STRENGTH 28 DAYS

From Fig. no. 5. and Fig no. 6

- With the use of 2%, 2.5%, 3%, 3.5% & 4% fibres, the flexure strength of concrete used to be 6.9%, 13.8%, 31.0%, 37.9% and 31% respectively when compared with conventional mix
- The strength found to be 3, 3.2, 3.4, 3.9, 4.1 & 3.9 MPa with addition 0%, 2%, 2.5%, 3%, 3.5% & 4%.
- With the addition of 3.5% fiber the strength is found maximum i.e. 4.1 MPa at 28 days.
- With the 3.5% of fiber strength is maximum but at 4% it is decreased about 6.9% when compared with 3.5% addition of fiber.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 2, February 2020

F. COSTING

From Fig. no. 7.

- The cost of per cubic meter of concrete of M20 concrete grade with addition of 0%, 2%, 2.5%, 3%, 3.5% & 4% is Rs. 4530, Rs. 4600, Rs. 4650, Rs. 4675, Rs. 4700 respectively.
- With the addition of 3% & 3.5% all the strength is on higher side and the cost is relatively same i.e. difference between 3% and 3.5% addition of fiber Rs. 25 per cum.
- The cost of 1 cum of concrete cost is increased by 1.5%, 2.1%, 2.6%, 3.2% and 3.8% when compared with conventional mix.

V. CONCLUSION

It was observed with addition of coconut fiber the workability of concrete decreases, but the mix gets more cohesive. To achieve the constant slump for all the mixes the admixture dosage was increased by 0.05% with every addition of 0.5% of coconut fiber. At 28 days the maximum compressive strength & split tensile strength is maximum with addition of 3% of fiber whereas flexure strength found be higher with the 3.5% of fiber strength. With the increasing % of fiber above 3% the strength decreases as there is low gaining of strength even after curing for more days under constant water content because thixotropy reaction take place due to close placing of fiber.

ACKNOWLEDGMENT

We beholden to Mr. Shrikant Varpe (Deputy General Manager, M/s Square Constructions, Mumbai) for explaining to us the diverse facts of the experimental work involved in our present study. The experimental work of such an extent is not possible without the active help of the technical supporting staff, Attendant of the Global Concrete Laboratory, there support is deeply acknowledged.

REFERENCES

- [1] M. A. OthumanMydin, N.A. Rozlan, S. Ganesan, "Experimental study on the mechanical properties of coconut fiber reinforced lightweight foamed concrete", JMES (2015).
- [2] J. Sahaya Ruben, Dr.G.Baskar, "Experimental study of coir fiber as concrete reinforcement material incement based composites", IJERA-International journal of engineering and research and applications, Volume 4, Issue 1 (2014).
- [3] RajanSikha, Saxena A. K., Jha A. K., "Evaluation of compressive strength of concrete using coconut coir fiber", IJRASET-International journal of research in applied science & engineering technology, volume 3, Issue IX. (2015).
- [4] SoumenSantra, Jaydeep Chowdhury, "A comparative study on strength of conventional concrete and coconut fiber reinforced concrete", IJSER-International journal of scientific & engineering research, Volume 7, Issue 4 (2016).
- [5] Ajay Kumar, Bharath, Malik Bashas, Nagaraj S Mahajanshettar, Yogesh N R, D S Maganur, B Shivakumar, "The mechanical properties of coconut fiber reinforced concrete with foundry sand as a partial replacement of fine aggregate", IJRSET- International journal of innovative research in science, engineering and technology, Volume 7, Issue 5 (2018).
- [6] Majid Ali, "Coconut Fiber- A versatile material and its applications in engineering" University Politecnica DELLE Marche, Ancona, Italy, ISBN 978-1-4507-1490-7, www.claissse.info/Proceedings.htm (2010).
- [7] Aditya Tom, "Coconut fiber reinforced concrete", ResearchGate, DOI:10.13140/RG.2.1.3699.1522, ww.researchgate.net/publication/275407239 (2015).
- [8] Anoop Singh Chandel, Tanmay Shah, Tarak Shah, Dixit Varde, "A comparative strength study of coir fiber reinforced concrete (CFRC) over plain cement concrete (PCC)", Volume 13, PP 101-103. (2016)
- [9] Kshitija Nadgouda, "Coconut Fiber Reinforced Concrete", IJMAPE- International journal of mechanical & production engineering, volume 3, Issue 1 (2015).
- [10] Raphael Chacko, S Hema and M Vadivel "Experimental studies on coconut fiber and banana fiber reinforced concrete", ISSN 0974-5904, volume 09, No. 03, (2016).
- [11] Sanjay Kumar Yadav, Avinash Singh, "An experimental study on Coconut fiber reinforced concrete", IRJET-International journal of research in engineering and technology, volume 6, Issue 05, (2019).
- [12] Syed Intikhab Zia, "Use of coconut fiber concrete", IRJET-International journal of research in engineering and technology, volume 2, Issue 6 (2015).
- [13] V. Sai. Uday, B.A. jitha, "Concrete reinforced with coconut fiber", Research article, volume 7, Issue No.4 (2017).
- [14] Yalley, P. P. and Kwan, A. S K., "Use of coconut fibers as an enhancement of concrete." Journal of Engineering and Technology 3, Pages 54-73 (2009).
- [15] C. Kodiarasan, K Janarthanan, P Dinesh and Ramesh Kumar G. B.3, JCEET-Journal of civil engineering and environmental technology, Volume 3, Issue 7 (2016).
- [16] Bamigboye Gideon Olukunle, "Data on acoustic behavior of coconut fiber reinforced concrete", ELSEVIER (2018).
- [17] Shreeshaail B.H, Jaydeep Chougale, Dhanraj Pimple, Amar kulkarni, "Effects of coconut fibers on the properties of concrete", IJRET-International journal of research in engineering and technology, Volume 3, Issue 2 (2014).
- [18] Nithin Sam, Sheeja M K, "Durability study on coir fiber reinforced concrete", IJERT-International journal of engineering research and technology, Volume 5, (2016).

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 2, February 2020

- [19] Abhijit. R. Agrawal, Sanket S. Dhase, KautukS.Agrawal, "Coconut fiber in concrete to enhance its strength and making lightweight concrete" IJERD- International journal of engineering research and development, Volume 9, Issue 8, PP. 64-67 (2014).
- [20] Abdul Nazeer, "To study the mechanical properties of coconut coir fiber reinforced with epoxy resin AW 106 & HV 953 IN", IJMER-International journal of modern engineering research, Volume 4, Issue No.7 (2014).
- [21] Kavitha S, Dr.T Felix Kala, "A review on natural fibres in concrete", IJAET-International journal of advanced engineering & technology , Volume 1, Issue No.1 (2017).
- [22] Parmeshwar lalSahu, Pankaj Baghmare, Suryakant Pandey, "Use of coconut fiber in fibre reinforced concrete", IJAERD- International journal of advance engineering and research development (2017).
- [23] P. Purnachandrasai, K Murali, G sravan Kumar, K varunTeja, "Study on properties of natural fiber reinforced concrete made with coconut shells and coir fibre", IJCIET-International journal of civil engineering & technology , Volume 9, Issue 1 (2018).
- [24] AnandhSekar , Gunasekaran kandasamy, " Optimization of coconut fiber in coconut shell concrete and its mechanical and bond properties" MDPI,doi:10.3390/ma11091726(2018).
- [25] G.A.P Gampathi, "Application of coconut fibre in cement block industry", OIDA International Journal of sustainable Development, ISSN no 1923-6654 (2011).
- [26] Damre Shraddha, FirakeHitali, Dode Pradeep, Shrikant Varpe, "Sustainable concrete by partially replacing coarse aggregate using coconut shell", Journal on Today's Ideas Tommorrow's Technologies, Vol.2, No.1, pp. 1-14 (2014).

BIOGRAPHY



Ms. Sakshi Nagesh Kanade, D.C.E (Swami Vivekananda Institute of Polytechnic, Latur), U.G. Student, Department of Civil Engineering, MGM CET, Kamothe, Navi Mumbai, India.



Ms. Pranali Prabhakar Keni, D.C.E (NJBSPM's Shantiniketan Polytechnic, New Panvel), U.G. Student, Department of Civil Engineering, MGM CET, Kamothe, Navi Mumbai, India.



Ms. Priya Pramod Mhatre, D.C.E (Government Polytechnic, Pen), U.G. Student, Department of Civil Engineering, MGM CET, Kamothe, Navi Mumbai, India.



Ms. Pradnya Prakash Jadhav, D.C.E (Fr. Angel Polytechnic, Vashi), U.G. Student, Department of Civil Engineering, MGM CET, Kamothe, Navi Mumbai, India.



Prof. Khultej Hiralal Gurav, (Assistant Professor), M.E (Construction Management - NMU Jalgaon, 2016), Date of Joining: 07/07/2017, E-mail Id: khultejgurav1993@gmail.com.



Prof. Padmakar Jagannathrao Salunke, (Head), M.E. (Environmental Engineering - DR. Bamu, Aurangabad, 1995), Date of Joining: 31-08-1990, E-mail Id: salunke_pad@yahoo.co.in.