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An Advancement in Partial Replacement of Cement with Nylon Crystal to Improve Concrete Properties

B.Mahesh Babu[1] | Dr.K.Chandramouli[2]

[1]PG Scholar, Structural Engineering, NRI Institute of Technology, Guntur, Andhra Pradesh, India.
[2]Professor & Head, Department of Civil Engineering, NRI Institute of Technology, Guntur, Andhra Pradesh, India.

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ABSTRACT

Concrete has occupied an important place in construction industry in the past few decades and it is used widely in all types of constructions ranging from small buildings to large infrastructural dams or reservoirs. Cement is major ingredient of concrete. The cost of cement is increasing day by day due to its limited availability and large demand. In the present study an attempt been made on concrete and also an experimental investigation on the concrete using Nylon Crystal.Experimental studies were performed on plain cement concrete and replacement of cement with Nylon crystal is done. In this study the concrete mix were prepared by using Nylon crystal from 1% to soon by weight of cement were added partially to the mixes. A comparative analysis has been carried out for concrete to that of the Nylon crystal reinforced concrete in relation to their compressive strength, split tension strength and flexural strength properties. The concrete made with Nylon crystal performed well in terms of compressive strength, split tension strength and flexural strength showed higher performance at the age of 7, 28, 60 and 90 days than conventional concrete. And also Bond Strength by using cylinders and two different types of acid attack is done to determine the Bond Strength and compressive strength both on conventional concrete and Nylon crystal reinforced concrete. Keywords: Acid Attack, Bond Strength, Compressive strength, Flexural strength, Nylon crystal, Split Tensile strength.

KEYWORDS: *Concrete, Construction, Nylon Crystal, Reinforced Concrete, Compressive strength*

I. INTRODUCTION

The availability of natural resources for the production in construction industrial is decreasing day to day from the past few decades . The increase in productivity in construction industry results in the depletion of natural resources and release of waste. Many industries are releasing the industrial waste without pre treatment into the atmosphere. Replacement of coarse aggregate and fine aggregate in concrete by waste material can decline the environmental degradation. .The coarse aggregate occupies 60-70% of the concrete volume. The rheological and mechanical properties of the aggregate play a vital role in concrete structures. Replacement of concrete in percentages of volume by waste material exhibiting similar properties to that of coarse aggregate can save natural resources. Some of the .Development of composite concretes using various admixtures increased the strength properties. The utilization of the waste materials reduces the density of the concrete. Different experimental methods has to be improved to replace the coarse aggregates or fine aggregates to improve strength parameters of the concrete in a more innovative way the increase in population

density in India stood second position among world population has rapid growth in construction industry result in increase of infra structures of ingredients

In the present study the partial replacement of cement with nylon crystals and different experiments have done to examine physical properties of concrete with nylon crystal as an ingredient .

II. Experimental tests on the materials

A. Cement

Table 1 Physical properties of cement

S.NO	Properties	Test Values	Standard Values (IS)
1	Specific gravity	2.68	
2	Fineness (%)	3.1	< 10
3	Initial setting time (min)	152	>30
4	Final setting time(min)	225	<600

B. Fine Aggregate

Table 2 Physical Properties of fine aggregate

S.NO	PROPERTY	VALUES
1	Specific gravity	2.5
2	Bulk density i) Loose state ii) Compacted state	 1535.42 kg/m³ 1685.56 kg/m³
3	Fineness modulus	2.327

C. Coarse Aggregate

Table 3 Physical properties of coarse aggregate

S. NO	PROPERTY	VALVES
1	Specific gravity for 20mm size	2.6
2	Specific gravity for 10mm size	2.71
3	Bulk density i) Loose state ii) Compacted state	 1528.37kg/m³ 1854.15kg/m³
4	Impact valve	15.1%
5	Crushing valve	19.35%
6	Elongation index	21.13%
7	Water absorption	0.81%
8	Fineness modulus	8.32

D. Super Plasticizer

The effect of Conplast SP430 on workability is:

- Appearance: Greenish Blue
- Specific Gravity: 1.128 at 250C
- Viscosity:1.39 cP at 250C

III. Nylon crystal

As per my investigation, Nylon is a strongest crystal fibre and it have good abrasion resistance. Generally Nylon crystals are in Octagonal shape which is made by Polymer and Wax on melt spinning machine.

Figure 1 Nylon Crystal

A. Experimental Tests on Concrete

Fresh Concrete Tests

For -determining the self-compatibility properties (slump flow, T50 time, V-funnel flow time, L-box blocking ratio) tests were performed on all the mixtures. The order of testing was

(a) Slump flow test

It is a test to assess the flow ability and the flow rate of SCC in the absence of obstructions.. The result is an indication of the tilling ability of SCC, and the T50 time is a measure of the speed of flow and hence the viscosity. The fresh concrete is poured into a cone. When the cone is upwards the time from commencing upward movement the cone to when the concrete has flowed to a diameter of 500 mm is measured; this is the T50 time. The largest diameter of the slow spread of the concrete and the diameter of the spread at right angles to it are then measured and the mean is the slump-flow.

Table 4 Fresh properties of the concrete.

MIX NOTATIONS	T 50 (s)	Slump Flow Value (MM)
C.C	6	118
C.C+1% NC	6	115
C.C+2% NC	6	113
C.C+3% NC	6	112
C.C+4% NC	5	109
C.C+5% NC	5	108
C.C+6% NC	5	107
C.C+7% NC	5	106

6.2 HARDENED CONCRETE TESTS

(a) Compression Strength

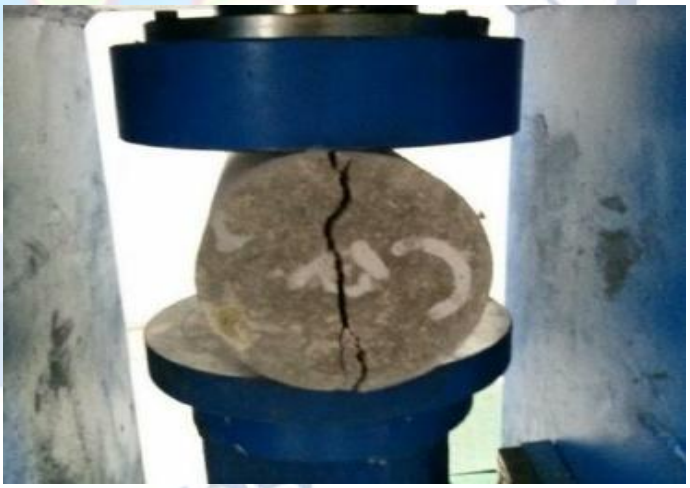
The compressive strength of cube and cylinder was obtained, at a loading rate of 2.5kN/s at the age of 7 and 28 days on 3000kN machine. The average compressive strength of three specimens was considered for each age. The split tensile strength was also tested on the same machine at the age of 7 and 28 days.

(b) Split Tensile Strength Test

The tensile strength of concrete is much lower than the compressive strength, and is usually not considered in design (it is often assumed to be zero) (Neville, 1971). However, it is an important property, since cracking in concrete is most generally due to the tensile stresses that occur under load, or due to environmental changes. In general a compressive force is applied to a concrete specimen in such a way that the specimen fails due to tensile stresses developed in the specimen. The tensile stress at which the failure occurs is termed the tensile strength of concrete. The splitting tests are well known indirect tests used for determining the tensile strength of concrete sometimes referred to as split tensile strength of concrete. The test consists of applying a compressive line load along the opposite generators of a concrete cylinder placed with its axis horizontal between the compressive plates. Due to the cpmpression loading a fairly uniform tensile stress is developed over nearly 2/3 of the loaded diameter as obtained from an elastic analysis.

Split Tensile Strength $= \frac{2P}{\Pi dl}$

Where, P is the fracture compression acting along the cylinder, d is the diameter of the cylinder.
L is the length of the cylinder



(C) Flexural strength Test:

For this test the beams of dimension 100mmX100mmX500mm were casted. Flexural strength, also known as modulus of rupture, bend strength, or fracture strength [dubious – discuss] a mechanical parameter for brittle material, is defined as a material's ability to resist deformation under load. The transverse bending test is most frequently employed, in which a rod specimen having either a circular or rectangular

cross-section is bent until fracture using a three point flexural test technique. The flexural strength represents the highest stress experienced within the material at its moment of rupture. The beam tests are found to be dependable to measure flexural strength. The value of the modulus of rupture depends on the dimensions of the beam and manner of loading. In this investigation, to find the flexural strength by using third point loading. In symmetrical two points loading the critical crack may appear at any section not strong enough to resist the stress with in the middle third, where the banding moment is maximum. Flexural modulus of rupture is about 10 to 20 percent of compressive strength depending on the type, size and volume of coarse aggregate used.

Calculations:

F_b= PL/ bd2

Where b= width in cm of specimen
d= depth in cm of specimen at point of failure
L= length in cm of specimen on which specimen was supported
P= maximum load in kg applied to specimen Final values are adopted using standard deviations.

Fig : Testing of beams

(d) HYDROCHLORIC ACID ATTACK:

Hydrogen chloride gas is highly corrosive and will damage metal structures and buildings or monuments made of limestone. If high levels of Hydrogen chloride gas dissolve in a water body, aquatic organisms will be harmed and even killed. This is only likely as a result of an accidental spill of much larger amounts of Hydrogen chloride than are typically released to the environment. The very high solubility of Hydrogen chloride gas means that releases to the atmosphere are quickly washed out by rain and moisture in the air. Some soils and lakes may be sensitive to this acid rain if amounts of it falling are above certain amounts defined as "critical loads". This makes Hydrogen chloride pollution a global as well as local environmental problem. The chemicals formed as the products of reaction between hydrochloric acid and hydrated cement phases are some soluble salts and some insoluble salts. Soluble salts, mostly with calcium, are subsequently leached out, whereas insoluble salts along with amorphous hydrogels, remain in the corroded layer. Besides dissolution, the interaction between hydrogels may also result in the formation of some Fe-Si, Al-Si, Ca-Al-Si complexes which appear to be stable in PH range above 3.5.

$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$

The reaction essentially causes leaching of Ca (OH) $_2$ from the set cement. After leaching out of $Ca(OH)_2$, C-S-H and ettringite start to decompose, with release of Ca^{2+} to counteract the loss in $Ca(OH)_2$ and the set cement starts to disintegrate accelerating the dissolution.

$Ca_6Al_2(SO_4)_3(OH)_{12}.26H_2O \rightarrow 3ca^{2+}+2[Al(OH)_4]^- +4OH^- +26H_2O$

$3Ca^{2+} +2[Al(OH)_4]^- +4OH^- +12HCL \rightarrow 3Cacl2+2ALCL_3+12H_2O$

There are few indications through experiments about the formation of Friedel's salt, $C_3A.CaCl_2.10H_2O$, by the action of $CaCl_2$, formed due to the reaction of HCL with CH and C_3A. Hydrochloric acid attack is a typical acidic corrosion which can be characterized by the formation of layer structure.

Properties of Hydrochloric Acid

- Molecular formula : Hcl
- Molecular weight : 36.46
- Specific gravity : 1.18 (15℃, 35% concentration)
- Melting point : −66℃(35% concentration)
- Boiling point : 108.6℃(constant boiling mixture of 20.2% concentration)
- Vapor pressure : 10.6 mmHg (20℃, 30% concentration)
- 322.0 mmHg (40℃, 36% concentration)

Fig 3 i.curing in water ii.curing in HCL solution

(e) Bond strength:

A hollow hydraulic machine with maximum loading capacity of 30 ton was needed to perform cement bond tests.The load was applied with a rate of 2KN/sec and distributed on the specimen surface by a square plate with size of 20cm and a hole at the centre.Bond stress is calculated as average stress between the reinforcing bar and the surrounding concrete along the embedded length of the bar. For uniform bond ,the bond stress S can be expressed as:

S= Pmax/(*L*D)

Where Pmax = Maximum load applied

L = length of the specimen

D= diameter of the specimen

Figure 5 Bond strength Testing Machine

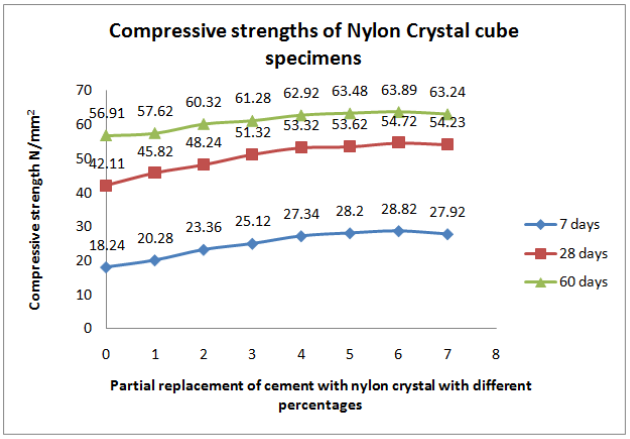
RESULTS AND DISCUSSION

Compressive Strength of Nylon Crystal in Cube Specimens:

Table 5 Compressive strengths of Nylon Crystal cube specimens

Mix Proportion	7 Days	28 Days	60 Days
C.C	18.24	42.11	56.91
C.C+1% NC	20.28	45.82	57.62
C.C+2% NC	23.36	48.24	60.32
C.C+3% NC	25.12	51.32	61.28
C.C+4% NC	27.34	53.32	62.92
C.C+5% NC	28.2	53.62	63.48
C.C+6% NC	28.82	54.72	63.89
C.C+7% NC	27.92	54.23	63.24

Figure 6 Compressive strength values of C.C and Nylon Crystal at 7, 28 and 60 Days



Result:

1. At 7 days, It is observed that the maximum compressive strength of the concrete cube is obtained at C.C+6%NC replacement. It is increased upto 58% and beyond the 6% of Nylon Crystal replacement, the compressive strength of a cube is decreases.
2. At 28 days, It is observed that the maximum compressive strength of the concrete cube is obtained at C.C+6%NC replacement. It is increased upto 29.94% and beyond the 6% of Nylon Crystal replacement, the compressive strength of a cube is decreases.
3. At 60 days, It is observed that the maximum compressive strength of the concrete cube is obtained at C.C+6%NC replacement. It is increased upto 12.26% and beyond the 6% of Nylon Crystal replacement, the compressive strength of a cube is decreases.
4. From the above results we can state that the maximum compressive strength is obtained at C.C+6% NC replacement.

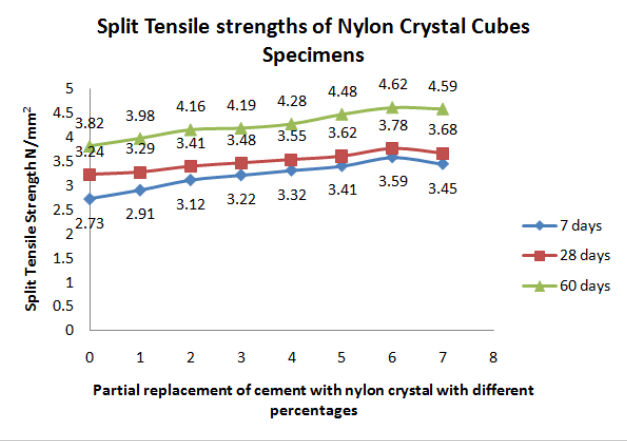
Split Tensile Strength of Nylon Crystal in Cylinder Specimens:

Table 6 Split Tensile strengths of Nylon Crystal Cylinder Specimens

Mix Proportion	7 Days	28 Days	60 Days
C.C	2.73	3.24	3.82
C.C+1% NC	2.91	3.29	3.98
C.C+2% NC	3.12	3.41	4.16

C.C+3% NC	3.22	3.48	4.19
C.C+4% NC	3.32	3.55	4.28
C.C+5% NC	3.41	3.62	4.48
C.C+6% NC	3.59	3.78	4.62
C.C+7% NC	3.45	3.68	4.59

Figure 7 Split tensile strength values of C.C and Nylon Crystal at 7, 28 and 60 Days



Result:

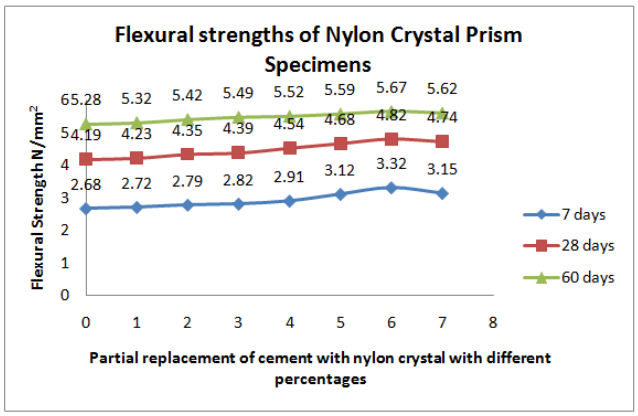
1. At 7 days, It is observed that the maximum Split tensile strength of the concrete cube is obtained at C.C+6%NC replacement. It is increased upto 31.5% and beyond the 6% of Nylon Crystal replacement, the Split tensile strength of a cube is decreases.
2. At 28 days, It is observed that the maximum Split tensile strength of the concrete cube is obtained at C.C+6%NC replacement. It is increased upto 16.66% and beyond the 6% of Nylon Crystal replacement, the Split tensile strength of a cube is decreases.
3. At 60 days, It is observed that the maximum Split tensile strength of the concrete cube is obtained at C.C+6%NC replacement. It is increased upto 20.94% and beyond the 6% of Nylon Crystal replacement, the Split tensile strength of a cube is decreases.
4. From the above results we can state that the maximum Split tensile strength is obtained at C.C+6% NC replacement.

Flexural Strength of Nylon Crystal in Prism Specimens:

Table 7 Flexural strengths of Nylon Crystal Prism Specimens

Mix Proportion	7 Days	28 Days	60 Days
C.C	2.68	4.19	5.28
C.C+1% NC	2.72	4.23	5.32
C.C+2% NC	2.79	4.35	5.42
C.C+3% NC	2.82	4.39	5.49
C.C+4% NC	2.91	4.54	5.52
C.C+5% NC	3.12	4.68	5.59
C.C+6% NC	3.32	4.82	5.67
C.C+7% NC	3.15	4.74	5.62

Figure 8 Flexural strength values of C.C and Nylon Crystal at 7, 28 and 60 Days



Result:

1. At 7 days, It is observed that the maximum Flexural strength of the concrete cube is obtained at C.C+6%NC replacement. It is increased upto 23.88% and beyond the 6% of Nylon Crystal replacement, the Flexural strength of a cube is decreases.
2. At 28 days, It is observed that the maximum Flexural strength of the concrete cube is obtained at C.C+6%NC replacement. It is increased upto 15.03% and beyond the 6% of Nylon Crystal replacement, the Flexural strength of a cube is decreases.
3. At 60 days, It is observed that the maximum Flexural strength of the concrete cube is obtained at C.C+6%NC replacement. It is increased upto 7.38% and beyond the 6% of Nylon Crystal replacement, the Flexural strength of a cube is decreases.

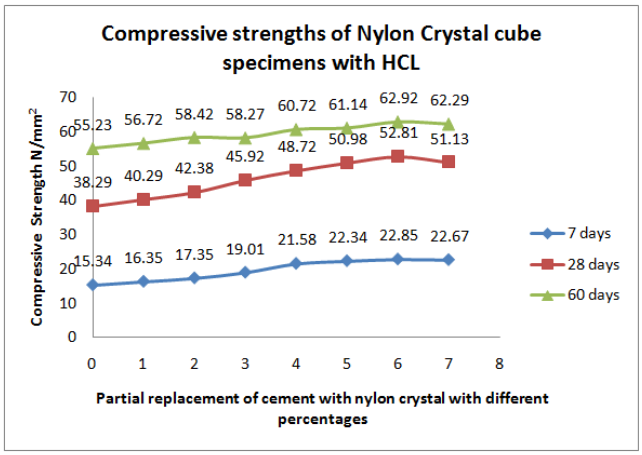
4. From the above results we can state that the maximum Flexural strength is obtained at C.C+6% NC replacement.

Acid Attack On Concrete:

Table 8 Compressive strengths of Nylon Crystal cube specimens with HCL

Mix Proportion	7 Days	28 Days	60 Days
C.C	15.34	38.29	55.23
C.C+1% NC	16.35	40.29	56.72
C.C+2% NC	17.35	42.38	58.42
C.C+3% NC	19.01	45.92	58.27
C.C+4% NC	21.58	48.72	60.72
C.C+5% NC	22.34	50.98	61.14
C.C+6% NC	22.85	52.81	62.92
C.C+7% NC	22.67	51.13	62.29

Figure 9 Compressive strengths of Nylon Crystal cube specimens with HCL



Result:

1. At 7 days, It is observed that the maximum compressive strength of the concrete cube is obtained at C.C+6%NC replacement. It is increased upto 48.9% and beyond the 6% of Nylon Crystal replacement, the compressive strength of a cube is decreases.
2. At 28 days, It is observed that the maximum compressive strength of the concrete cube is obtained at C.C+6%NC replacement. It is increased upto 37.92% and beyond the 6% of Nylon Crystal replacement, the compressive strength of a cube is decreases.
3. At 60 days, It is observed that the maximum compressive strength of the concrete cube is obtained at C.C+6%NC replacement. It is increased upto 13.92% and beyond the 6% of Nylon Crystal replacement, the compressive strength of a cube is decreases.
4. From the above results we can state that the maximum compressive strength is obtained at C.C+6% NC replacement.

Bond Strength on Concrete

Table 9 Bond strength of Nylon Crystal in Cylinder Specimens

Mix Proportion	Bond Strength
	28 days
C.C	3.2
C.C+1% NC	3.5
C.C+2% NC	3.9
C.C+3% NC	4.1
C.C+4% NC	4.3
C.C+5% NC	4.6
C.C+6% NC	4.9
C.C+7% NC	4.7

Result:

1. At 28 days, It is observed that the maximum Bond strength of the concrete cube is obtained at C.C+6%NC replacement. It is increased upto 53.12% and beyond the 6% of Nylon Crystal replacement, the Bond strength of a cube is decreases.
2. From the above results we can state that the maximum Bond strength is obtained at C.C+6% NC replacement.

CONCLUSIONS

- At 7 days, It is observed that the maximum compressive strength of the concrete cube is obtained at C.C+6%NC replacement. It is increased upto 58% and beyond the 6% of Nylon Crystal replacement, the compressive strength of a cube is decreases.
- At 28 days, It is observed that the maximum compressive strength of the concrete cube is obtained at C.C+6%NC replacement. It is increased upto 29.94% and beyond the 6% of Nylon Crystal replacement, the compressive strength of a cube is decreases.
- At 60 days, It is observed that the maximum compressive strength of the concrete cube is obtained at C.C+6%NC replacement. It is increased upto 12.26% and beyond the 6% of

Nylon Crystal replacement, the compressive strength of a cube is decreases.

- At 7 days, It is observed that the maximum Split tensile strength of the concrete cube is obtained at C.C+6%NC replacement. It is increased upto 31.5% and beyond the 6% of Nylon Crystal replacement, the Split tensile strength of a cube is decreases.
- At 28 days, It is observed that the maximum Split tensile strength of the concrete cube is obtained at C.C+6%NC replacement. It is increased upto 16.66% and beyond the 6% of Nylon Crystal replacement, the Split tensile strength of a cube is decreases.
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- At 28 days, It is observed that the maximum Flexural strength of the concrete cube is obtained at C.C+6%NC replacement. It is increased upto 15.03% and beyond the 6% of Nylon Crystal replacement, the Flexural strength of a cube is decreases.
- At 60 days, It is observed that the maximum Flexural strength of the concrete cube is obtained at C.C+6%NC replacement. It is increased upto 7.38% and beyond the 6% of Nylon Crystal replacement, the Flexural strength of a cube is decreases.
- At 7 days, It is observed that the maximum compressive strength of the concrete cube is obtained at C.C+6%NC replacement. It is increased upto 48.9% and beyond the 6% of Nylon Crystal replacement, the compressive strength of a cube is decreases.
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REFERENCES

[1] Dr.Suji D, Poovendran S, Prabhakar P "Experimental Study on Partial Replacement of Waste Foundry Sand in Flexible Pavements" in IJCSER, 2015.

[2] Deepak R "Experimental study on Mechanical properties of Bituminous paving mixes using steel slag" in IJCSER, 2015.

[3] Lejumol.T.U "Experimental study on Sulphate Attack in Granite Powder concrete with GGBFS" in IJCSER, 2015.

[4] Naveen Kumar MS, Nikhil B, Nikhil Patel AR "Experimental studied on clay tile power as partial replacement of cement for sustainable concrete" in IJETT, 2015.

[5] Krishna Kumar S "Experimental Study on Concrete using Waste Marble Power and Quarry Dust as Partial Replacement of Cement and Fine Aggregate" in IJCSER,2015.

[6] P.Rajalakshmi, Dr.D.Suji "Studies on Strength Characteristics on Utilization of Waste Ceramic Tiles a Aggregate in Concrete" in IJCSER, 2015.

[7] Abhijeet.R.Agrawal, Sanket.S.Dhase, Kautuk.S.Agrawal "Coconut Fiber In Concrete To Enhance Its Strength And Making Lightweight Concrete" in IJERD, 2014.

[8] S.A Kanalli, Ramu palankar, Bharat kumar, Praveen kumar, Prakash S.K "Comparitive Study of Polymer Fiber Reinforced Concrete with Conventional Concrete Pavement" in IJRET, 2014.

[9] IS 383 – 1970: Indian Standard "Specification for coarse and fine aggregates from naturals sources for concrete"

[10] Selina Ruby G., Geethanjali C., Jaison Varghese, P. Muthu Priya" Influence Of Hybrid Fiber On Reinforced Concrete" in IJASGE, 2014.

[11] Kshitija Nadgouda"Coconut Fibre Reinforced Concrete" in Proceedings of Thirteenth IRF International Conference, 14th September 2014, Chennai, India, ISBN: 978-93-84209-51-3.

[12] Rajarajeshwari B Vibhuti, Radhakrishna, Aravind N. "Mechanical Properties of Hybrid Fiber Reinforced Concrete for Pavements" IJRET NOV2013

[13] Kavita S kene, Vikrant S Vairagade and Satish Sathawane "Experimental Study on Behaviour of Steel And Glass Fiber Reinforced Concrete Composites" in Bonfring International Journal of

Industrial Engineering and Management Science, Vol. 2, No. 4, December 2012.

[14] A.M Shende, A.M Pande, M. Gulfam Pathan, "Experimental Study on Steel Fiber Reinforced Concrete for M40 Grade" in International refereed Journal of engineering and science.

[15] Indrajt Patel, C D Modherav , " Study Effect Of Polyester Fibers On Engineering Properties Of High Volume Fly Ash Concrete" in Journal of engineering research and studies,2011.

[16] Munawar, S. S., Umemura, K., and Kawai, S. 2007. "Characterization of the Morphological, Physical, and Mechanical Properties of Seven Nonwood Plant Fiber Bundles" in Journal of Wood Science, 53(2): 108-113

[17] "CONCRETE TECHNOLOGY" Theory and practice, a text book by M.S.Shetty, 2005.

[18] A.A Ramezanianpour, P.pourbiek, M.Mahdikhani, and F.Moodi. "Mechanical properties and durability of concrete containing rice husk ash as supplementary cementing material" International journal of civil Engineering. Vol. 7. 2, June 2009, June 2010.

[19] Alireza Nirshid, suraya Abdul Rashid, Farah Nora A.Aziz, Mohamad Amran Mohd Salleh. "Contribution of Rice husk ash to the properties of mortar and concrete A Review" journal of American science: 2010.

[20] Moayad N A1-Khalaf and Yousif," Use of rise husk ash in concrete" , the International journal of cement composites and Lightweight concrete, Vol. 6, November 4 ,1984.

[21] Muhammad Soaid Ismail and A.M. Waliuddin, "Effect of rice husk ash on high strength concrete", Construction and Building Material, Vol. 10.No. 7, 1996, 521-526.

[22] Gemma Rodriguez de Sensale, "Syrength development of concrete with Rice-husk ash", Cement & Concrete Composition, Vol. 28, 2006, 158-160.

IS Codes

[23] IS: 2386 -1963, "Methods of testing for aggregate for concrete".

[24] IS: 10262-2009, "Recommended guidelines for concrete mix design, Bureau of Indian standards", New Delhi, India.

[25] IS: 516-1959, Indian standard methods of tests for strength of concrete, Bureau of Indian Standards, New Delhi, India.

[26] IRC: 58-2002, Guide lines for the design of plain jointed Rigid Pavements for the Highways. [5]. IS 456 – 2000: Indian Standard "Plain and reinforced concrete" – code of practice

[27] IS 383 – 1970: Indian Standard "Specification for coarse and fine aggregates from naturals sources for concrete"