

EXPERIMENTAL STUDY ON BEHAVIOUR OF RUBBER CONCRETE ON PARTIAL REPLACEMENT OF COARSE AGGREGATE

B Vamshipriya¹, A Mahesh Yadav²

Civil Dept, Nagole Institute Of Technology And Science, Hyderabad, Telangana.

ABSTRACT:- It has been estimated that around one billion tires are withdrawn from use in the world every year. Waste tire rubber is not easily bio degradable even after a long period of landfill and results in a lot of environmental and health problems. Rubber finds its use in concrete because of its property of energy absorption. A lot of research is being done on the usage of waste rubber as replacement of aggregate and cement in concrete.

But the compressive, split tensile and flexural strengths of concrete have been observed to decrease with the increase of rubber quantity. To compensate this loss of strength, reinforcement is necessary. In tropical regions, natural fibres are abundantly available which when utilized will reduce cost of construction and improve performance. For this study, coconut fibres shall be used as they are freely available in large quantities at cheap costs. The use of coconut fibres will also lead to better management of these waste fibres.

The present experiment is carried out to investigate the fresh and hardened properties of binary blended concrete with 20% of Fly ash, by weight of cement, as partial replacement of cement and replacement of 0%, 5%, 10%, 15% and 20% of sand with Crumb rubber, by volume and addition of Coconut fibres at 0.1%, 0.2% and 0.3%, by weight of cement. Compressive strength of concrete is measured by testing standard cubes (150mm x 150mm x 150mm) at the age of 28 days, split tensile strength of concrete is measured by testing standard cylinders (150mm Ø, 300mm height) at the age of 28 days and impact resistance of concrete is measured by testing beams (100mm x 100mm x 500mm) at the age of 28 days. In maintain the ecological balance thus reducing the consumption of cement and river sand The compressive strength and split tensile strength shall be evaluated and compared with coconut fiber reinforced concrete and normal concrete.

Keywords: Crumb Rubber, Coconut Fibre, Fly ash, Compressive Strength, Split Tensile Strength, M30 grade concrete.

I INTRODUCTION

Concrete is the most widely used construction material all over the world. The importance of concrete in modern society cannot be underestimated. Typical concrete is a mixture of fine aggregate (sand), coarse aggregate (rock), cement, and water. The aggregates, both fine and coarse, are bound together by cement when mixed with water. Since the late 1800s onwards, when consistent mass produced Portland cement became readily available, the world has been transformed by the design and construction of all sorts of concrete structures. The usage of concrete is increasing from time to time due to the rapid development of construction industry. With innovations in science and technology in construction industry, the scope of concrete as a structural material, has widened.

But for numerous reasons, the concrete construction industry is not sustainable. It consumes a lot of virgin materials and the principal raw material of concrete i.e., cement is responsible for greenhouse gas emissions and causing a threat to environment through global warming. Therefore, the industry has seen various types of concrete in which fine

aggregate and coarse aggregate are replaced with cheaper or lighter alternatives such as waste foundry sand, stone dust, crumb rubber etc. Many reinforcing fibres are also being used to enhance strength such as steel, glass, nylon, jute, coconut etc. Many supplementary cementations materials are also being used to minimize the use of cement such as fly ash, silica fume, met kaolin, rice husk ash etc. Rubberized Concrete and Fibre Reinforced Concrete are some of the technological advances in improving the quality and properties of concrete.

CRUMB RUBBER:- Sand has by now become the most widely consumed natural resource on the planet, next only to fresh water. Especially in Asia and Arab states the hunger of the construction industry is ever growing. Once sand is used in concrete, the components are bound forever and are no longer available as resources. On the other hand, large quantities of scrap tyres are being generated every year globally. The waste tyre rubber is not easily bio degradable even after a long period of landfill and results in a lot of environmental and health problems. A number of innovative solutions that meet the challenge of the tyre disposal problem involve using rubber crumb as an additive to cement based materials.

COCONUT FIBRES:-Coconut fibres are agricultural waste products obtained in the processing of coconut oil and are available in large quantities in the tropical regions of the world, especially in Africa, Asia and America. Coconut fibres are not commonly used in the construction industry but are often dumped as agricultural wastes. However, with the quest for affordable housing system for both the rural and urban population in the developing countries, various schemes focusing on cutting down conventional building material costs have been put forward. In countries where abundant agricultural wastes are discharged, these wastes can be used as potential material or replacement material in construction industry.

FIBRE REINFORCED CONCRETE:-

Fibre reinforced concrete is a concrete mix containing water, cement, aggregate and discontinuous fibres of various shapes and sizes. Plain concrete possesses a very low tensile strength, limited ductility and little resistance to cracking. Internal micro-cracks are inherently present in the concrete and its poor tensile strength is due to the propagation of such micro-cracks, eventually leading to brittle fracture of the concrete. In the past, attempts have been made to impart improvement in tensile properties of concrete members by way of using conventional

reinforced steel bars and also by applying restraining techniques. Although both these methods provide tensile strength to the concrete members, they however, do not increase the inherent tensile strength of concrete itself.

NEED FOR THE PROJECT:-

The replacement of sand with crumb rubber may tend to mar the fresh properties of concrete as indicated by some researchers. Therefore, significant quantity of cement is often replaced with admixtures to enhance the fresh properties of concrete and reduce heat generation.

The use of Fly ash in concrete is well established and widespread; it is not only economical but also improves the fresh and hardened properties of concrete. It also helps to solve the problem of storage and disposal of the ash.

Crumb rubber produced from waste rubber tyres, can be a potential alternative of natural sand. In concrete production, it could be used as a partial replacement of natural sand. It is a very good replacement of river sand, which is in short supply currently. Besides, the utilization of crumb rubber, will reduce the cost of concrete production. The successful utilization of crumb rubber as fine aggregate would turn this waste material into a valuable resource. However, it should be

ensured that the incorporation of crumb rubber does not harm the strength, and other key properties of hardened concrete and durability of concrete.

Previous researches have indicated that the use of rubber as aggregate in concrete can decrease the strength of concrete significantly. It has been observed that the addition of fibres to concrete helps in enhancing the strength of concrete. In tropical regions, natural fibres such as Coconut fibre are abundantly available and often are wasted. Addition of such fibres to concrete with crumb rubber as sand replacement can enhance the strength of concrete and also help in producing economical concrete and in maintaining ecological balance.

Therefore an attempt has been made in the present study to assess the use of fly ash as cement replacement along with crumb rubber as river sand replacement and addition of coconut fibres on the properties of concrete.

OBJECTIVES OF THE PRESENT STUDY

- To study the influence of addition of coconut fibres as reinforcement, by weight of cement, on strength properties of binary blended concrete.
- To study the influence of crumb rubber in various percentages of sand replacement, by volume, on strength

properties of coconut fibre reinforced binary blended concrete.

- To form a comparative study of the properties of coconut fibre reinforced binary blended concrete and rubberized coconut fibre reinforced binary blended concrete.

II METHODOLOGY

CONCRETE MIX DESIGN: The concrete mix of M30 grade was designed as per IS 10262-2009 using the properties of cement and aggregate. For each mix of Rubberized concrete, the concrete mix was modified by replacing the amount of sand to be replaced by crumb rubber for the mix. The coconut fibres were added to the concrete mixes by weight of cement. The mix design procedure and calculations are presented in Appendix A, the following proportions by weight were obtained after trial mixes.

Water (kg/m ³)	Cement (kg/m ³)	Fine Aggregate (kg/m ³)	Coarse Aggregate (kg/m ³)
197	438	651	1130
0.45	1	1.486	2.58

COMPRESSIVE STRENGTH:-The Compression Testing Machine used for testing the cube specimens is of standard make. The capacity of the testing machine is 200 Tones or 2000 KN. The machine has a facility to control the rate of

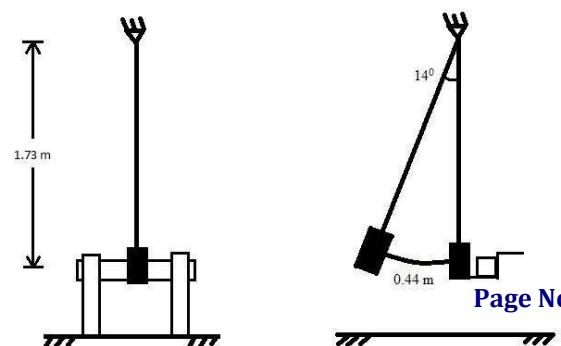
loading with a control valve. The machine has an ideal gauge on which the load applied can be read directly. The oil level is checked, the MS plates are cleaned and the machine is kept ready for testing specimens. The specimens are removed from the curing pond just before testing on the specified due date and time and cleaned to wipe off the surface water. The cube specimen is placed on the lower platen such that the load is applied centrally on the faces other than top and bottom faces of casting. The top plate is brought in contact with the specimen by rotating the handle, the oil pressure valve is closed and the machine is switched on. A uniform rate of loading is maintained. The maximum load at failure at which the specimen breaks and pointer starts moving back is noted. The test is repeated for the three specimens and the average value is taken as mean strength.

The Compressive strength is taken as load applied on the specimen divided by the area of the load bearing surface of specimen (P/A).

SPLIT TENSILE STRENGTH:- Though concrete is not expected to resist direct tension, the determination of Tensile strength of concrete is necessary to determine the load at which the concrete member may crack, since cracking is a tensile failure. The Split Tensile test is an indirect method of determining tensile strength of concrete. The test consists of applying a compressive live

load along the opposite generators of a concrete cylinder placed with its axis horizontal between the compressive platens. Due to compressive loading, a fairly uniform tensile stress is developed over nearly $2/3$ of the loaded diameter. Before testing, diameter, length of specimen is determined to nearest 0.2mm. Center one of the plywood strips along the center of lower platen. The specimen is placed on the plywood strip. The second plywood strip is similarly placed on the top of the cylinder. The load is applied without shock until failure occurs. The appearance of concrete and any unusual features in the type of failure is carefully observed. Splitting strength of specimen is computed to nearest of 0.05 N/mm^2 .

IMPACT RESISTANCE TEST:- Test for Impact Resistance was carried out on plain concrete mix and optimum concrete mix. Three specimens of size 100mm x 100mm x 500mm were casted for each mix. These specimens were tested by Modified Chirpy Method. The length of the pendulum of Modified Chirpy apparatus is 1.65m and the striker is a steel cylinder of 15 kilograms attached to the end of the pendulum.



0.1%, 0.2% and 0.3%, by weight of cement, on the workability of concrete was studied by testing the mixes for Slump and Compaction factor.

Plate 6 Impact resistance test

Methodology

The specimens are removed from the curing pond just before testing on the specified due date and time and cleaned to wipe off the surface water. The prism specimens were arranged evenly on the horizontal surface and supported by the vertical wall surface. The axis of the prism was horizontal and perpendicular to the movement of the pendulum. The specimens were arranged such that the centre of the axis of the prism was in line with the movement of the pendulum and touching the striker. The cylinder is pulled away from the specimen to a distance of 0.44 m and then left to strike the prism at its mid-section. This was repeated till the specimens developed crack and failed. The number of blows required for the specimen to crack and fail were recorded.

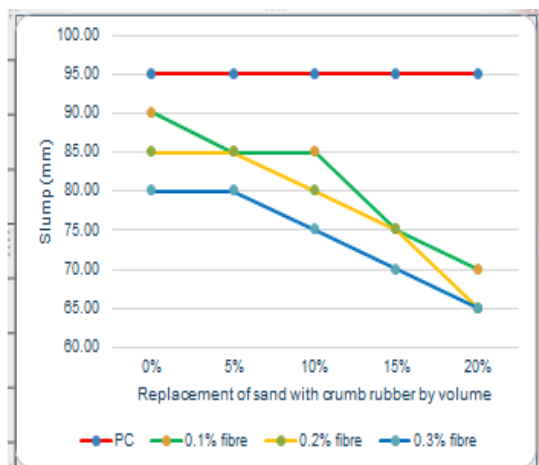
III RESULTS AND DISCUSSION

Tests on Workability

The effect of replacement of 20% of cement with Fly ash, replacement of 5%, 10%, 15% and 20% of sand with Crumb rubber (by volume) and addition of Coconut fibres at

Slump Cone Test

S.No.	Type of mix	Slump (mm)		
1	M30	95		
S.No.	Replacement of sand by crumb Rubber	Addition of coconut fibres (in %)		
		0.1	0.2	0.3
2	0%	90	85	80
3	5%	85	85	80
4	10%	85	80	75
5	15%	75	75	70
6	20%	70	65	65



Variation of Slump values of Rubberised Coconut Fibre Reinforced Binary Blended Concrete with increase in Rubber content and Fibre content

Percentage increase in Split tensile strength of Rubberised Coconut Fibre Reinforced Concrete with Plain CoconutFibre Reinforced Binary Blended Concrete

S.No.	Replacem ent of sand by crumb rubber	Increase in split tensile strength with plain coconut fibre reinforced binary blended concre te (%)		
		Addition of coconut fibres (in %)		
		0.1	0.2	0.3
1	5%	-4.24	-2.01	-12.27
2	10%	-11.70	-8.00	-17.95
3	15%	-18.23	-14.02	-22.27
4	20%	-22.32	-19.96	-28.33

Percentage increase in Split tensile strength of Rubberised Coconut Fibre Reinforced Concrete with Plain Concrete

S.No.	Replace ment of sand by crumb rubber	Increase in split tensile strength with plain concrete (%)		
		Addition of coconut fibres (in %)		
		0.1	0.2	0.3
1	5%	-18.17	-10.90	-15.45
2	10%	-24.55	-16.35	-20.93
3	15%	-30.13	-21.83	-25.09
4	20%	-33.62	-27.22	-30.93

Inferences on Test Results

There is a decrease in the split tensile strength of concrete with the replacement of 20% of cement with fly ash. Split tensile strength decreased with the replacement of sand with crumb rubber but increased with the addition of coconut fibres upto 0.2% fibres and decreased when 0.3% fibres are added. When compared with plain coconut fibre reinforced binary blended concrete, with the replacement of sand with crumb rubber from 5% to 20%, split tensile strength of rubberized coconut fibre reinforced concrete decreased by 4.24%

to 22.32% when 0.1% coconut fibres are added, 2.01% to 19.96% when 0.2% coconut fibres are added and 12.27% to 28.33% when 0.3% fibres are added. When compared with plain concrete, with the replacement of sand with crumb rubber from 5% to 20%, compressive strength of rubberized coconut fibre reinforced concrete decreased by 18.17% to 33.62% when 0.1% coconut fibres are added, 10.90% to 27.22% when 0.2% coconut fibres are added and 15.45% to 30.93% when 0.3% fibres are added.

Impact Resistance Test

For Impact Resistance test prism specimens of dimensions 100mm x 100mm x 500mm were prepared. The specimens were cured in water and tested at the age of 28 days. The results of Impact Resistance test of Plain Concrete and Rubberized Coconut Fibre Reinforced Binary Blended Concrete of optimal mix (rubber-5%, fibre-0.2%)

Impact resistance of Plain Concrete and Rubberised Coconut Fibre Reinforced Binary Blended Concrete of optimum mix

S.No.	Type of mix	Impact resistance at 28 days (No. of blows)	
		At first crack	At failure
1	M30	57	62

2	Rubberised coconut fibre reinforced binary blended concrete with 5% rubber and 0.2% Fibre	69	77
---	---	----	----

CONCLUSIONS

- The workability of fresh binary blended concrete decreased with the increase in sand replacement with crumb rubber and addition of coconut fibres.
- Replacement of river sand with crumb rubber ranging from 0% to 20% decreases the compressive strength of concrete. It decreased by 14.22% to 29.12% when 0.1% coconut fibres are added, 1.06% to 23.4% when 0.2% coconut fibres are added and 8.88% to 29.79% when 0.3% fibres are added at the age of 28 days when compared with plain coconut fibre reinforced binary blended concrete. When compared with plain concrete, the strength decreased by 28.08% to 40.58% when 0.1% coconut fibres are added, 16.44% to 35.31% when 0.2% coconut fibres are added and 22.54% to 40.32% when 0.3% fibres are added.

- Split Tensile strength of concrete mix also decreases with increase in replacement of sand with crumb rubber.

- The impact resistance of optimum mix is 21% more than that of plain concrete for first crack and 24% for failure.

- The mix containing replacement of 20% of cement with Fly ash (by weight), replacement of 5% of sand with Crumb rubber (by volume) and Coconut fibres added at 0.2% by weight of cement is the optimum mix.

- The compressive strength and split tensile strength for all the fibre reinforced mixes increase upto 0.2% addition of coconut fibres and decreased thereafter.

The combination of partial replacement of cement with Fly ash and sand with Crumb rubber, with the addition of Coconut fibres shall be very economical and can also help in the utility of Industrial wastes and in maintaining the ecological balance thus reducing the consumption of Cement and River sand.

REFERENCES

1. **PitiSukontasukkul**(2008), "Use of crumb rubber to improve thermal and sound properties of pre-cast concrete

panel", Construction and Building Materials 23

(2009) 1084-1092.

2. **PitiSukontasukkul and somyotWiwatpattanapong**(2009),

"Moderate Lightweight Concrete Mixed with Recycled Crumb Rubber", Thammasat Int. J.

Sc. Tech., Volume 14, No. 1, January-March 2009.

3. **YogenderAntil, Er. VivekVerma, Er, Bhupinder Singh** (2012), "Rubberized

Concrete Made with Crumb Rubber", International Journal of Science and Research, ISSN (Online): 2319-7064.

4. **Noor Md. SadiqulHasan, HabiburRahmanSobuz, Md. ShibleeSayed and Md. Saiful Islam**

(2012), "The Use of Coconut Fibre in the Production of Structural Lightweight Concrete", Journal of Applied Sciences 12 (9): 831-839, 2012.

5. **Pravin V Domke**(2012), "Improvement In The Strength Of Concrete By Using Industrial And Agricultural Waste", IOSR Journal of Engineering, Volume 2(4) pp: 755-759, April 2012.

6. **Olonade, KolawoleAdisa, Alake, AdewaeDoyinsala and Morakinyo, Abiola Gabriel** (2013), "Strength

development and crack pattern of coconut

fibrereinforced concrete (CFRC)", Civil and Environmental Research, Volume 4, 2013, Special Issue for International Congress on Materials & Structural Stability, Rabat, Morocco, 27-30 November 2013.

7. **Parveen, SachinDass, Ankit Sharma** (2013), "Rubberized Concrete: Needs of Good Environment (Overview)", International Journal of Emerging Technology and Advanced Engineering, Volume 3, Issue 3, March 2013.
8. **J. Sahaya Ruben, Dr. G. Baskar**(2014), "Experimental Study of Coir Fiber as Concrete Reinforcement Material in Cement Based Composites", International Journal of Engineering Research and Applications, Volume 4, Issue 1 (Version 3), pp. 128-131, January 2014.