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Literature Review on Utilization of By-Products in Concrete

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Abstract: *This paper presents literature study on use of plastic waste and natural fibers such as plastic aggregate, coir, jute, etc in cement concrete. Due to urbanization, the resources of sand available on the earth are replenishing. The quality of natural sand available which also decreasing the sources of sand and which are located far from the places where it is required and thus becomes difficult to transport. Environmental concerns are also being raised against uncontrolled extraction the main aim is to protect river bed from soil erosions of natural sand. Due to this we have to use by-products and recyclable waste. The paper emphasizes on the use of material to be replaced by natural sand will give new technology that are to be adopted in concrete mix design and if applied to large extend would be revolutionary for the construction industry by which not only economical and modern construction cost can be achieve but also we can save or conserve our natural resources and thus conserving our planet Earth.*

Keywords: *Concrete, Coir, Jute, Plastic Waste, Test.*

I. Introduction

Nowadays the necessity of suitable, non-hazardous and cost effective material is the main challenge for the construction industry to improve their image in term of sustainability. Most of the wastes are generated from manufacturing processes, industries and municipal solid wastes [1]. With the increasing concern towards the environment in the world, the new techniques are invented for utilization of the waste products like plastic waste, jute, coir etc. Now a days plastic waste is increasing the burden for the government. It is due to hardship in the management of the wastes as their disposal process is very hard and tedious. In the similar way natural fiber encompasses all forms from woody, water & wild plants, grasses, fruits, agriculture crops, seeds, natural fiber possess more advantage than the synthetic fibers. A synthetic fiber has a good potential as reinforcements in the thermoplastic and thermo set polymer composites. This is due to low density and high specific properties of fiber [2].

There are numerous of plastic waste available which can replaced the fine aggregates. They are mainly plastic bottles, plastic bags etc. which are generally recycled plastic material those can be used in concrete paver block and solid block which provides less susceptible to rutting & minimum fatigue or thermal cracking. I also provide low stripping due to moisture and offer great durability, little or no impact on processing. It also produces ecofriendly construction and costs less.

Concrete contains numerous flaws and micro cracks. The rapid propagation of micro cracks under the applied load is responsible for the low tensile strength of concrete. It is reasonable to assume that the tensile strength and the flexure strength of the concrete can be substantially increase by introducing closely spaced fibers. These fibers would arrest the propagation of micro cracks. Thus delaying the tensile strength and thus increase the tensile strength of the material [3].

Similarly we can use natural fiber in concrete as primary and secondary reinforcement .Fibers work as primary reinforcement in thin-sheets product. In this conventional reinforcing bars cannot be used and includes no coarse aggregates. The fibers used as primary reinforcement to increase both strength and toughness of the composite. Fibers are also included in the matrix as secondary reinforcement. This is to control cracking induced by humidity or temperature variations or to provide post-failure integrity in the event accident overload. Different varieties of fiber are available naturally which have been incorporated into cement commonly, geography relating to fiber availability plays a major role. Selection of fiber based matrices which composed of paste, mortar or concrete [4].

Generally higher performance is achieved with the varieties having higher cellouse content. This tends to occur in bats fibers (e.g. flax, hemp, keaf, jute and ramine) that have structural requirements in providing support for the stalk of the plant. The properties of natural fiber vary considerably depending on chemical composition and structure. This is related to fiber type as well as growing condition, harvesting time, extraction method, treatment and storage procedures. This paper present the detailed review about plastic waste such as recycled materials and natural fiber that can be effectively used in concrete as a sand replacement [5],[6].

II. Mix Material

Concrete is the major building material. Cement concrete is a mixture of cement, coarse aggregate, fine aggregate and water. In this we study about replacement of sand by plastic waste and natural fibers.

2.1 Cement

For experimental study Ordinary Portland Cement (OPC) was used conforming to IS: 8112 was used throughout the work.

Fig-1 Ordinary Portland Cement

2.2 Sand

The fine aggregate used for the experiment in with maximum size of 4.75mm diameter.

2.3 Water

The water used was potable, fresh, colorless, odorless and tasteless water that is free from organic matter of any type.

2.4 Plastic Aggregates

The recycled E-plastic was used to replace coarse aggregates. For making concrete specimens, the basic test are conducted same as coarse aggregate to find the properties of E-plastic waste. [1, 2]. The properties are mentioned in table-1.

Table- 1 Properties of Plastic Aggregates

Sn.	Characteristics	Value
1.	Type	Crushed
2.	Maximum Size	20 mm
3.	Specific Gravity (20 mm)	1.1
4.	Total Water Absorption (20 mm)	0%
5.	Fineness Modulus Of Bigger Size Plastic Aggregate(Above 20 mm)	7.59
6.	Fineness Modulus Of Medium Size Plastic Aggregate(20 mm)	8.2
7.	Fineness Modulus Of Smaller Size Plastic Aggregate (below 20 mm)	9.18

2.5 Coir

Coconut fiber was used as alternative partial replacement for natural river sand as fine aggregate. Coir fiber was obtained from local coir industrial plant. Obtained coir fiber was chopped into 1cm, 1.6cm, 2cm, and 2.5cm. These are replaced with natural river sand by weight of 2.5%, 5%, and 7.6%. Coir fibers are found between the hard, internal shell and the outer coat of a coconut. The individual fiber cells are narrow and hollow, with thick walls made of cellulose. They are pale when immature. But later become hardened and yellowed as a layer of lignin is deposited on their walls [3].

Fig-2 Coir Fiber

2.6 Jute

Also known as Golden Fiber because of its golden and silky color. Jute as high tensile strength and low extensibility. Jute fiber is 100% bio-degradable and environment friendly.

Jute is long, soft, shiny, vegetable fiber that can spun into coarse strong thread. In the mix jute reinforced fiber of about 4-6 mm. These fibers are then chemically treated to increase stability. It contains 13-15% lignin and 60-65% cellulose; the rest is hemicelluloses and a few other soluble sugars [5].

Fig-3 Jute Fiber

III. Test Method

3.1 Slump Test

Slump test is used for measuring consistency of concrete which can be done in laboratory or at the site. It indicates the uniformity of the concrete. The apparatus for slump test consist of frustum whose bottom diameter is 200mm, top diameter is 100mm and height is 300mm. The mixture is filled in frustum and tampered 25 times after each ¼ layer of the height of frustum.

Fig-4 Slump Test Apparatus

3.2 Compressive Strength Test

Compressive Strength Test is the utmost important test which gives an idea about all the characteristics of concrete. It depends on the water-cement ratio, concrete strength, etc. Specimen cubes of size 150mmX150mmX150mm are prepared by tampering the concrete in the mould. After 24 hours the specimens are poured in water for curing. After this the specimen is tested by Compressive Testing Machine after 7 days and 28 days curing. Load is applied gradually at the rate of 140kg/cm^2/min till the specimen fails. Load at failure per area of specimen gives compressive strength of the concrete.

Fig-5 Compression Testing Machine

3.3 Flexural Strength Test

Flexural Strength is expressed as the modulus of rupture (f_b). For testing purpose specimen of size 150mmX150mmX700mm were casted and cured in water for 28 days and tested in Universal Testing Machine (UTM).

Fig-6 Universal Testing Machine

IV. Literature Study

4.1 Ashwini Manjunath: (2016) - Partial replacement of E- Plastic waste as coarse aggregate in concrete.

E-Plastic waste is generated from IT industries. With low recycling rate it can be hazardous. Using E-plastic waste will reduced aggregate cost and provide strength to the structure. This also reduces land fill cost. Experimental study was made on the utilization of E- plastic waste as coarse aggregate with a percentage replacement ranging from 0%, 10% ,20%, 30%, on the strength criteria of M-20 concrete.

In this experimental study cement used was OPC. Coarse aggregate used as crushed coconut shell aggregate of size 12.55mm to 20mm. Fine aggregate is extracted from river that is river sand. The mix proportion of 1:1.4:2.4:0.5 with w/c ratio 0.5. E- Plastic aggregate were added in amount 0%, 10%, 20% and 30% by the weight of cement. The cubes of size 150mmX150mmX150mm were prepared. After this workability test, compressive strength test and flexural strength test were performed. The results derived were:

When 0% E-plastic waste was added, workability was high. When 10%, 20%, 30% E-Plastic waste was added than the workability was high, medium, medium respectively. Compressive Test results after 7 days with 0%, 10%, 20%, 30% was 36N/mm^2, 33.18N/mm^2, 19.9N/mm^2 and 16.3N/mm^2 respectively. Flexural Strength result after 7 days for 0%, 10%, 20%, 30% was found as 1.5N/mm^2, 1.2N/mm^2, 1.0N/mm^2, 0.75N/mm^2 respectively.

Plastic can be used to replace some of the aggregates in a concrete mixture. This contributes to reducing the unit weight of the concrete. This is useful in application requiring non-bearing lightweight concrete, such as concrete panels used in facades.

4.2 Zainah Z. Ismail, Enas Al-Hashmi: (2008) - Use of plastic in concrete mixture of aggregate replacement.

Industrial activity in the world is associated with significant amount of non-biodegradable solid waste. This study involves experiment to determine the efficiency of reusing waste plastic in the production of concrete. 30 kg of waste plastic of fiber form shaped uses as partial replacement for sand by 0%, 10%, 15%, and 20% with 80kg of concrete mix. Concrete mixture was tested at room temperature. This test ensures reusing of waste plastic as a sand substitute aggregate in concrete which gives a good approach to reduce cost & solve waste management problem.

Portland cement was used for all type of aggregate mixture consists of 80 % polythene & 20% of polystyrene. After collecting waste plastic, it was analyzed for physical properties like density. Mixture contains

715 kg/m^3 sand & 1020 kg/m^3 gravel, 380 kg/m^3cement w/c ratio is 0.53.These mixture were 0% waste plastic. They were cured for 3, 7, 14 and 28 days & the mixture prepared by 10%, 15% ,20% in addition of plastic waste as replacement.

The result of the slump test of waste plastic concrete mixture was presented. This indicated that slump was proven in decreasing sharply with increasing the waste plastic ratio workability has broad gauge from very low to high. The result of the compressive strength for the waste plastic concrete mixture by increasing the compressive strength. The compressive strength test for waste plastic ratio, the result shows tendency of compressive strength values of waste plastic concrete mixture to decrease below the plain mixture at each curing age.

The flexural strength values of waste plastic concrete mixture tend to decrease below the values for the reference concrete mixture with increasing the waste plastic ratio. A concrete mixture made of 20% waste plastic has the lowest flexural strength at 28 days curing age, viz. 30.5% below the value of the reference concrete mixture.

4.3 Bharat Kumar, Sandeep R: (2016) - Parametric study on concrete by partial replacement of fine aggregate with coir fiber.

Due to increase in demand of construction materials, we need to find materials for replacing the aggregates in the concrete. In this investigation we have used coir fiber which will replace the fine aggregates. As large amount of waste is generated every year and the coconut fiber is one among such waste, coconut fiber consists of cellulose, lignin and ash in various percentages when dried it is easily available. Therefore proper use of coir fiber in construction industry will reduce the environment problem.

In this investigation OPC grade 43 confirming to IS 12269-1987 whose specific gravity was 2.99 and initial setting time was 38 minutes. Natural river sand was used as fine aggregate which is confirming to IS 383-1970. We had used coconut fiber which replaced river sand coir fiber. It was obtained from coir industrial plant which was chopped into 1cm, 1.5cm, 2cm, and 2.5cm and replaced sand by weight of 2.5%, 5%, and 7.5%. 20mm sized crushed granular aggregates conforming to IS 338-1970 whose specific gravity 2.78 was used as worse aggregates. No. of specimens casted were 72 cubes with addition of varying length and percentage of coir fiber were casted to conduct various tests and 3 specimens of sand concrete were also prepared. The tests performed were compressive strength test and flexural strength test and the following results were derived:

The Compressive Strength for 2.5%, 5%, 7.5% replaced coir fiber after 7 days was 18 N/mm^2, 17.5 N/mm^2 and 15.2 N/mm^2 respectively. The flexural strength for 2.5%, 5%, 7.5% replaced coir fiber was 6.3 N/mm2, 5.7 N/mm^2, 4.8 N/mm^2 respectively.

Concrete fiber being low in density tends to reduce the self-weight of the fiber reinforced concrete hence it can be used as a structural light weight concrete.

4.4 B.Harini ,V.Ramana: Use of recycle plastic waste as partial replacement of fine aggregates in concrete.

In this paper B. Harini and V. Ramana studied the use of recycled plastic waste as partial replacement of fine aggregates in concrete. The investigation had been carried out, the strength properties of M30 grade concrete was studied with different plastic percentage proportions. The various plastic proportions were 5%, 6%, 8%, 10%, 15%, 20% by volume. They studied strength properties of these mixes there is decrease in compressive strength.

The main objective of this investigation was to study strength properties after partially replacing fine aggregates with plastic. In this study, M30 grade concrete with w/c of 0.40 workability, compressive strength, tensile strength, flexure strength were studied. The material used in this investigation are Zauri OPC 53 grade cement conforming IS 12269:1987 and IS 388:2003 and natural river sand recycled pet plastic, worse aggregates, water, master glenium formerly B 223 as admixture of BASF company. The mix design were made confirming IS 10262:2009. Ten mixes were made in investigation included reference mix and other than reference mix. The mixture were partially replaced plastic to fine aggregates 5%, 6% ,8%, 10%, 15%, 20%.

By increasing the waste plastic to fine aggregate, result show tendency to decrease the compressive strength. The compressive strength after 7 days when 0%, 5%, 6%, 8%, 10%, 15%, 20% replaced by plastic waste was 28.2 N/mm^2, 27.66 N/mm^2, 27.6 N/mm^2, 27.24 N/mm^2, 26.52 N/mm^2, 25.26 N/mm^2 and 24N/mm^2 respectively.

By partially replacing fine aggregates with 20% of plastic in concrete, the compressive strength has been decreased by 14.89% when compared to reference mix. By taking the mix which has least compressive strength. We have had enhanced it by using a partial replacement to cement of silica fume by 5%, 10%, 15%. The mix in which 15% of silica fume was used as binder the compressive strength increased by 22.5% when compared to mix with no silica fume and plastic percentage of 20%.

4.5 ***Mohammad Zakaria, Mashud Ahmed, Md. Mozammel Hoque and Abdul Hanan: The effect of jute yarn on the mechanical behavior of concrete composites.***

This study shows the effect of jute yarn on the mechanical behavior of concrete composites. The objective of the studies is to investigate the effect of introducing jute yarn on the mechanical properties of concrete. Jute fiber is produce abundantly in nature and hence it is very cheap. If the investigation is successful, than it will not only enhance new way in the properties of concrete but it will also explore the use of jute. This restrict the utilization of polymer which is environmental detrimental. To accomplish the investigation they perform the compressive , flexure and tensile strength by forming cylinders, cubes, prisms of standard dimension have been made by introducing jute yarn varying the mix proportion of ingredients in concrete water cement ratio length and volume of yarn to know the effect of parameters as mentioned. The yarn was cut in different length (10,15,20, and 25 mm) and volume content of jute yarn(0.1,0.25,0.5,0.75%)

The different parameters of concrete composites the length and volume fraction of the jute yarn content were used. The different length of yarn 10,15,20 and 25 mm and the content 0,0.1,0.25,0.50,and 0.75 % were used .The different specimen cubes (150mm x 150mm x 150mm_), prisms (450mm x 150mm x 150mm) and cylinders(150mm x 300mm) were cast to determine the compressive , flexure, and tensile strength of the composites respectively. The yarn was cut in mentioned length with the help of scissors after mixing all the ingredients the specimen were left for 24 hours for remolding. They were then cured in water for 28 days .At the end of curing period specimen were allowed to be dried in air for 24 hours before testing.

The addition of jute yarn contributes enriched results for mechanical properties of concrete composites for a particular yarn length and yarn content. More specifically, compressive , flexural, and tensile strength were found to enhance significantly for volume content of 0.1 and 0.25% and the yarn cut length of 10 and 15mm.

4.6 SaandeepaniVjje, Dr.N.R.Krishnamurthy (2013): Study on addition of the natural fiber into concrete.

For studying the addition of natural fibers to concrete in order to determine the strength properties and to observe is there any reduction in prorogation of shrinkage cracks problems. Basically natural fiber are of two type; Natural organic fiber such as Basalt, Asbestos etc. and other are natural organic fibers such as coconut, palm leaf, jute, sisal, banana, pine sugarcane ,bamboo etc. The work on M30 grade of concrete as per IS:456-2000 for fiber-cement ratio 0.5%,1%,1.5% were carried out with fiber length of 6mm-10mm chopped. The mixing was done in such a way that particular ingredients were mixed dry in electric concrete miller for 2 minutes and then the fibers were spread into the miler while mixing and after 2 more minutes, the particular water was added and mixed thoroughly for 3 minutes. The mixture was then quickly tested for slump and poured into the mould which was readily placed on the electric vibrators in three layers .After few seconds of vibration the surface was properly leveled before it is hardened then left the mould for drying for 24 hours. Then remove the mould and placed it in for curing.

While mixing, the fiber-cement ratio was increasing. The slump decreased due to water absorption of fibers. Based on absorbency, different fibers possess different change in the slump values. The results obtained were:

The slump was increasing rapidly as the fiber-cement ratio was increasing. The slump for jute fiber when used 0.5% was 70mm, 1% was 45mm, 1.5% was 50mm. The compressive strength for jute 0.5% was 47.2 N/mm^2, 1% was 45.64 N/mm^2, and 1.5% was 44.44 N/mm^2.

The addition of fibers increased compressive strength with 0.5% fiber cement ratio and little increase for 1% of fiber cement ratio compared to plain concrete. But at 1.5% of fiber of fiber cement ratio, though plasticizer were added. The compressive strength was decreased as compared to plain concrete.

V. Conclusion

Following are the conclusion can be made based upon the studies made by various researches:

5.1 The use of plastics in the mix lowers the density, compressive strength, tensile strength of concrete. Moreover it makes the concrete more ductile. This increases the ability of concrete to deform before failure.

5.2 Compressive strength, Flexural Strength and slump tend to decreases on increasing the ratio of plastic waste in concrete.

5.3 Coconut fibre reduces the self weight of the fibre reinforced concrete. Moreover it increases crack resistance property.

5.4 On increasing the plastic waste, workability increases because plastic used is smooth. Moreover The Compressive strength has been decreased on increasing the plastic aggregate. Tensile strength also decreases as plastic waste is increased.

5.5 Compressive, Flexural and tensile strength were found to enhance significantly. However, with larger yarn length and content the properties were affected adversely.

5.6 Slump is decreasing with the addition of fibres. The addition of fibres increases Compressive strength. Brittle fracture is also resisted.

References

1 Ashwini Manjunath, "Partial replacement of E-plastic waste as coarse-aggregate in concrete" ISSN: 1878-0296, Science Direct, Procedia environmental sciences 35 (2016) page no. 731-739.
2 Zainab Z. Ismail, Enas A. AL-Hashmi, "Use of waste plastic in concrete mixture as aggregate replacement", ISSN: 0956-053, Elsevier, Waste Management 28 (2008) page no. 2041-2047.
3 Bharat Kumar, Sandeep, "Parametric study on concrete by partial replacement of fine aggregate with coir fiber", ISSN: 2395-0056, IRJET, Volume: 03 issue: 08 Aug-2016, page no. 228-231.
4 B.Harini, V. Ramana, "Use of recycle plastic waste as partial replacement of fine aggregates in concrete" ISSN: 2347-6710, IJIRSET, Volume: 04 Issue: 09 September, 2015, page no. 8596-8603.
5 Mohammad Zakaria, Mashud Ahmed, Md. Mozammel Hoque and Abdul Hanan, "The effect of jute yarn on the mechanical behavior of concrete composites", ISSN: 0151-5047, Spinger, Volume: 05 issue: 2015, page no. 002-008.
6 Saandeepani Vjje, Dr. N. R. Krishnmurthy,"Study on addition of the natural fiber into concrete" ISSN: 2277-8616, IJSTR, Volume: 02, Issue: Nov, 2013, page no. 213-218.

Books

1. Concrete Technology (Thirteenth Edition) by A.M. Neville, Chapter 2 page no.30-35
Chapter 5, page no. 92
Chapter 6, page no. 109
Chapter 7, page no. 138
Chapter 16, page no. 314-338

2. Concrete Technology (Fifth edition) by M.L.Gambhir, Chapter 2 -page no. 77
Chapter 3 – page no. 63-69