Experimental Investigation on Fibre Reinforced Concrete using Waste Materials

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***Abstract* —** *Advancement in concrete technology enhances not only human comforts but also damage the ecology of environment. Use of metals as containers have become popular and safe, especially to carry liquids, in spite of the inherent advantages and disadvantages existent in its discarding. Today the construction industry is in need of finding cost effective materials for increasing the strength of concrete .Hence forth an attempt has been made in the present investigations to study the influence of adding of waste materials like lathe waste, soft drink bottle caps, empty waste tins, waste steel powder from workshop at a dosage of 1 % of total weight of concrete as fibers .The lathe waste ,empty tins, soft drink bottle caps were deformed into rectangular strips of 3 mm width and 10 mm length. Experimental investigation was completed using M25 mix and tests were carried out as per. recommended procedures by relevant Indian Standard Codes The compressive strength test, split tensile test and flexural strength test were conducted and compared with conventional concrete results.*

***Keywords* —** *Empty waste tins, Soft drink bottle caps, Rectangular strips 3mm width and 10 mm length.*

I.INTRODUCTION

Concrete is a composite building material composed primarily of aggregate, cement and water. There are lots of formulations that have varied properties. The aggregate is normally coarse gravel or crushed rocks such as limestone, or granite, along with a fine aggregate such as sand. The cement, usually Portland cement, and other cementations materials such as fly ash and slag cement, serve as a binder for the aggregate. Various chemical admixtures are also added to achieve different properties. Water is then mixed with this dry composite which enables it to be shaped and then solidified and hardened keen on rock-hard strength through a chemical process known as hydration. The water react with the cement which bonds the other components together, eventually create a robust stone-like material. Concrete have comparatively high compressive strength, but lower tensile strength.

Concrete is extensively used for creation architectural structures, foundations, brick/block walls, pavements, bridge/overpasses, motorways/roads, runway, parking structure, dams, pool/reservoirs, pipes, footings for gates, fences and poles and even boats. Structures complete of concrete can have a long service existence. As concrete has a high thermal mass and extremely low permeability, it can create for energy efficient housing.

II. LITERATURE REVIEW

1. Saud Al Otaibi (2008),"Recycling Steel Mill Scale as Fine Aggregate in Cement Mortars"

During the processing of steel inside steel mills, iron oxides will form on the surface of the metal. These oxides, known as mill scale, occur during incessant casting, reheating, and hot rolling operations. The scale is removed by water sprays and composed then disposed of by discarding. A local steel manufacturing company generates quantity reaching almost 7000 tons/year. This paper presents preliminary findings of a learn that investigates the potential for recycle steel mill scale into concrete. The composition of the steel mill scale was determined by XRF. Several mortar mixes were complete using the creation as a replacement for the fine aggregates. Compressive strength, flexural strength and drying shrinkage were precise for dissimilar specimens from the mortar mixes. The results are promising and encourage further study in exact application in concrete, brick, and block manufacturing.

2. Venu Malagavell and Neelakanteswara Rao Patura,(2011), "Strength Characteristics of Concrete Using Solid Waste an Experimental Investigation"

Concrete is a mixture of cement, fine aggregate, coarse aggregate and water. Concrete plays a vital role in the development of infrastructure, buildings, industrial structures, bridges and highways etc. leading to utilization of large quantity of concrete. Solid waste disposal i.e. water bottles, polythene bags, disposable glasses, cement bags, cool drink bottles etc. was creating lot of environmental problems. An attempt has been made in this study by using solid waste (non-biodegradable) material in the concrete. Fibre Reinforced Concrete (FRC) is an emerging field in the area of Concrete Technology. This study mainly focused on the use of cement bags waste (High Density Polyethylene (HDPE)) in concrete. Concrete having compressive strength of 30 N/mm2 was used for this study. Cubes, cylinders and beams are casted with 0 to 6% of fibre with 0.5% increment. Samples were tested for the compressive strength, split tensile strength and Flexural strength and comparison analysis was made for the conventional concrete and modified concrete. It has been found that, increase in the compressive strength, split tensile strength and flexural strength of concrete by using the fibres up to some extent.

(**3. ZainabZIsmail and EnasaAl-Hashmi (2011), "Validation of Using Mixed Iron and Plastic Wastes in Concrete"**

Metals and plastics waste materials generate serious environmental problems, mainly owing to the inconsistency of the wastes streams. The reason of this paper is to evaluate the possibility of using mixed iron filings and granulated plastic waste materials simultaneously to partially alternative the fine aggregate in concrete composites. Type I Portland cement was mixed with the aggregates to create the concrete composites. Three weight fractions (30, 40, and 50%) of iron filings waste aggregate were used along with 5% of granulated plastic waste. The slump, compressive and flexural strengths as well as the fresh and hard density of the concrete mixture were determined. The results of the mechanical properties were analysed in comparison to the control specimens. The main findings of this investigation revealed that the mixture of iron filings and plastic waste materials could be used successfully as partial substitutes of sand in concrete composites. rising the granulated plastic waste in the mixed aggregate waste materials up to 10% did not seriously hinder the strength properties of the waste-concrete specimens.

4. R.Kandasamy and R.Murugesan(2011), "Fibre Reinforced Concrete Using Domestic Waste Plastics as Fibres"

Fibre Reinforced Concrete FRC) is a composite material consisting of cement based matrix with an ordered or chance division of fibre which can be Steel, Nylon, Polythene and etc. The addition of steel fibre increases the properties of concrete, viz., flexural strength, impact strength and shrinkage properties to name a few. A number of papers have previously been published on the use of steel fibres in concrete and a considerable amount of research has been directed towards study the various properties of concrete as well as reinforced concrete due to the addition of steel fibres. Hence, an attempt have been complete in the present investigations to study the influence of addition of polythene fibres (domestic waste plastics) at a dosage of 0.5% by weight of cement. The properties studied include compressive strength and flexural strength. The study were conducted on a M20 mix and tests have been carried out as per recommended procedures of pertinent codes. The results are compared and conclusions are complete.5.

5. Youjiang Wang H.C.Wu and VitorC.Li (2000) ,"Concrete Reinforcement with Recycled Fibers"

Fibre reinforcement can effectively increase the toughness, shrinkage, and durability characteristics of concrete. The use of recycled fibres since industrial or postconsumer waste offers extra advantages of waste reduction and resources preservation. This paper reviews some of the work on concrete reinforcement using recycled fibres, counting tire cords/wires, carpet fibres, feather fibres, steel shavings, wood fibres from paper waste, and high density polyethylene. This paper also provides a summary of the properties and applications of concrete reinforced with these fibres.

IV.SCOPE AND OBJECTIVE

Scope

- To increase the strength of concrete.

Objective

- To conduct laboratory test to check the properties of cement, sand and aggregates.
- To conduct laboratory test to check the strength of fiber reinforced concrete.
- To compare the strength of the normal concrete to the reinforced concrete fiber

III.NEED FOR STUDY

Today the construction industry is in require of finding cost effective materials for increase the strength of concrete structure. Hence an attempt has been made in the present investigations to study the influence of adding of waste materials like lathe waste, soft drink bottle caps, empty waste tins, waste steel powder so as to increase the strength of concrete, Since the concrete is inherit weak in tension. it comparatively possess little resistance and ductility to cracking .these cracks propagate on applications of loads, Which leads to brittle fracture of concrete.

The following techniques are adopted to improve the strength of concrete.

- Introduction of steel reinforcement.
- Introduction of several layers of wire mesh.
- Addition of chemicals and resins.
- Introduction of pre-compression by the pre-stressing techniques.
- The addition of both long and short fiber.

However this method do not increase the tensile strength of concrete, it has been recognized that the addition of small fibers to the concrete matrix improve the basic properties. The fibers inhibit cracks formation thus acting crack arrester. And recycled material has been used for two decades in concrete manufacturing. it deserves attention environment and economic consideration. Hence the influence of steel fiber with non-conventional is studied and its performance investigation.

V.MATERIALS USED

Concrete has become an indispensable construction material. In this experimental work specimen of cubes, beam and cylinders were made using concrete. The concrete is a mixture in definite proportions of cement, fine and coarse aggregates and water. Sand forms the fine aggregate while the gravel forms the coarse aggregate. Sand procured locally was used as fine aggregate. Gravel of size 20mm was used as coarse aggregate. The grades of concrete used were M25. The mix proportion used for mix was 1:1:2. The water cement ratio adopted was 0.45 for determining the water content.

Waste materials

The metallic wastes obtained from a variety of sources such as mild steel lathe waste, empty beverage tins, soft drink bottle caps are distorted into the rectangular form with an approximate size of 3mm wide and 10mm long as in the form of fibres. These fibres are additional in the concrete with 1% by weight of concrete.

Fig-1 waste tins (before cutting)

Fig-2 Soft drink caps steel powder.

VI.SPECIFIC GRAVITY TEST FOR FINE AGGREGATE

Specific gravity is the ratio of the weight of given volume of a substance at a given temperature to the weight of an equal volume of a orientation substance. The reference substance is always water for liquids and air for gases.

Scope and objective

The objective of the test is to determine the specific gravity of fine aggregate passing through 4.75mm IS sieve by pycnometer.

Material and equipment

- Pycnometer with conical brass cap
- Electronic balance

***Observation and calculation*:**

Mass of pycnometer (M_1) = 0.595 Kg

Mass of pycnometer + mass of dry soil (M_2) = 1.275 Kg

Mass of pycnometer + soil + water (M_3) = 1.88 Kg

Mass of pycnometer + water (M_4) = 1.455 Kg

$$G = \frac{1.275 - 0.595}{(1.275 - 0.595) - (1.88 - 1.455)}$$

G = **2.67**

The specific gravity(G) = **2.67**

Fig-3 Pycnometer test

VII.SIEVE ANALYSIS FOR FINE AGGREGATE

The percentage of various sizes of particles in the soil can be determined by sieve analysis. The sieve analysis is the true representative of grain size distribution, since the test is not affected by temperature, etc.

Scope and objective

The objective of the test is to determine the fineness modulus and grain size distribution of fine aggregate by sieving.

Material and equipment

- Set of IS sieves : 4.75mm, 2.36mm,1.18mm, 600µ, 300µ, 150µ
- Electronic balance

Calculation

Fineness modulus of sand = (cumulative % retained

= 256/100

= 2.56

Fineness modulus of fine aggregate = 2.56

VIII.BULK DENSITY TEST FOR SAND

Bulk density is defined as the total mass per unit volume of material. It is expressed in terms of g/cm^3 or kg/m^3.

Scope and objective

The objective of the test is to determine the bulk density of fine aggregate by sand replacement method.

Material and equipment

- Sand pouring cylinder
- Calibrating cylinder
- Electronic balance

Calculation

Bulk density, ρ= W/V = 16.96/12870

ρ = 1317 Kg/m^3

IX.WATER ABSORPTION TEST FOR COARSE AGGREGATE

Scope and objective

The objective of the test is to determine the percentage of water absorption of coarse aggregate.

Material and equipment

- Wire basket
- oven
- Electronic balance

Observation and calculation

Weight of aggregate (W_1) = 2 Kg

Weight of saturated surface = 2.12 Kg by sample (W_2)

Weight of oven dry sample (W_3) = 2.095 Kg

% Water absorption = (W_2-W_3) / W_3 X 100

X. IMPACT VALUE FOR COARSE AGGREGATE

Scope and objective

The objective of the test is to determine the impact value of coarse aggregate.

Material and equipment

- Cylindrical measure
- Tamping rod
- Impact testing machine
- Electronic balance

Observation and calculation

Wt. of empty cup = 1.755 Kg

Wt. of empty cup + aggregate = 2.405 Kg

Wt. of aggregate (A) = 0.65 Kg

Wt. of aggregate passing through 2.36mm sieve (B) = 0.04 Kg

Aggregate impact value =**6.15%**

XI.CASTING

- After the mix is formed the mix is put in the cube mould in three layers and each layer is compacted by giving 25blows using tamping rod.

Fig-4 Compaction of mix in the cube mould

- Once the cube and cylinder mould filled with the mix the finishing work is done for making the top surface is level.
- After allowing setting for one day, the cube and cylinder is demoulded and put for 28 days curing.
- In the similar way the mix is put in the cylinder mould and compacted by giving 25blows using tamping rod

XII.CURING

After 7days and 28days, the cube specimens were separate from curing tank and taken for testing. After 28days, the cylinder specimens and beam were removed from tank and taken for testing.

XIII.TESTING

Cubes of size 150mm X150mm X150 mm, cylinders with 150mm diameter X300mm height and prisms of size 100mmX100mmX500 mm were prepared use the standard moulds. The samples are casted using the four dissimilar waste materials. The sample are demoulded after 24 hours from casting and reserved in a water tank for 28 days curing. A total of 30 specimens are casted for testing the properties for instance compressive strength, split tensile strength and flexural strength.

XIV.COMPRESSIVE STRENGTH

Compression test of concrete for 150 X 150 X 150mm size cubes were conducted. All the cubes were tested in saturated surface dried condition. For each effluent a minimum of three cubes were tested using a concrete

compression testing machine. The loading was continued till the specimen reaches its ultimate load. The test is carried out by placing a cube specimen vertically between the loading surfaces of a compression testing machine.
The compressive strengh is calculated from the following formular;

$$\text{Compressive Strength} = W_f/A_p$$

Table 1: COMPARISION OF COMPRESSIVE STRENGTH RESULTS:

Strength of control mix in N/mm^2			Strength of Addition of TiO2 by 1.75% in N/mm^2			Strength of Addition of TiO2 by 2% in N/mm^2		
7 Days	14 Days	28 Days	7 Days	14 Days	28 Days	7 Days	14 Days	28 Days
20.44	25.55	31.11	24	27.11	33.33	26.6	29.5	34.7

Table 2: COMPARISION OF FLEXURAL STRENGTH RESULTS:

Strength of control mix in N/mm^2			Strength of Addition of TiO2 by 1.75% in N/mm^2			Strength of Addition of TiO2 by 2% in N/mm^2		
7 Days	14 Days	28 Days	7 Days	14 Days	28 Days	7 Days	14 Days	28 Days
4.8	6.0	7.5	5.1	5.7	6.6	5.25	6.15	7.8

Table 3: COMPARISION OF SPLIT TENSILE STRENGTH RESULTS:

Strength of control mix in N/mm^2			Strength of Addition of TiO2 by 1.75% in N/mm^2			Strength of Addition of TiO2 by 2% in N/mm^2		
7 Days	14 Days	28 Days	7 Days	14 Days	28 Days	7 Days	14 Days	28 Days
1.62	1.9	2.5	3.74	4.24	5.93	3.82	4.95	6.08

XV.SPLIT TENSILE STRENGTH

Split tensile test is an indirect tension test method. The test is carried out by placing a cylindrical specimen horizontally between the loading surfaces of a compression testing machine and the load is applied until failure of the cylinder, along the vertical diameter of the cylinder is subjected to a horizontal stress of

$$T = 2P/\pi DL$$

Fig-5: Split Tensile Test

Curing of concrete cylinders with industrial effluents E1, E2 and E3 over a period of 28 days have shown that there is a substantial increase in split tensile strength compared to conventional water curing. The percentage improvements in split tensile strengths after curing were establish

The specimens W1, W2, W3, and W4 also have a positive effect on the split tensile property. The tensile strength of those specimens were establish to be 25.74%, 26.47%, 40.81% and 26.10% more than that of the conventional concrete and is shown below.

XVI.FLEXURAL STRENGTH

Flexure test of concrete specimens of size 500X100 X 100mm was conducted in a universal testing machine. All the prisms were tested in saturated surface dried condition. For each effluent a minimum of three prisms were tested. The loading was continued till the specimen reaches its ultimate load. The flexural strength of concrete was obtained using the formula,

$$\text{Flexural strength} = 3PL/2bd2$$

Where,
P= Axial load
L = Supporting length of specimen = 420mm
b = width of the specimen
d = depth of the specimen
Similarly the flexural strength also has been increased due to the adding of those waste materials. The percentage increase of flexural strength of the specimens W1, W2, W3, W4 were found to be 25.88%, 9.70%, 23.53% and 12.94% correspondingly, as depicted in figure below.

Fig-6: Flextural Test**.**

XVII .CONCLUSION

The conclusions have been based on the results obtained from the experimental investigation:

1. The specimens with steel powder as waste material was found to be excellent in compression which had the compressive strength of 41.25% higher than the conventional concrete.

2. Better split tensile strength was achieved with the addition of the steel powder waste in concrete. The strength has improved up to 40.87% when compared to that of the conventional concrete specimen.

3. In flexure the specimen with soft drink bottle caps the waste material was found to be good. While addition the soft drink bottle caps the flexural strength improved by 25.88% that of the conventional concrete.

ACKNOWLEDGMENT

I express my sincere thanks to Mr.J.Rajprasad, Assistant Professor, Dept. of Civil Engineering, SRM University and Mrs.V.Anuradha, Assistant Professor, DMI College of Engineering for their valuable guidance, encouragement and suggestions given during the entire period of work.

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