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Waste Foundry Sand and Rubber Tyre as a Substitute for Aggregates in Concrete

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ABSTRACT: From the last few years, various project had done work in concreting and invent various techniques and methods to produce concrete which has the desired properties. Concrete is one of the most vital and common materials used in the construction field. The current area of research in the concrete was introducing waste foundry sand (WFS)and rubber tyre in the ordinary concrete. Waste foundry sand is the byproduct of metal casting industries, which causes environmental problems because of its improper disposal. Thus, its usage in building material, construction and in other fields is essential for reduction of Environmental problems. This research is carried out to produce an eco-friendly concrete. This paper recommends the effective use of waste foundry sand as a partial replacement for fine aggregate and rubber tyre as a partial replacement for course aggregate in concrete. Ingredients for concrete are cement, course aggregate, Rubber tyre, fine aggregate and waste foundry sand. The aim of this project was to know the behavior and mechanical properties of concrete for its eco-friendly and economical use.

KEYWORDS: Universal testing machine, Compression tesing machine,Waste foundry sand and waste rubber tyre.

I. INTRODUCTION

Waste materials are being generated in large amounts by various industries now a day. Dumping or disposal of these waste materials causes various environmental and health problems. The utilization of industrial waste or secondary materials has encouraged the production of cement and concrete in construction field. Concrete prepared with such materials showed improvement in workability and durability compared to normal concrete and has been used in the construction of power, chemical plants and under-water structures. Over recent decades, intensive research studies have been carried out to explore all possible reuse methods

Foundry sand is basically high quality silica sand which is a by-product of both ferrous and non-ferrous metal casting industries. Industries use large amounts of sand as part of the metal casting process, which can be recycle and reuse the sand many times in a foundry. Foundry sand production is nearly 6 to 10 million tons annually. There are basically two types of foundry sand available, chemically bonded sand and Green sand. Green sand also known as the moulding sand that uses clay as the binding material, and chemically bonded sand that uses polymers to bind the sand grains together. Green sand is the most commonly used by foundries. High content of silica sand resists high temperatures while the coating of clay binds the sand together. Chemically bonded sands are used both in core making where high strengths are necessary to with stand the heat of molten metal, and in mould making. Most chemical binder systems consist of an organic binder that is activated by a catalyst although some systems use inorganic binders. Foundry sand can be used as an alternative by replacing fine aggregate.

In recent decades, the worldwide growth of the automobile industry and the increasing use of cars as the main means of transport have tremendously boosted tire production. This has generated massive global issue for the environment. Discarded waste tyres often create black pollution because they are not readily biodegradable and pose a potential threat to the environment. The use of scrap tires including tire chips or tire shreds comprised of pieces of scrap tires, tire chip/soil mixtures, tire sidewalls, and whole scrap tyres. Rubber tyre can be used as an alternative by replacing coarse aggregate.

II. RELATED WORK

Pranita Bhandari et al discussed at artificial fine sand is replaced with waste foundry sand (0%, 10%, 20% 30% 40% 60% 80% and 100% in M25. Good value of compressive strength obtained at 10 %.M

Pendhari Ankush R and Demse Dhananjay G et al discussedPartial replacement of fine aggregate with foundry sand in concrete by 0%, 10%, 20%, 30%, 40% and 50% by weight. At 10% replacement of sand gives maximum strength at the age of 28 days.

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K.Charankumar &Dr.S.SiddiRaju et al discussed Replacement of coarse aggregate by 10% ,25%and 50% of rubber aggregate is used in M15 & M25. Reduction of compressive strength and tensile strength is noted.

Haolin Su, Jian Yang ,Tung-Chai Ling, Gurmel S. Ghataora Samir Dirar et al discussed Replacing the FA with 20% of tyre rubber with different sizes 3mm, 0.5mm & 0.3mm & sample of continuous size grading were used. Cubes casted of M40.Compressive strength of the concrete increased modestly with a decrease in the rubber particle size.Flexural strength decreased with decrease in rubber tyre chips.

III. METHODOLOGY

A.Collection of raw materials

Cement used in the work was PPC 43(Portland Pozzolana Cement) from cement store, Mannarmala. Fine aggregate use as M sand and collected from Moulana quarry, Perinthalamana. Coarse aggregate use as natural gravel and collected from Moulana quarry, Perinthalmana.

B. Collection of replacement material: waste foundry sandand waste rubber tyre

Two bag of foundry sand collected from Smart Cast, Coimbatore. Obtained black color waste foundry sand with lumps and fine particles.

The tyres collected are that of lorry and we cuts it in to desired shape and size with hand tools .The reason for choosing it is that they can give the required shape and size which is similar to the common natural gravel. For this study, rubber aggregate is prepared by manual cutting and sieved through 20mm IS sieve.

IV. MATERIAL PROPERTIES

A. Fine aggregate

M sand used. The properties of sand used are given in Table 1

Table 1: Preliminary test result of fine aggregate

Tests	**Results**	**IS 1489-1(1991) Specification**
Sieve analysis	Zone 2	Normal sand
Specific gravity	2.3	2.59

B. Coarse aggregate

Natural gravel used. The properties of coarse aggregate used are given in Table 2.

Table 2: Preliminary test result of coarse aggregate

Tests	**Loose**	**Compact**	**IS 2386 part 3, specification**
Specific gravity	3.26	2.88	2.6-2.8
Bulk density	1.53	1.73	1.52-1.68

Percentage of voids (%)	0.89	0.663	0.3-0.6
Porosity (%)	46.84	39.90	25-70

C. Cement

PPC 43 RAMCO brand is used.

Table 3: Preliminary test result of cement

Test conducted	Results	IS 1489-(1991) specification
Fineness	5%	<10%
Standard consistency	38%	25-35%
Initial setting time	120 min	>30 min

D. Waste foundry sand

Table 4: Preliminary test result of foundry aggregate

Tests	Results	IS 1918(1996), specification
Bulking	4% moisture	12% moisture
Sieve analysis	Zone 2	Normal sand
Specific gravity	2.3	2.3-2.7

E.Waste rubber tyre

Table 5: Preliminary test result of rubber tyre

Tests	Results
Bulk density in kg/m	0.445
Void ratio(%)	0.838
Specific gravity	1.25

V. EXPERIMENTAL TEST PROGRAM

Test conduct as compression test with cubes, split tensile test with cylinder and flexural test with cuboid after 28 days of curing. Casting the specimen in metal moulds.
After 24 hours, the specimen has to be removed from the mold and water cured for 28 days by keeping them in a water tank. The water used for curing was similar in standards with that used for casting. After 28 days, specimens to be taken out and kept ready for testing.

Table 6: Casting of M20 concrete

Specimen	**Size in cm**	**Number of specimen in each set**
Cube	15 x15 x 15	3
Cuboid	50 x 10 x 10	3
Cylinder	15 dia x 30	3

Check the suitability of partial replacement of fine aggregate with foundry sand and coarse aggregate with rubber tyre pieces in conventional concrete. The investigation was done experimentally by casting concrete cube, cuboid and cylindrical specimens and through laboratory testing. The strength performance of this concrete with conventional concrete is mainly investigated and results were recorded.

Table 7: Percentage of foundry sand and rubber tyre

Sets of concrete	**% of rubber waste replaced**	**% of foundary sand waste replaced**
SET A	0	0
SET B	5	10
SET C	10	10
SET D	15	10
SET E	20	10

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Figure 1: Universal testing machine(UTM)

Figure 2: Compression tesing machine

VI. TEST RESULTS AND DISCUSSIONS

The test result indicate that decrease in compressive strength, flexural strength and split tensile strength. These findings indicates that it is not advisable to use rubber tyre aggregate and foundry sand in concrete mixes for high strength and load bearing applications.

The experiment showing the properties of percentage addition of rubber tyre waste as coarse aggregate and foundry sand as fine aggregate mixed in concrete of grade M20.The test result indicate that decrease in compressive strength and these findings indicates that it is not advisable to use rubber tyre aggregate and foundry sand in concrete mixes for high strength and load bearing applications. However these concretes mixtures can be used in other applications for non-load bearing components such as road paving, flooring, terrace and other auxiliary construction activities. Using these mixtures of concrete in such applications can help to prevent pollution and over come the problem of storing used tyres and also the foundry sand makes the concrete ecofriendly .Advantages if using rubber aggregates to replace and is coarse aggregate is that waste rubber tyre is expensive to store and is a hazard, can be reused. Rubber tyres storage requires large areas since about 80% of a tyre is made of voids.

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Table 8: Compression strength, Flexural strength, Split tensile strength in N/mm^2

Sets	A	B	C	D	E
Compression strength	23	27.11	15.9	16.8	15.6
Flexural strength	2.96	4.2	3.6	3.83	2.9
Split tensile strength	2.55	2.91	2.08	1.74	1.69

Replacement of fine aggregate with 10% of foundry sand and coarse aggregate with 5% of waste rubber tyre in concrete gives compressive strength as 27.11N/mm^2, flexural strength 4.2N/mm^2 and split tensile strength 2.91N/mm^2 at 28 days gives good result. The findings indicates except above mix, it is not advisable to use these composition of mixtures for load bearing applications. These concrete can be used for non load bearing application in construction field.

VII. CONCLUSIONS

The experiment showing the properties of percentage addition of rubber tyre waste as coarse aggregate and foundry sand as fine aggregate mixed in concrete of grade M20.The test result indicate that decrease in compressive strength and these findings indicates that it is not advisable to use rubber tyre aggregate and foundry sand in concrete mixes for high strength and load bearing applications. However these concretes mixtures can be used in other applications for non-load bearing components such as road paving, flooring, terrace and otherauxiliary construction activities. Using these mixtures of concrete in such applications can help to prevent pollution and over come the problem of storing used tyres and also the foundry sand makes the concrete ecofriendly

- The test result show decrease in compressive strength, flexural strength and split tensile strength
- Replacement of fine aggregate with **10% of foundry sand and coarse aggregate with 5% of waste rubber tyre** in concrete gives compressive strength as 27.11N/mm^2 , flexural strength 4.2N/mm^2 and split tensile strength 2.91N/mm^2 at 28 days
- The findings indicates except above mix, it is not advisable to use these composition of mixtures for load bearing applications
- These concrete can be used for non load bearing application in construction field.

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