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Experimental Investigation on Strength of Concrete by Partial Replacement of Fine and Coarse Aggregates with Iron ore tailing and Rubber Chips

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Abstract: **Concrete is a composite material composed of cement, fine aggregates, coarse aggregates and water. Now a day's construction cost is very high with conventional material due to unavailability of natural materials. This problem can be solved by total replacement of concrete with the different material which is not convenient in terms of required properties. Due to this limitation of unavailability of material which plays the vital role of concrete we have the only choice of partial replacement of concrete ingredients by waste material. In this project, an attempt is made to find the variation in strength properties of concrete on partial replacement of fine aggregate and coarse aggregate by iron ore tailing (IOT)and rubber chips respectively. Experiments were conducted to determine the suitability of rubber chips and IOT as coarse aggregates and fine aggregates respectively for concrete. Compression, Split tensile and Flexure test were carried out for different percentage of rubber chips and IOT for 3%, 5%, 6%, 9%, 10%, 20% and 5%, 10%, 12%, 20%, 24%, 30%, 36% respectively. The results are convenient up to 50% usage of Rubber Chips and IOT.**

Keywords: Iron ore tailing, Rubber crumbs, compression strength, split tensile strength and flexure strength.

I. INTRODUCTION

In past few years, waste has been increased day by day all over the world. As it causes environmental problems, some of the waste can be utilized in the concrete as additives, such as scrap rubber and iron ore tailing which are obtained from different industries. In India about 15 million tons scrap rubber waste are generated per year as well as iron ore tailing estimated about 11 million tons per year. The rubbers after use doesn't decompose easily due to its composition and it can't be burnt as it emits poisonous gases when burnt. Even IOT doesn't decompose easily as it is mineral waste and it pollutes the environment. To avoid these problems these materials can be used as partial replacements for aggregates in concrete.

Ali Umar Shettima, Mohd Warid Hussin, Jahangir Mirza, 2016[4] reported that IOT enhances compressive and splitting strengths, durability property up to 25% replacement. Partha Saika, Owais Mushtaq and A.Arunya, 2016[2] reported that rubber chips can be used in light weight concrete as it decreases the density of concrete, compressive strength of the concrete decreases as there is increase in the rubber chips. Francis Atta Kuranchie, Sanjay Kumar Shukla, Daryoush Habibi and Alireza Mohyeddin, 2015[3] reported that concrete with IOT has low potential of corrosion and low potential of acid attack. Mohd Kharim, Naim Ibarahim, Dr.Mohd Yunus Ishak, 2016[5] reported workability of rubberized concrete decreases as percentage of rubber increases, due to lack of cohesiveness and proper bonding between rubber and cement

Causes shear slump.

II. MATERIALS

A. Cement and aggregates

For concrete, conventional materials such as cement, sand and crushed stone aggregates were used.

B. Iron ore tailings and rubber chips

Iron ore tailings obtained from steel industry. The particle size ranges from 75µ to 4.75mm.. And scrap rubber tyres are collected and cut into different size passing through 12mm and retained on 10mm sieve as shown in fig.1 & fig.2.

C. Figures

Fig. 1: Iron ore tailing

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Fig. 2: Rubber chips

III. MIX PROPORTION

Table 1 shows the mix proportion according to IS1026-2012 for M25 grade concrete. Cement 43grade, coarse aggregates of 20mm down size and water cement ratio 0.4.Design slump 100mm. without use of any super plasticizers.

Eight batches of mix proportions were prepared with different percentage of IOT and rubber chips (Table 2)

Table 1

Mix proportion

Cement (kg)	Fine aggregates(kg)	Coarse aggregates(kg)	Water cement ratio
1	1.45	2.48	0.4

Table 2

Percentage replacement

Sample	IOT %	Rubber chips %	Total %
1	0	0	0
2	5	5	10
3	12	3	15
4	10	10	20
5	24	6	30
6	20	20	40
7	36	9	45
8	30	20	50

IV. EXPERIMENTAL PROGRAM

A. Casting and curing

For each concrete mix, cube size of 150x150x150mm, cylinder size 150x300mm, beam sizes 500x100x100mm were casted. The cubes were used as testing specimen for determining compression strength, cylinders were used as testing specimen for determining split tensile strength, and beams were used as testing specimen for determining flexure strength. All the specimens were remolded after 24 hours of casting and were cured in water.

B. Compressive strength split tensile strength and flexure strength

Compressive strength, split tensile strength and flexure strength were determined using compression testing machine with maximum loading capacity 2000kN. The results of compression test, split tensile strength and flexure strength is given in Table 3, Table 4 and Table 5 respectively.

V. RESULTS AND DISCUSSION

A. Workability

For fresh conventional concrete the slump value is 100mm. With increase in percentage replacement of IOT and rubber chips workability decreases. This is due to high water absorption capacity (16.27%) of IOT. The fineness modulus of IOT is 3.3; which is more than the M sand. The ease of flow of concrete is directly dependent on the fineness modulus of the specimen used in casting of concrete.

B. Compression strength

The compression strength test readings are shown in Table 3. The compression strength of different percentage of replacements of IOT and Rubber chips at 7 days and 28 days were decreasing as the percentage of additives increases. This result was obtained due to the smooth surface texture of rubber as it has poor bond with the aggregates and cement.

Table 3

Compression test 1

Sl. no	Total replacement (%)		Compression strength(N/mm^2)	
	IOT	Rubber chips	7 days	28 days
1	0	0	25.25	30.5
2	12	3	24.9	33.28
3	24	6	24.25	32.57
4	36	9	20.43	28.93

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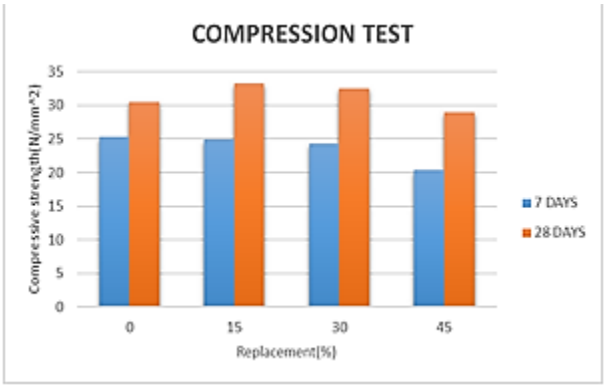


Compression test 2

Sl. no	Total replacement (%)		Compression strength(N/mm^2)	
	IOT	Rubber chips	7 days	28 days
1	0	0	25.25	30.5
2	5	5	24.9	31.8
3	10	10	20.9	28.74
4	20	20	14.64	15.9
5	30	20	15.63	17.63

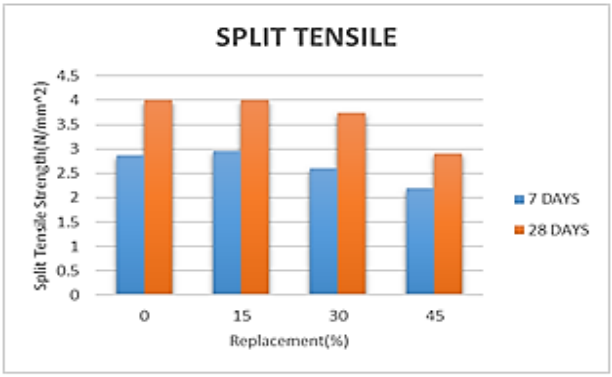
C. Split tensile strength

The split tensile strength test readings are shown in Table 4. The test are carried out splitting tensile testing machine as per IS 5816-1999 and the results are determined for both 7days and 28 days of curing. The result shows that the split tensile strength increases in the concrete sample containing up to 30% replacement which is higher than the conventional concrete. Ali umara shettima and group [4] concluded that the splitting tensile strength has been increased up to 75% of replacement of IOT. Partha saika and group [2] concluded that the splitting tensile strength has been increased up to 4% replacement of rubber chips. Further increase in rubber chips the split tensile strength decreases. Since we combine both IOT and Rubber chips the results obtained are more than the conventional concrete.

Table 4

Split tensile strength

Sl. no	Total replacement (%)		Split tensile strength (N/mm^2)	
	IOT	Rubber chips	7 days	28 days
1	0	0	2.87	3.88
2	12	3	2.96	4.08
3	24	6	2.60	3.74
4	36	9	2.2	2.9



D. Flexure strength

The flexure strength are shown in Table 5;

The test has been conducted for single point load. It has been shown that the flexure strength decreases for 20% of replacement of additives which is less than the conventional concrete.

Table 5

Flexure strength

Sl. no	Total replacement (%)		Flexure strength (N/mm^2)	
	IOT	Rubber chips	7 days	28 days
1	0	0	6.405	7.91
2	10	10	3.89	5.23
3	20	20	3.75	4.8

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VI. CONCLUSION

• The compressive strength of concrete increases compared to conventional concrete up to 30% (24% IOT+6% Rubber aggregate) replacement. Further increase in percentage replacement reduces the strength.
• The split tensile strength of concrete increases up to 30% replacement (24% IOT+6% Rubber aggregates). Further increase in percentage replacement reduces the split tensile strength comparing to conventional concrete.
• The flexure strength of concrete decreases compared to conventional concrete with increase in percentage replacement.
• The unit weight (density) of concrete reduces as increase in the percentage replacement compared to conventional concrete due to this reason this concrete can be used for construction of light weight structures.
• It is recommended to use silica fumes as admixture in concrete for proper bonding of rubber aggregates due to which workability increases which directly increases compressive strength.
• Due to use of IOT the pH value increases due to which the concrete has high resistance to acid and Sulphur attack.

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