Study of RUBCRETE as an Alternate Material to Conventional Concrete

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1. ABSTRACT :

In recent times, Non- Bio Degradable waste has been a major problem in World. In our Day-to-Day life due to increased consumption of the materials like Plastic, Rubber, Glass in Domestic and Industrial activities in rapidly developing countries like India, USA, Germany etc., it has been creating major harm to the Environment. About 6.3 billion tons of plastic waste, 3.5 billion tons of Rubber waste has been generated in the world so far. If this continues, then our future generations will have to face many serious problems. The probable solutions to reduce their damage to the Environment are either reducing their usage in daily times or recycling them. The first choice is inevitable, as we are habituated using these products. It is possible to adopt the latter. Using proper techniques, Rubber and other materials could be used in construction and other activities by adopting latest technologies. Our research is about, how we could properly use the Scrap Rubber as a Replacement material to Coarse Aggregate in Concrete and minimize the use of Coarse Aggregate. Concrete is a versatile, legendary and supremely strong material which is manufactured with the combination of Cement with Aggregates and Water. It is used in Construction of Structural Elements like Foundations, Columns, Beams and Slabs. It has been ruling the Construction industry since mid 1800's.By Replacing Coarse Aggregate with Rubber, it will save the Environment against Pollution from Rubber and Extraction of Aggregates through Quarrying. This will be a major boon towards the Environment. The Concrete obtained by Replacing Coarse Aggregate with Rubber can be called as ''RUBCRETE''. Cost analysis comparison is also done in this paper for rubcrete concrete and conventional concrete.

KEY WORDS:

Compressive Strength, Cost Analysis, Rubcrete, Strength Characteristics,.

2. LITERATURE REVIEW :

Zaher K. Khatib and Fouad M. Bayomy [1] have investigated on workability of rubcrete, and reported that there is a decrease in slump with increase in rubber content by total aggregate volume. They further mentioned that at rubber contents of 40% by total aggregate volume, slump was almost zero, and concrete was not workable manually.

Güneyisi E, Gesoğlu M, Özturan T[2] have investigated and found that there has been drastic fall of compressive strength of concrete upon the increase of rubber content. But,

upon by introducing Silica Fume into Concrete have improved the Mechanical properties and gradually minimized the loss of strength.

E. Ganjian, M. Khorami and A. A. Maghsoudi[3] have noticed that the Compressive strength of Concrete depends upon 2 factors., Grain Size of Rubber and Percentage of Rubber added to concrete. And they have also noticed that With 5% replacement of Rubber to Aggregates, the decrease in the compressive strength was very low (lower than 5%) and also, the replacement of Rubber to coarse aggregate have drastically pulled down the Flexural Strength for about 37% for Concrete.

C. E. Pierce and M. C. Blackwell[4] have performed an extensive research on concrete using crump rubber and concluded that , Usage of Crump rubber in Mortar or Concrete have reduced the Mass Density and Compressive Strength, while there was an improvement in Ductility Property. They have also quoted that usage of crump rubber gives of a proper flowable concrete in a eco-friendly and most economical manner.

3. MATERIALS AND METHODS:

The Primary Materials required for this process of Research are Cement, Fine Aggregate, Course Aggregate, Water, and Rubber.

3.1. CEMENT:

Cement is one of the basic construction material that will be generally in powdered form and hardens upon the addition of water to it. It can serve as a binding material to aggregates to obtain strength. It possesses cohesive and adhesive properties. The cement used for this research is Ordinary Portland Cement of 53 Grade (As per Indian Standards). Generally, it's Specific Gravity is 3.15 [6]

3.2. AGGREGATES:

Aggregates are the most important elements for the concrete. They add shape, body and strength to the concrete. They occupy about 70% of the Volume of concrete [6]. They also enhance the Bulk Density of Concrete.

3.3. FINE AGGREGATE:

The Aggregate passing through IS: 4.75 mm sieve could be called as Fine Aggregate [6]. Generally, Fine Aggregate is a filling material for the Concrete. The Fine Aggregate used for this project is River Sand. The Specific Gravity of Fine Aggregate is 2.4 to 2.6 [6].

3.4. COARSE AGGREGATE:

The Aggregate passing through IS: 20 mm sieve and retained on IS: 4.75mm sieve could be called as Coarse Aggregate. Generally, Coarse Aggregate is a material that enhances the strength and stability for the Concrete. The Coarse Aggregate used for this project is from Miyapur Quarry. The Specific Gravity of Fine Aggregate is 2.4 to 2.6 [6].

3.5. RUBBER:

Rubber is an inorganic material that is obtained from Latex collected from Tapped Rubber trees. It has a property to compress and is a ductile material. The Rubber used for this research is Scrap gaskets of 20mm thick and 100mm diameter, from IDA Jeedimetla, cut into 20mm size pieces.

Generally, the Specific gravity of Rubber is 1.52.

3.6. WATER CEMENT RATIO:

Water cement ratio is one of the most important factors affecting the quantity of air. At very low water cement ratio, water firms on the cement will be insufficient to produce adequate foaming action. [6].

3.6. RUBCRETE:

Rubcrete is a Homogeneous material concrete, obtained by replacing the Coarse Aggregate in concrete in a specific quantity. The mixing of Rubcrete is not like that of mixing conventional concrete. Its process goes in a different way. Initially, the cement paste is prepared with respect to calculated weights. Fine and Coarse Aggregates and Rubber pieces are mixed separately as per the obtained weights. Then, cement paste is added to this mixture and then by thoroughly mixing this entire thing, we can get the fresh Rubcrete, which can be proceeded for further operations.

3.7. CONCRETE MIX PROPORTIONS:

For this Research, we have adopted 2 Concrete Grades M40 and M20 concrete respectively.

The Mix Design for these grades are done as per IS 10262-2009.

For, M40 Concrete (1: 1.4: 2.4) the quantities of Ingredients are as follows, [7]

TABLE: 1: Detail's of M40 Mix Proportion

Water	Cement	Fine Aggregate	Coarse Aggregate
180 kg/ m^3	450 kg/ m^3	630 kg/ m^3	1080 kg/ m^3

For M20 Concrete (1: 2:4) the quantities of Ingredients are as follows, [7]

TABLE: 2: Detail's of M20 Mix Proportion

Water	Cement	Fine Aggregate	Coarse Aggregate
180 kg/ m^3	378 kg/ m^3	756 kg/ m^3	1512 kg/ m^3

4. METHODS OF TESTING ON CONCRETE:

Concrete has to be properly tested at various stages in order to learn about its strength characteristics.

4.1 TESTS ON FRESH CONCRETE:

After Mixing the Concrete in Required proportions is done, it has to be tested before casting it. Here is a test for Fresh Concrete.

4.1.1. SLUMP TEST:

Slump Test is carried out to determine the Consistency and Workability of Fresh Concrete. It has a Frustum Cone and a tampering rod. We have to get proper workability of Concrete when test with this method as per standard norms [7] .

4.2 TESTS ON HARDENED CONCRETE:

After casting, compacting and curing the concrete for a certain period of time, we obtain the Hardened concrete which can further proceeded for the standard tests.

4.1.2. COMPRESSIVE STRENGTH TEST:

In order to determine the Compressive Strength of the Hardened specimen cube of Concrete of size 70.6mm x 70.6mm x 70.6mm, after 7, 14, 28 days of curing, the specimen will be

introduced into Compression testing Machine and the load will be applied on its cross-sectional area until the specimen fails.

5. RESULT'S AND DISCUSSIONS:

The Result's of the Tests done are mentioned below:

5.1. RESULTS OF TESTS ON FRESH CONCRETE:

5.1.1 SLUMP TEST (OR) WORKABILITY TEST RESULT'S:

TABLE: 3: Test Result's of M40 Grade Workability

Grade of Concrete	Percentage of Replacement of Coarse Aggregate with Rubber	Height of Slump (cm)
M40	0%	76
M40	30%	70
M40	50%	60
M40	100%	55

TABLE : 4: Test Result's of M20 Grade Workability

Grade of Concrete	Percentage of Replacement of Coarse Aggregate with Rubber	Height of Slump (cm)
M20	0%	72
M20	30%	68
M20	50%	63
M20	100%	60

5.2. RESULTS OF TESTS ON HARDENED CONCRETE:

5.2.1. COMPRESSIVE STRENGTH TEST RESULTS:

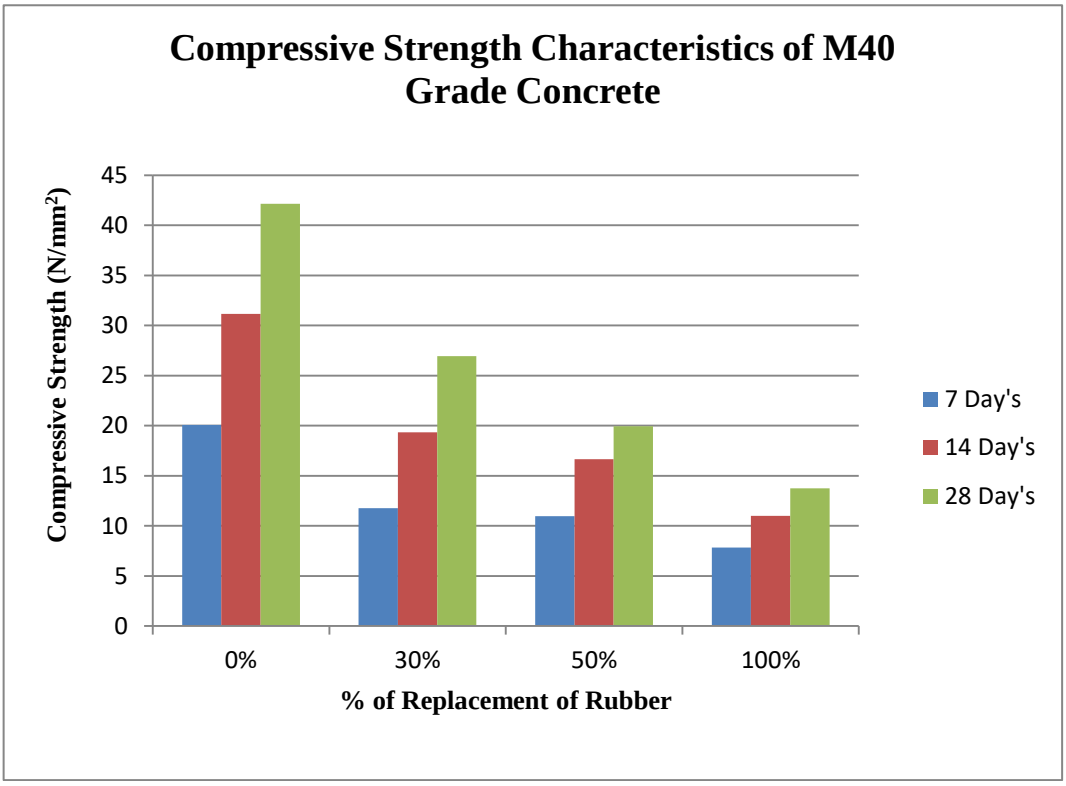
Table: 5 : Test Result's of M40 Grade Compressive Strength :

Grade of Concrete	Percentage of Replacement of Coarse Aggregate with Rubber	Cross-Sectional Area (mm^2)	Compressive Strength (N/mm^2)		
			7 day's	14 day's	28 day's
M40	0%	70.6mm x 70.6mm	20.07 /mm^2	31.17 N/mm^2	42.15 N/mm^2
M40	30%	70.6mm x 70.6mm	11.75 N/mm^2	19.35 N/mm^2	26.95 N/mm^2
M40	50%	70.6mm x 70.6mm	10.97 N/mm^2	16.66 N/mm^2	19.95 N/mm^2
M40	100%	70.6mm x 70.6mm	7.85 N/mm^2	11 N/mm^2	13.75 N/mm^2

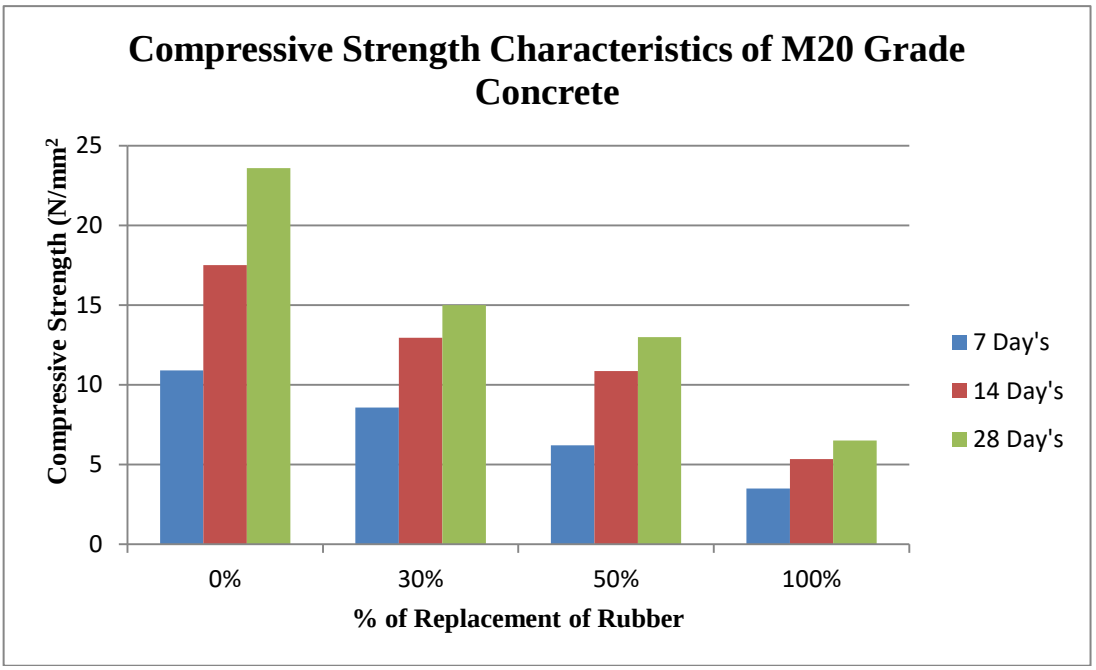
TABLE : 6: Test Result's of M20 Grade Compressive Strength:

Grade of Concrete	Percentage of Replacement of Coarse Aggregate with Rubber	Cross-Sectional Area (mm^2)	Compressive Strength (N/mm^2)		
			7 day's	14 day's	28 day's
M20	0%	70.6mm x 70.6mm	10.9 N/mm^2	17.5 N/mm^2	23.59 N/mm^2
M20	30%	70.6mm x 70.6mm	8.58 N/mm^2	12.96 N/mm^2	15.0 N/mm^2
M20	50%	70.6mm x 70.6mm	6.2 N/mm^2	10.87 N/mm^2	13.0 N/mm^2
M20	100%	70.6mm x 70.6mm	3.5 N/mm^2	5.35 N/mm^2	6.5 N/mm^2

GRAPH : 1 Percentage of Replacement of Rubber V/s Compressive Strength of M40 Concrete :



GRAPH : 2 Percentage of Replacement of Rubber V/s Compressive Strength of M20 Concrete :



5.3. COST ANALYSIS:

After, the above tests on fresh and Hardened concrete the results of M40 concrete with 30% replacement

Of rubber is friendly to compare amongst M40 and M20 concrete's of 0% Rubber replacement or

Conventional Concrete.

Cost of 1 kg of Cement : 20/kg

Cost of 1 kg of Fine Aggregate : 10/kg

Cost of 1 kg of Coarse Aggregate : 5/kg

Cost of 1 kg of Water : 0.2/kg

Cost of 1 kg of Rubber : 0.5/kg

Cost of 1 m^3 Concrete for mixing : 4500/ m^3

5.3.2. COST ANALYSIS OF 1m^3 OF M20 CONCRETE:

SR. NO	INGREDIENT	QUANTITY	COST
1	Cement	450 kg	9000
2	Fine Aggregate	630 kg	6300
3	Coarse Aggregate	1080 kg	5400
4	Water	180kg	36
5	Mixing	1 m^3	4500
TOTAL COST OF 1m3 OF M40 CONCRETE			25,236

5.3.2 .COST ANALYSIS OF $1m^3$ OF M20 CONCRETE:

SR. NO	INGREDIENT	QUANTITY	COST
1	Cement	378kg	7560
2	Fine Aggregate	756kg	7560
3	Coarse Aggregate	1512kg	7560
4	Water	180kg	36
5	Mixing	1m3	4500
TOTAL COST OF $1m^3$ OF M20 CONCRETE			27,216

5.3.3 COST ANALYSIS OF $1m^3$ OF M40 CONCRETE WITH 30% RUBBER :

SR. NO	INGREDIENT	QUANTITY	COST
1	Cement	450kg	9000
2	Fine Aggregate	630kg	6300
3	Coarse Aggregate	756kg	3780
4	Rubber	324kg	162
5	Water	180kg	36
6	Mixing	1m3	4500
TOTAL COST OF $1m^3$ OF M40 CONCRETE WITH 30% RUBBER			23,778

6. CONCLUSION:

Here, is the set that represents the conclusion of our Research. Before the conclusion, the achievements of objectives set in the beginning of the project and also, the strange experiences during the project are also discussed below.

6.1. ACHIEVEMENTS OF OBJECTIVES:

These Research achievements are as follows:

In this project, the review and research of current usage to the use of rubber in concrete was discussed.

- The investigation and the laboratory testing on the Rubcrete such as Compressive test, Slump Test. All the results for the test was recorded in an appropriate manner.
- Moreover, result of each test was analyzed in detail, All of these results are discussed in the above

6.2 CONCLUSION:

Research on the recycling of the Non- Bio Degradable Waste is very important gradually increasing with the increased of population and increasing of urban development. The reasons that many investigations and analysis had been made on rubcrete because rubber is easy to obtain and the cost is cheaper than fresh aggregate.

Fresh aggregate need to mine but rubber usage can ignore this process. This is on-going research project is to determine the strength characteristics of rubcrete for potential

application in high structural concrete. The test performed on hardened concrete such as compression test results clearly decreasing by increasing waste material.

From the observations of the results we can conclude that the replacement of coarse aggregate by Rubber for about 30% is recommended as it attains satisfactory strength. To obtain higher strength addition of some admixtures is also recommended. By the effective replacement of non bio degradable waste in our construction it would be Eco friendly. The cost of construction is also minimized as replaced materials are scrap waste which are of negligible cost.

6.3. STRANGE EXPERIENCES WHILE WORKING WITH RUBCRETE:

- The unit weight of Hardened Rubcrete was found very lower than the unit weight of the Hardened

  Conventional Concrete.
- When introduced, in the Compression Testing Machine, Rubcrete wasn't found to have any internal cracks

  or major crack's due to loading, but only spalling was found on the Rubcrete Specimen.

6.4. SCOPE FOR FURTHER STUDIES:

Further testing and studies on the Rubcrete is recommended to indicate the strength characteristics of rubcrete concrete for application in high strength concrete.

Below are some of the recommendations for further studies:

- Although by altering the water/cement ratio Rubcrete can achieve high strength. Therefore it is also

Recommended that adding admixtures such as Super Plasticizer and Silica Fume into the mixing, so that the Workability can be improved.
- More investigations and laboratory tests should be done on the strength characteristics of rubcrete. It is

Recommended that testing can be done on concrete slabs, beams and walls. Some mechanical properties

Such as creep, durability and abrasion were also recommended.
- More trails with different sizes of rubber and percentage of rubber are recommended to get different

Outcomes and higher strength characteristics in rubcrete.

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