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Comparative Analysis of Concrete Strength Against Recyclable Ballast and Granite Scrap as Partial Replacement of Coarse Aggregate

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***Abstract*:** This Project Presents results of an experimental program to determine "COMPARATIVE ANALYSIS OF ICONCRETE STRENGTH AGAINST RECYCLABLE BALLAST AND GRANITE SCRAP AS PARTIAL REPLACEMENT OF COARSE AGGREGATE". The main objective of this project is to generate a study on concrete which incorporate Railway Ballast stones with 0%, 5%, 10%, 15%, 20% and White granite stones with 0%, 5%, 10%, 15%, 20% by replacing the usage of coarse aggregate and concrete waste partially due to their abundance. Analysis of incorporated concrete will be done in fresh state as well in hardened state to evaluate different properties of concrete i.e. slump, compaction factor test, unit weight, and compressive strength are evaluated. From all the results and experimental approach, it will get concluded that Concrete formed with ballast stones and waste granite stones are shows beneficial performance as compared with the concrete made up of natural aggregate obtained from local resources. It reduces the cost of concrete by reducing the aggregate cost and produces economical infrastructure system. The main observation will be that the use of waste materials results in the formation of light-weight concrete. Uses of such waste materials will not only cut down the cost of construction, but will also contribute in safe disposal of waste materials.

Key Words— Ballast Stones, White Granite Stone, slump, natural aggregates.

I. INTRODUCTION

Concrete is a mixture of cement, aggregates and water with or without suitable admixtures. To attain desirable strength and other properties, curing is necessary. Curing is the process of maintaining the proper moisture content to promote optimum cement hydration immediately after placement. Proper moisture conditions are critical because water is necessary for the hydration of cementation materials. Concrete is produced by mixing cement, sand, coarse aggregate and water to produce a material that can be molded into almost any shape. The major volume of concrete is filled with aggregate. Aggregate inclusion in concrete reduces its drying shrinkage and improves many other properties. Aggregate is also the least expensive per weight unit, put it makes the most amount of the weight. It is costly to transport so local sources are needed, but due to geographical constraint this is not available at all places, therefore it necessitates finding other sources and alternatives from local sources.

In eastern and north eastern states of India where natural rock deposits are scarce, ballast and granite are used as an alternative source of coarse aggregate. In these places of India brick aggregate are traditionally used as coarse aggregate. The use and performance of concrete made with broken brick as coarse aggregate are quite extensive and satisfactory for ordinary concrete. Fine and coarse aggregate make up the bulk of concrete mixture. Sand, natural gravel and crushed stone are mainly used for this purpose. Recycled aggregates (from construction, demolition and excavation waste) are increasingly used as partial replacements of natural aggregates. In this investigation, an attempt has been made Ito study the feasibility of using ballast stones and waste granite stones of locally available construction waste for making IRAC and from locality railway track.

Tam et al. (2005) attempted to improve the quality of recycled aggregate by Two Stage Mixing Approach (TSMA) and analyzed the micro structure of recycled aggregate concrete produced from TSMA. The authors reported that the water absorption of recycled coarse aggregate decreased with the increase in size of coarse aggregate which contradictory to the water absorption of virgin aggregate. The higher water absorption of 10mm than 20mm size recycled aggregate was attributed to the higher adhered mortar. The authors compared the performance of concrete made with Normal Mixing Approach (NMA) and TSMA by studying its compressive strength at 7, 14, 28 and 56 days. The virgin aggregate was replaced with recycled aggregate in percentages of 0, 10, 15, 20, 25 and 30. An increase in compressive strength was found by authors in case of TSMA when compared to NMA. This improvement in strength might be attributed to the premix process that fills up some of the pores resulting into a denser concrete.

II. MATERIALS AND PROPERTIES

1. Cement

Cement is the essential ingredient to bind all other materials to form workable concrete. It is a fine and grey powder form and it is mixed with water and materials such as sand, gravel and crushed stone to make the concrete uniform. Cement and water form paste together to bind the materials to harden the concrete.

The Pozzalano Portland Cement is used in this project.

Specific gravity: 3.15

Fineness of cement: 8%

2. Fine aggregate

Fine aggregate used for concrete should is properly graded to give the minimum voids and shall be free from deleterious material like clay, silt content and chloride contamination. Those fractions from 4.75 mm to 150 micron are termed as fine aggregate. The manufacturing sand (M-sand) is used as a fine aggregate conforming to the requirements of S: 383. The fine aggregate is screened, to eliminate deleterious materials and over size particles.

Specific gravity: 2.59

Free moisture: 1%

3. Course Aggregate

The coarse aggregate is the strongest and least porous component of concrete. Some important properties of coarse aggregate like crushing strength, durability modulus of elasticity, gradation, shape and surface texture characteristics, percentage of deleterious materials and flakiness and elongation indices need special consideration while selecting the aggregate for concrete.

Nominal size: 20mm

Specific gravity: 2.9

Water absorption: 0.15%

4. Water

Water conforming to Standards should be used in concrete. Mixing water is required in accordance with the quality standards of drinking water.

5. Ballest stones

Ballast forms the track bed upon which rail road ties (sleepers) are laid. It is packed between, below, and around the ties. It is used to bear the load from the railroad ties, to facilitate drainage of water, and also to keep down vegetation that might interfere with the track structure. Ballast also holds the track in place as the trains roll over it. It typically consists of crushed stone, although other, less suitable, materials have sometimes been used such as burnt clay.

Nominal size: 20mm

Specific gravity: 2.62

Water absorption: 0.12%

6. White granite stones

Broken tiles were collected from the solid waste of granite manufacturing unit. Crushed them into small pieces by manually and by using crusher. And separated the coarse material to use them as partial replacement to the natural course aggregate. Separated the tile waste which is 20mm. Crushed tiles were partially replaced in place of coarse aggregate by the percentages of 5%, 10%, 15% and 20%. This tiles were collected form dundigal construction sight.

Nominal size: I20mm

Specific gravity: I2.7

Mix Proportions: 1:1.45:2.8

III. TEST RESULTS AND DISCUSSION

1. Workability

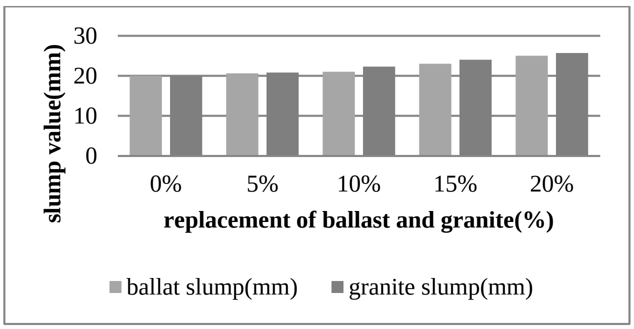
Workability is a property of raw or fresh concrete mixture. In simple words, workability means the ease of placement and workable concrete means the concrete which can be placed and can be compacted easily without any segregation.

2. Slump cone test

The test was conducted for fresh concrete prepared before the moulding process. A total of 14 concrete mixes are prepared at different times. Workability Results obtained from slump cone test for M30 grade of concrete is shown in table.1.

Table.1.

S.No	Workability test	Workability test values				
		0%	5%	10%	15%	20%
1	Slump (mm) (ballast)	20	20.6	21	23	25
2	Slump (mm) (granite)	20	20.8	22.3	24	25.7



Water absorption: 0.13%

3. *Compressive strength*

A total of 42 cubes of size 150x 150 Ix 150mm were casted and tested for 7 days, 14 days and 28 days testing each of specimens after conducting the workability tests. The results are tabulated below.

Table.2.

S. No .	Percentage replaced by ballast stone	7 Days	14 Days	28 days
1	B0	14.95	23.10	39.23
2	B5	14.98	23.37	39.69
3	B10	15.37	23.59	39.97
4	B15	15.49	23.98	40.40
5	B20	15.73	24.32	40.86

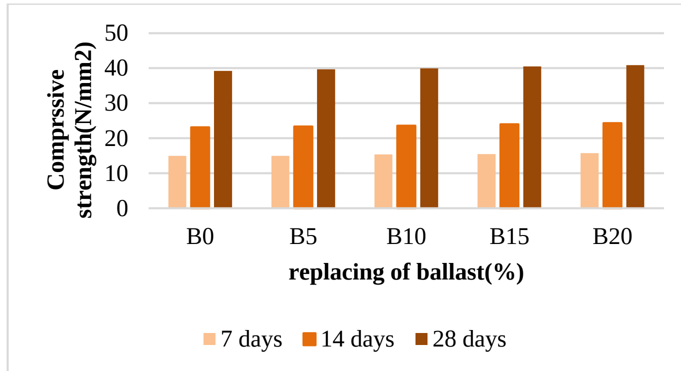
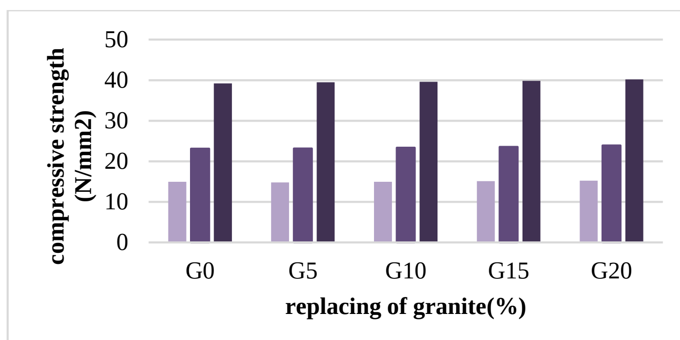


Table.3.

S.No.	Percentage replaced by granite stone	7 Days	14 Days	28 days
1	G0	14.95	23.10	39.23
2	G5	14.79	23.17	39.49
3	G10	14.96	23.35	39.62
4	G15	15.11	23.54	39.83
5	G20	15.23	23.92	40.19



4. *Split tensile strength*

The split tensile strength obtained by testing the cylindrical specimen for M30 grade of concrete to all the mixes designed for various replacements are given below

Table.4.

S.No.	Percentage replaced by ballast stone	7 Days	14 Days	28 days
1	B0	2.10	2.69	3.02
2	B5	2.23	2.84	3.17
3	B10	2.46	2.99	3.26
4	B15	2.73	3.39	3.45
5	B20	2.89	3.53	3.67

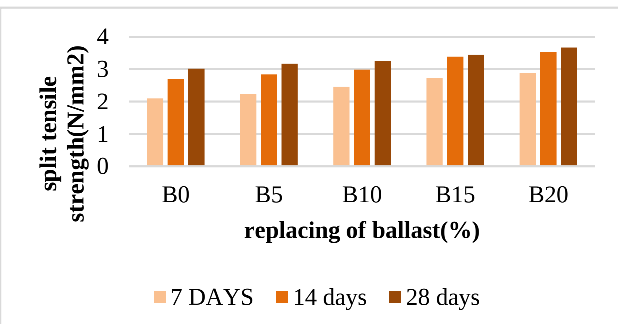
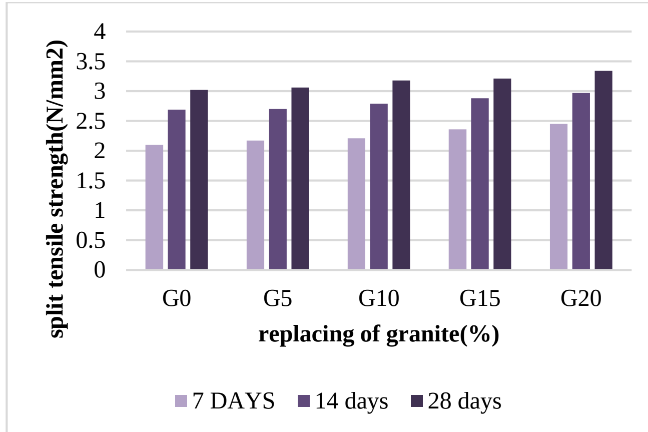


Table.5.

S.No.	Percentage replaced by granite stone	7 Days	14 Days	28 days
1	G0	2.10	2.69	3.02
2	G5	2.17	2.70	3.06
3	G10	2.21	2.79	3.18
4	G15	2.36	2.88	3.21
5	G20	2.45	2.97	3.34



5. *Flexural Strength*

The flexural test was conducted for M3 mix only since it has the highest compressive and split tensile strength to compare it with conventional. A Total of 9 beams were casted and tested as follows:

Table.6.

S.No.	Percentage replaced by ballast stone	7 Days	14 Days	28 days
1	B0	2.93	3.41	4.23
2	B5	3.08	3.56	4.38
3	B10	3.19	3.69	4.55
4	B15	3.33	3.85	4.76
5	B20	3.49	4.09	4.97

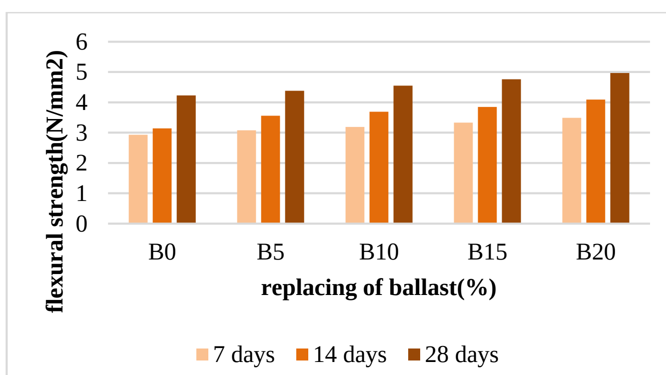


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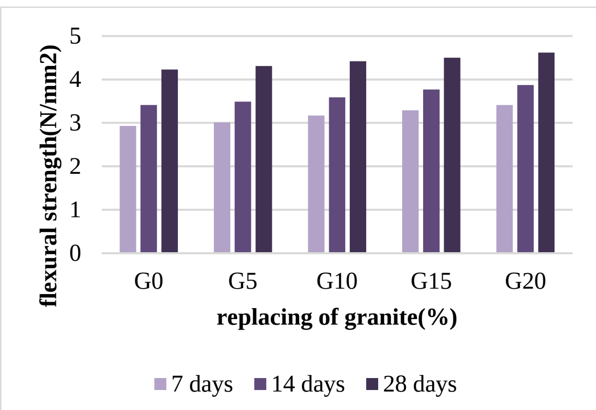
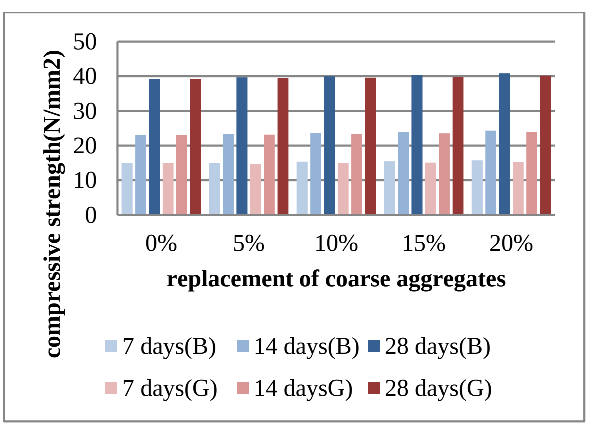
Table.7.

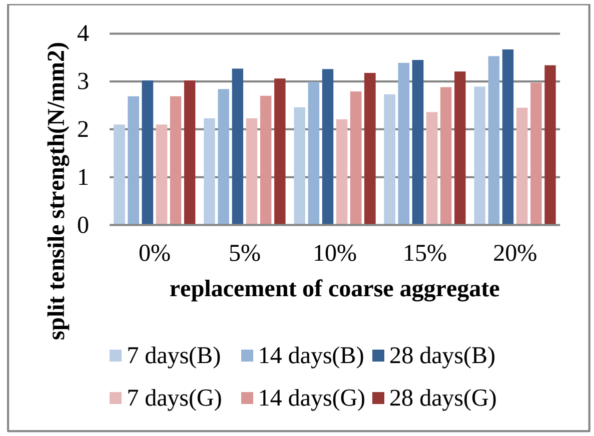
S.No.	Percentage replaced by granite stone	7 Days	14 Days	28 days
1	G0	2.93	3.41	4.23
2	G5	3.01	3.49	4.31
3	G10	3.17	3.59	4.42
4	G15	3.39	3.77	4.50
5	G20	3.41	3.87	4.62

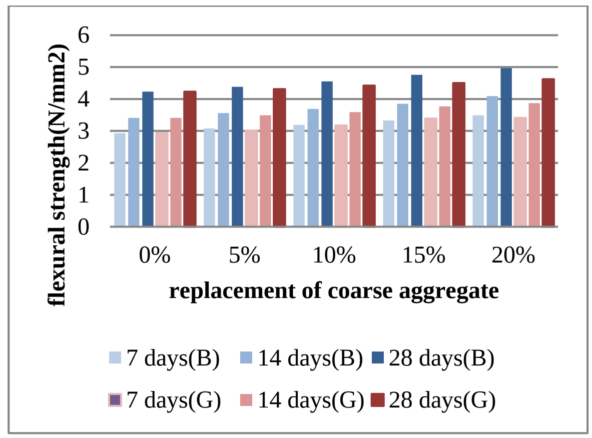


6. *Comparative Analysis*

The comparative analysis of concrete strength by using the ballast stones and white granite stone as partial replacement of coarse aggregate as shown in the graph below.







IV. CONCLUSION

Ballast and granite will require more water to be workable hence could be adduced for reduced compressive strength. However, unwashed gravel is not suitable for construction of structural members in multi-storey building.

It was observed that concrete prepared with crushed ballast achieved better compressive strength than those made with crushed granite. This study validates the previous studies.

The findings in the current study may be of practical importance to stake holders in the construction industry (i.e. contractors, clients, government, policy makers, and so on) that could adequately adjust their implementation and development plans based on the results of the study.

V. RECOMMENDATIONS

Notwithstanding the limitations of differences in compressive strength due to variation in compaction, the study suggests that gravel obtained with impurities should be sieved and washed before use in concrete production.

The utilization of granite is strongly advised in higher strength concrete applications like in high rise buildings where strength compromise cannot be accommodated. Even, if granite is to be used in high higher strength applications also.

However, ballast and granite can be used for concrete production in blinding and mass concrete works. Evaluation of the aggregates for strength capabilities is crucial to the sustainable growth of the construction industry and the economy in general.

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