Investigation on the Properties of Concrete by Replacing Coarse and Fine Aggregate with Granite Waste and Crushed Tiles, Quarry Dust

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ABSTRACT

In India, Concrete is the main constituent material for construction purpose. Concrete consists of cement, sand, aggregate and in some cases admixtures are used. Since concrete is majorly used construction field, the ingredients present in concrete are led to scarcity. Due to this reason, the demolished construction waste and solid waste from manufacturing units are used as replacement material, to reduce the need of natural aggregate. First part of the study, deals with the compressive strength of concrete by partial replacement of fine aggregate with crushed tiles and coarse aggregate with granite cutting waste with various percentage such as 15%, 30% and 50%. Second part of the study, deals with the compressive strength of concrete by partial replacement of fine aggregate with quarry dust and coarse aggregate with granite cutting waste with various percentage such as 15%, 30% and 50%. From the study, it was found that 30% replacement in concrete was the optimum percentage, beyond which the compressive strength reduces. From the test result, the specimens were casted with replacement of fine aggregate with 15% crushed tiles aggregate, 15% of quarry dust and 30% of crushed granite aggregate in replacement with coarse aggregate. From the test results, it was found that the replacement of fine and coarse aggregate with crushed tiles, quarry dust and crushed granite respectively depicted improvement in the compressive strength and splitting tensile strength of concrete. By the replacement of natural resources with environmental waste and construction waste leads to decrease in scarcity and environmental pollution.

KEY WORDS: Crushed Tiles, Crushed granite, Quarry dust.

1. INTRODUCTION

Now a days aggregate become costly for the usage in construction industry. The aggregates are chosen according to the use, environmental conditions and availability of the aggregate. Development of a country depends upon the infrastructure and construction works carried out. For the development purpose the natural resources are being depleted. So, necessary steps for the future must be taken to save the natural resources. Various methods were developed to save the natural resources from depleting. One of the methods used was replacing the natural resources with waste material such as construction waste, environmental waste etc. This will help us to ensure the sustainability environmental pollution and depletion of natural resources. In this project, the environmental waste such as crushed granite, crushed tiles and quarry dust were reused instead of natural aggregate.

The maximum compressive strength was obtained for the concrete mix of 20% of tiles powder replaced as fine aggregate (Hemanth Kumar, 2015). 40% replacement of quarry dust as fine aggregate gives maximum result in compressive strength than normal concrete and then decreases from 50% (Hanumantha Rao, 2016). Substitution of 10% of sand replaced by granite powder was the most effective in increasing the compressive and flexural strength (Rosa Vasconez, 2016). The compressive strength of concrete is same with the conventional concrete only at 10%, 20%, 30% replacement of granite waste as coarse aggregate and it is reduced at 40% and 50% (Haripriya, 2016).

In this paper, Natural fine aggregate (NFA) was partially replaced by crushed tiles (CT) and quarry dust (QD) and natural coarse aggregates (NCA) was partially replaced with crushed granite aggregate (CGA). This replacement was carried out with various percentages such as 15%, 30% and 50%. The fresh concrete and hardened concrete properties were tested. The workability of the concrete was tested by the slump value and the compressive and splitting tensile strength of concrete was determined under various percentage of replacement. The compressive strength and splitting tensile strength was determined at 7, 14, 28 days with various replacements of fine and coarse aggregate.

2. MATERIALS AND SETUP

The basic materials of concrete are tested and results are obtained. The replacing materials of fine and coarse aggregate are tested for its properties. The various tests on cement, NFA and NCA were conducted as per Indian Standard (IS) codal recommendations. Ordinary Portland Cement (OPC) cement was used with grade of 53. The specific gravity and fineness of cement was found to be 3.15 and 7% respectively. The initial and final setting time of cement was found to be 45 mins and 553 mins respectively. The compressive strength of mortar cubes at 7, 14 and 28 days was 24 MPa, 35 MPa and 52 MPa respectively. The NFA, NCA, QD, CT and CGA were tested and results are given in table.1.

Table.1. Test Results on Natural Aggregate and Replacing Aggregate

Sl. No	Name of the test	NFA	NCA	QD	CT	CGA
1.	Specific Gravity	3	2.89	2.8	2.63	2.86
2.	Water Absorption	12%	8.5%	15%	10%	-
3.	Impact Test	-	8.1%	-	-	9.4%

Based on the test results of cement, NFA and NCA, the mix ratio of concrete was found to be 1:1.7:2.8 as per IS: 10262-2009. The compressive and splitting tensile strength of concrete was found by using Compression Testing Machine (CTM) by using cube specimens of 150mm x 150mm x 150mm and cylinder specimens of 150mm diameter and 300mm height respectively. The compressive strength on normal concrete on 7, 14 & 28 days of curing was found to be 21.96MPa, 30.3MPa and 34.13MPa. The testing of compressive strength and splitting tensile strength of concrete is shown in figure1. The specimen details are given in table.2.

Figure.1. a) Compressive strength test b) Splitting tensile strength test

Table.2. Specimen Label

Sl.No.	Specimen name	Specimen label
1	Normal concrete	NC
2	Concrete replaced with 15% CT + 15% CGA	GT15
3	Concrete replaced with 30% CT + 30% CGA	GT30
4	Concrete replaced with 50% CT + 50% CGA	GT50
5	Concrete replaced with 15% QD + 15% CGA	GQ15
6	Concrete replaced with 30% QD + 30% CGA	GQ30
7	Concrete replaced with 50% QD + 50% CGA	GQ50
8	Concrete replaced with 15% QD+ 15% CT + 30% CGA	GQT

3. RESULTS AND DISCUSSION

Comparison of results of NC with GQ concrete: From the table.3, at 7 days of curing compressive strength of GQ15 concrete indicated 1.3% greater than NC, whereas, GQ30 concrete depicted 11.3% higher than the NC and GQ50 concrete exhibited 1.3% reduced compressive strength when related with NC. At 14 days of curing, compressive strength of GQ15 concrete indicated 2% lesser than NC, whereas, GQ30 concrete depicted 6.5% higher than the NC and GQ50 concrete exhibited 4.8% greater compressive strength when related with NC. At 28 days of curing, compressive strength of GQ15 concrete indicated 6.5% greater than NC, whereas, GQ30 concrete depicted 5.2% higher than the NC and GQ50 concrete exhibited 2.2% lesser compressive strength when related with NC.

Table.3. Compressive strength tests on GQ and GT at 15%, 30% & 50%

Compressive strength of concrete (N/mm^2)						
No of days of curing	GQ15	GQ30	GQ50	GT15	GT30	GT50
7 days	22.25	24.76	21.67	18.6	26.63	21.36
14 days	29.7	32.42	31.83	29.2	33.11	29.5
28 days	35.8	36	33.35	37.46	38.2	32.4

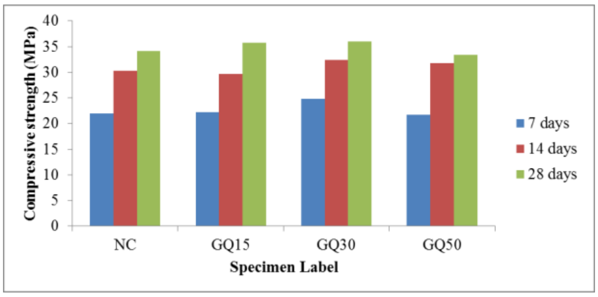

Figure.2. Compressive strength of NC and GQ concrete at 15%, 30% and 50% of replacement

Comparison of results of NC with GT concrete: From the table.3, at 7 days of curing compressive strength of GT15 concrete indicated 18.1% lesser than NC, whereas, GT30 concrete depicted 17.5% higher than the NC and

GT50 concrete exhibited 2.8% higher compressive strength when related with NC. At 14 days of curing, compressive strength of GT15 concrete indicated 3.8% lesser than NC, whereas, GT30 concrete depicted 8.5% higher than the NC and GT50 concrete exhibited 2.7% reduced compressive strength when related with NC. At 28 days of curing, compressive strength of GT15 concrete indicated 8.4% greater than NC, whereas, GT30 concrete depicted 10.65% higher than the NC and GT50 concrete exhibited 16% lesser compressive strength when related with NC.

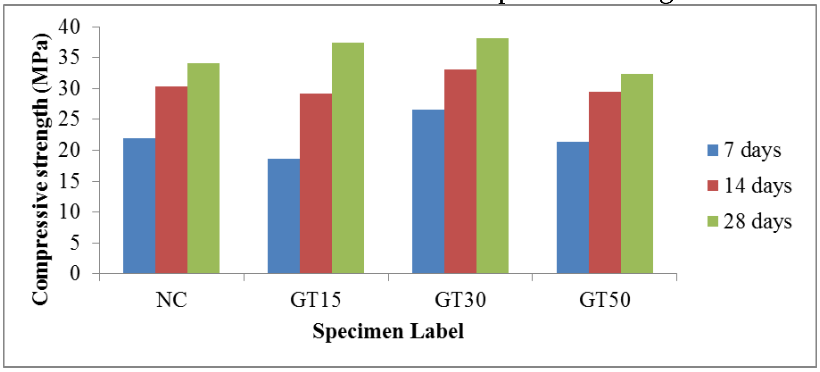

Figure.3. Compressive strength of NC and GT concrete at 15%, 30% and 50% of replacement

Comparison of results of GQ with GT concrete:

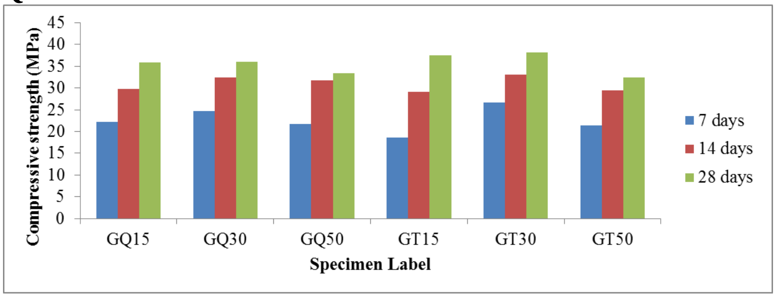

Figure.4. Compressive strength of GT and GQ concrete at 15%, 30% and 50% of replacement

From the figure.4, the compressive strength of GQ and GT at various percentages of replacement is associated with each other. At 28 days of curing, GT15 concrete showed 4.43% greater compressive strength when related to GQ15 concrete, whereas, GT30 concrete showed 7.85% higher compressive strength when compared with GQ30 concrete. But when GQ50 is compared with GT50, it was evident that GQ50 gave 2.8% higher compressive strength than GT50. It is evident that 30% of replacement with GQ and GT in concrete showed higher results when compared with other percentages of replacement. Beyond 30% of replacement in concrete, the compressive strength of concrete was found to decrease. So, it is evident that the optimum percentage of replacement was 30% in concrete.

Comparison of splitting tensile strength of concrete: The concrete specimens for testing splitting tensile strength were casted with the optimum percentage of replacement i.e. 30% of replacement of GQ and GT in concrete. From the table 4, at 7 days curing of concrete it was found that GQ30 concrete showed 0.16% higher the splitting tensile strength than NC. It was also depicted that GT30 concrete exhibited 1.14% lower tensile strength than NC. At 14 days of curing, it showed that GQ30 concrete has 4.42% higher splitting tensile strength than NC. It was also found that GT30 concrete showed 2.43% developed splitting tensile strength than the NC. At 28 days of curing, it showed that GQ30 concrete has 2.1% higher splitting tensile strength than NC. It was also found that GT30 concrete showed 0.54% developed splitting tensile strength than the NC.

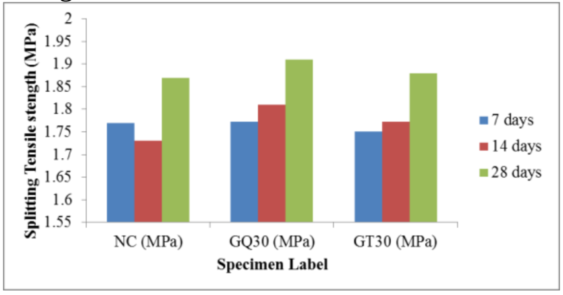

Figure.5. Splitting tensile strength of GT and GQ concrete with optimum of replacement

Table.4. Splitting tensile strength of concrete with optimum percentage of replacement

No of days of curing	NC (MPa)	GQ30 (MPa)	GT30 (MPa)
7 days	1.77	1.77	1.75
14 days	1.73	1.81	1.77
28 days	1.87	1.91	1.88

Comparison of GQT and NC concrete: With the optimum percentage obtained from comparing the results of GT and GQ with NC, the GQT30 concrete was casted. The compressive strength of GQT30 concrete is shown in table 5 from which the compressive strength at 7 of curing was found to be 8% lower than NC. But it was observed that at 14 days and 28 days of curing, GQT30 was found to be 2.4% and 6.36% higher compressive strength than NC.

Table.5. Compressive strength results of GQT30 concrete

No of days of curing	NC	GQT30
7 days	21.96	20.33
14 days	30.3	31.05
28 days	34.13	36.45

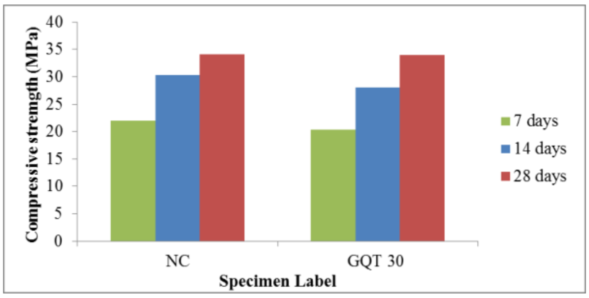

Figure.6. Compressive strength of GQT concrete compared with NC

4. CONCLUSION

The following conclusions were drawn from the investigation on the properties of concrete on the replacement of fine aggregate with QD and CT and coarse aggregate with CGA.

- At 28 days of curing, GQ30 and GT30 showed 6.5% and 8.5% higher compressive strength than NC respectively.
- When compared with the materials of replacement, GT gave higher compressive strength than GQ.
- Beyond 30% of replacement in concrete, the compressive strength of concrete was found to decrease. So, it is evident that the optimum percentage of replacement was 30% in concrete.
- By the optimum percentage of replacement of fine and coarse aggregate the compressive and splitting tensile strength of concrete were increased at 28 days of curing.
- By the replacement of natural resources in concrete, leads to decrease in scarcity and environmental waste pollution.

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