Economic and Qualitative Feasibility of Partial Replacement of Natural Sand in M 30 Grade of Concrete by Green Components.

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Abstract - *Granite and Marble stones are used in Civil industries for various aspects. Lot of cutting waste is produced during the processing of granite and marble. . This cutting waste is generally used for filling the land. An experimental research is carried out to explore the opportunity of using the crushed granite fines and marble fines as a partial substitute of sand in M 30 grade concrete. These cutting wastes with different combinations are fed to crusher. The combination of CGF and CMF, MIX 10% (CGF 5% + CMF5%), MIX 20% (CGF 10% + CMF 10%), MIX 30% (CGF 15% + CMF 15%), MIX 40% (CGF 20% + CMF 20%), MIX 50% (CGF 25% + CMF 25%) is again implied considering the benefit observed. Based on the economic analysis of the result, substitute for the sand with combination of granite and marble fines is recommended. The results for green concrete is finally compared with same grade concrete.*

Key Words: **Concrete Properties, C.G.F., C.M.F., Compressive Strength, Split Tensile Strength, Flexural Strength.**

1. INTRODUCTION

India is currently the second fastest developing economic system inside the world. Infrastructure zone is a key motive force for the Indian economy. Infrastructure sector consists of energy, bridges, dams, roads and urban infrastructure development. In India 11% Gross Domestic Product (GDP) is contributed by construction development sector. India desires to spend on infrastructure development with 70% of finances on power, roads and concrete infrastructure segments in coming five years. The construction materials such as cement, sand, steel and aggregate are used in building, road, bridges, power house construction. Mainly the construction cost depends on cement, sand, and steel. The cost of cement and steel are always fluctuating, but sand costs are increasing day by day. Large scale mining of sand is higher than the natural replenishments and hence damages the land, water and many habitats. The mining of sand has reached to a peak because of its increasing demand in the construction sector. Hence it is essential to replace by substitute material that may be available in waste form. It helps to reduce the cost of concrete. The cutting marble and granite waste cost is less; hence checked for feasibility. For the feasibility of concrete the test were carried out for different mechanical properties such as compressive strength, spilt tensile strength and flexural strength. The test were compared with conventional concrete.

2. EXPERIMENTATION DETAILS

Concrete is one of the major ingredient used in construction industry. Concrete is prepared using combination of cement, water, fine and coarse aggregates and, chemical and mineral admixtures for betterment of properties. In present study the following material were used in concrete.

A) Cement is the essential binding fabric in concrete. The Coromandel King 53 grade of cement was used. The specific gravity is 3.15 and fineness is 2%.

B) Fine Aggregates: In present study, fine aggregates were confirming to zone III. Fineness modulus and specific gravity of the sand were found to be 2.33 and 2.56.

C) Coarse Aggregate: Broken basaltic stone as coarse aggregate were used in concrete. Size of the coarse aggregate used in the investigation was 10 -20 mm. The specific gravity of the coarse aggregate was found to be 2.68.

D) Water is an important ingredient of the concrete as it actually participates in the chemical reaction with cement. Impurities in the water may affect setting time, strength, shrinkage of concrete or promote corrosion of reinforcement. Locally available drinking water was used in the present work.

E) Crushed Granite Fines (CGF): Granite belongs to igneous rock family. The density of the granite is between 2.65 to 2.75 g/cm^3 and crushing strength will be greater than 200 MPA. Locally available cutting granite pieces are collected and the crushed into the stone crusher. These crushed granite fines are partially used in concrete as fine aggregate.

F) Crushed Marble Fines (CMF): Marble belongs to metamorphic rock. The specific gravity of the marble is between 2.6 to 2.8 g/cm^3 and compressive strength will be greater than 50 MPA. Locally available cutting granite pieces are collected and the crushed into the stone crusher. These crushed granite fines are partially used in concrete as fine aggregate.

G) The Algisuperplast Super plasticizer was used during mixing the concrete to improve the workability of concrete. As per Indian standards, the dosage of super plasticizer should not exceed 2% by weight of the cement. In current study 1.5% dosage of super plasticizer was adopted.

The mix for M 30 grade of concrete was designed using IS 456:2000. The ratio 1: 2.18: 3.48 gave 30 MPA strength. For 2.18 ratio of fine aggregate amount 839 Kg. of 1 cum of concrete. Therefore 1 cum of concrete indicates dependency on 839 Kg. of natural sand.

Compressive Strength: The compressive test on concrete was carried out using Compression Testing Machine (CTM). The specimen used were of size 150 X 150 X 150 mm cube. The test was performed at 7 and 28 days respectively for different mix proportions.

Spilt Tensile Strength: The split tensile strength test was carried out on a Universal Testing Machine (UTM). The specimen used was 150 mm diameter and 300 mm length cylinder. The Test was performed at 7 and 28 days respectively for different mix proportions.

Flexural Strength: The flexural tests on concrete was carried out on a flexural testing machine. The specimen used were of size 500 X 100 X 100 mm beam. The Test was performed at 7 and 28 days respectively for different mix proportions. Various mix proportion of concrete are shown in table 1

Table -1: Mix Proportion

Mix Designation	Cement	Sand	C.G.F.	C.M.F.	Aggregate
N.S.100 %	100%	100%	-	-	100%
MIX 10%	100%	90%	5%	5%	100%
MIX 20%	100%	80%	10%	10%	100%
MIX 30%	100%	70%	15%	15%	100%
MIX 40%	100%	60%	20%	20%	100%
MIX 50%	100%	50%	25%	25%	100%

3. RESULTS

3.1 Compressive Strength: The impact of granite, marble and combination of crushed granite and marble fines as an alternative of sand on compressive strength of M30 grade concrete is presented in table 3.1. MIX 40% test results are better than conventional concrete.

Table -2: Compressive Strength Test Results

Mix Designation	7 Days	28 Days
Natural Sand 100 %	**3.40**	**3.87**
MIX 10%	3.33	3.73
MIX 20%	3.41	3.77
MIX 30%	3.45	3.85
MIX 40%	**3.57**	**3.97**
MIX 50%	2.89	3.12

3.2 Spilt Tensile Strength: Considering various application of concrete; it is essential to test the spilt tensile strength of concrete. The split tensile is an easy method of measuring the tensile strength. The specimens of 150 mm diameter cylinder have been tested at the age of 7 and 28 days are showed in table 3.2. MIX 40% indicates best results for 7 and 28 days of spilt tensile strength.

Table -3: Split Tensile Strength Test Results

Mix Designation	7 Days	28 Days
Natural Sand 100 %	**2.58**	**4.67**
MIX 10%	2.62	4.74
MIX 20%	2.83	4.74
MIX 30%	2.99	4.81
MIX 40%	**3.18**	**4.98**
MIX 50%	2.12	3.04

3.3 Flexural Strength: The variation of combination of crushed granite and marble fines and the performance of admixtures on flexural strength for all concrete mixes are showed in table 3.3. MIX 40% indicates best results for 7 and 28 days of flexural strength.

Table -4: Flexural Strength Test Results

Mix Designation	7 Days	28 Days
Natural Sand 100 %	**24.37**	**32.15**
MIX 10%	22.22	31.56
MIX 20%	22.44	32.37
MIX 30%	22.59	31.19
MIX 40%	**23.04**	**33.56**
MIX 50%	19.48	29.26

4 ECONOMIC ANALYSIS OF REPLACEMENT

The designed concrete mix with proportion 1: 2.18: 3.48 were used in M 30 grade of concrete. The demand of sand is more but availability of sand is less. Also the rate of sand is increasing day by day. In current study the sand is partially replaced with crushed granite and marble. In conventional concrete as per design the ratio of sand 2.18 required. It means the 1 cum concrete required 839 kg of sand. For using combination of crushed granite and marble fines replacing sand, the quantity of sand will reduced 40%. Cost comparison between conventional concrete and combination of crushed granite and marble fines was carried out for finding economic feasibility of different proportion.

Table -5: Mix Design for Conventional Concrete

Quantity For 1 Cum Concrete for M30	
Cement	385
Water	170
Chemical	5.8
River Sand	**839**
Aggregate 10 mm	803
Aggregate 20 mm	535

Table -6: Rate & Quantity for 1 cum Concrete for M30

	Quantity	Unit	Rate / Unit	Total Cost
Cement	385	Kg.	6.2	2387
Water	170	Lit.	0.1	17
Chemical	5.8	Lit.	60	348
River Sand	**839**	**Kg.**	**2.5**	**2098**
10 mm Aggregate	803	Kg.	0.44	353
20 mm Aggregate	535	Kg.	0.44	235
Total Cost				**5438**

Table -7: Mix Design for using Combination of CGF & CMF in Concrete

Quantity For 1 Cum Concrete for M30	
Cement	385
Water	170
Chemical	5.8
River Sand	**503**
CGF 20%	**168**
CMF 20%	**168**
Aggregate 10 mm	803
Aggregate 20 mm	535

Table -8: Rate & Quantity for 1 cum Concrete for M30

	Quantity	Unit	Rate / Unit	Total Cost
Cement	385	Kg.	6.2	2387
Water	170	Lit.	0.1	17
Chemical	5.8	Lit.	60	348
River Sand	**503**	**Kg.**	**2.5**	**1258**
20% C.G.F.	**168**	**Kg.**	**0.3**	**50.4**
20% C.M.F.	**168**	**Kg.**	**0.3**	**50.4**
10 mm Aggregate	803	Kg.	0.44	353
20 mm Aggregate	535	Kg.	0.44	235
Total Cost				**4699**

Table -9: Cost Difference While Replacing Sand With Crushed Granite & Marble Fines

Natural Sand 100%	5438		
20% C.G.F.+ 20% C.M.F.= MIX 40%	4699	739	**13%**

According to test results, the combination of crushed granite and marble fines used in concrete for replacing the sand is responsible for cost cutting of 13% in 1 cum. The local market rates from the retailer were used for finding percentage saving. However if more quantity of waste is needed, it can be managed directly from mines.

5. CONCLUSIONS

1. The sand mining has reached to a peak because of its increasing demand in the construction sector. Hence it is essential to replace by substitute material, which may be available in waste form.
2. MIX 40% (23.04 MPA, 33.56 MPA)indicates best result for 7 and 28 days compressive strength than the Natural Sand (24.37 MPA, 32.15 MPA) and
3. For 7 and 28 days, MIX 40% (3.18 MPA, 4.98 MPA) indicates best result of spilt tensile strength than the Natural Sand (2.58 MPA, 4.67 MPA).
4.). MIX 40% (3.57 MPA, 3.97 MPA) indicates best result for 7 and 28 days of flexural strength than the Natural Sand (3.40 MPA, 3.87 MPA).
5. The cost of 1 cum concrete will reduced 13% for 40% partial replacement of combination of crushed granite and marble fines
6. Replacing sand by using combination of crushed granite and marble fines. The sand quantity will get reduced 40%. The combination of crushed granite and marble fines. (MIX 40%) may substitute the sand in M 30 grade of concrete considering economic and qualitative aspects of concrete.

REFERENCES

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