Effects of Replacing Sand in Concrete by Ceramic tile Powder and Dolomite Powder

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Abstract
Due to a quick growth in population there have been many construction projects which are coming up. Projects like residential complexes help to accommodate the rising population, Commercial projects help in providing generating income employment and contribute to the economic growth of the country, Industrial projects are also experiencing a boom, Highway construction is also on the rise to facilitate quick transportation. Since, all the above mentioned construction projects are booming there is a rise need for construction materials like sand, cement, aggregates etc. Cement is obtained from manufacturing plants and is produced in bulk. Aggregates are obtained from quaries and mills. **(Muralidharan. T, 2018)**

Sand is obtained by mining activities near river beds which have an adverse effect on the river beds. Hence, in this project an attempt is made to find a suitable replacement for sand to reduce mining activities near river beds. In this paper sand is replaced by Ceramic Tile Powder and Dolomite Powder in the proportions of 5%, 10%, 15%, 20%, 25%, 30% and 35% to minimize the amount of sand used and also to find the best suited proportion for which maximum strength improvement is achieved. Also, the slump of each sample has been tested in this paper.

Keywords— River bed, Replacement, Workability, Strength, Mining, *Slump*, Ceramic tile Powder, Dolomite Powder.

I. INTRODUCTION

Concrete has its origins from ancient Greece. Today due to rapid urbanization and emergency of various industries, construction projects are on a boom. Due to this rapid boom in the construction industry various construction materials are in demand especially cement, Sand and crushed stones. Concrete is a very reliable material to use. However, it does have its flaws. Firstly, due to the use of cement (which is highly polluting) concrete as a result is not a eco-friendly material. Secondly, the use of fine aggregates like sand does lead to densification of concrete but this puts the condition of river beds in jeopardy, as excessive mining near river beds may lead to flooding and may also adversely affect the groundwater recharge. Keeping all these facts in mind various attempts have been made in the past to find a suitable replacement for sand. In India after construction industry the ceramic industry stands at second position as this is also a rapidly growing industry. Here quite a significant portion of the ceramic material is found as waste and their disposal may act as a hurdle for various industries to get rid of them. One needs to be prudent while disposing off such wastes as Ceramics cannot be dumped in landfills as they may cause harm to the strata lying below. Also, inhalation of Ceramic particles leads to various lung and heart diseases in human beings. Despite all the ill effects of Ceramic Tile Powder it has been observed that it can help to produce concrete which is lighter in weight. On the other hand, Dolomite Powder is obtained by crushing dolostone. It is a highly dense material and can improve the strength of concrete to quite a significant degree. It has also been observed that the workability of concrete has been improved slightly by using dolomite powder. In this paper we solve the issue of disposing of Ceramic wastes and also use dolomite powder wisely to avoid its environmental impacts and also to improve the quality of concrete.

II. RAW MATERIALS

Following are the materials which have been used in this research.

Cement

Cement is one of the oldest materials used since time immemorial. It has various applications like plastering, manufacturing concrete, repair works, filling of cracks and joints etc.

Before performing the laboratory tests some preliminary field tests were performed to check the quality of cement.

The cement was greenish grey in colour and there were no lumps present.

The cement particles were smooth and did not leave any stain on the fingers while rubbing against fingers. Also it was cool when touched.

Following are the properties of cement obtained after testing it.

Table I: Properties of Cement

SN	Tests Performed on Cement	Results
1	Specific Gravity	3.12
2	Fineness test	12.46%
3	Consistency test	26%
4	Initial setting time	43 minutes
5	Final setting time	318 minutes

Sand

Sand was obtained from a nearby construction site for a very reasonable price. It was brown in colour.

Following are the properties of Sand.

Table II: Properties of Sand

SN	Tests performed on Sand	Results
1	Specific Gravity	2.63
2	Water Absorption	1.11%

Coarse aggregates.

Coarse aggregates of size 20mm were used. They were picked up along with sand from the construction site nearby.

Given below are the properties of Coarse aggregates obtained after tests were performed.

Table III: Properties of Coarse aggregates

SN	Tests performed on Coarse aggregates	Results
1	Specific Gravity	2.97
2	Water Absorption	0.98%
3	Impact Value	4.66%

Ceramic tile Powder

This is a cementitious product obtained from the Ceramic Industry. It is White in colour.
Following are the properties of Ceramic Powder.

Table IV: Properties of Ceramic tile Powder

SN	Tests Performed on Ceramic tile Powder	Results

1	Specific Gravity	2.12
2	Water Absorption	1.06%

Dolomite Powder

This is a powder form of a mineral called dolostone and is white in colour.

Properties of Dolomite Powder obtained from tests are given below

Table V: Properties of Dolomite Powder

SN	Tests Performed on Dolomite Powder	Results
1	Specific Gravity	3.37
2	Water Absorption	0.76%

III.METHODOLOGY (SIZE 10 & BOLD)

At the start of this project the present situation of the environment and concrete industry were studied and suitable materials to replace sand were found. The materials were first procured and tests for aggregates like Specific Gravity test, Water Absorption test, Impact Value test were performed and also Slump test to check the Workability for all mix proportions of concrete was performed. After all these tests, Mix design was performed. Here grade of Concrete adopted was M25 and IS 10262 (2009) code of Mix Design was used.

After finding out the mix proportions, Hand mixing of concrete was carried out. After hand mixing the concrete was poured in the mould of size 150 mm x 150 mm x 150 mm and tamped mildly with a 10 mm dia. Tamping rod (as specified by IS 10262). After tamping the moulds containing the concrete specimen was placed on the Vibrator for compaction. After vibrating the concrete specimen for nearly 2 minutes, the moulds were placed as it is for 24 hours and then kept for curing. The cubes were tested for 7, 14 and 28 days. For each mix proportions there were 3 cubes casted. Hence, for conventional concrete there were 3 cubes casted. Similarly there were 4 mix proportions for ceramic powder i.e. *10%, 20%, 30%, and 40%*. There were a total of 12 cubes for Ceramic Powder. Beyond 30% there was a decrease in compressive strength in concrete hence it was not required to go above 40%

For Dolomite powder there were 5 proportions i.e. *10%, 20%, 30%, 40% and 50%*. There was a strength decrease after 40%.

The cubes were tested under a *Compression Testing Machine (CTM)*. The broken /failed specimens were disposed away.

Figure I: A Vibrating Unit

Figure II: Specimen under a CTM

Figure III: Failed specimen.

Figure IV: Cubes specimen placed in moulds

Figure II: Concrete sample after placing in moulds.

IV. RESULTS AND CONCLUSIONS

The following results were obtained after performing tests on concrete

Slump Test Results

Figure V: Slump Cone with Base plate attached to it.

Specimen	Slump Values (In mm)
Conventional Concrete	115
10% CP	95
20% CP	110
30% CP	120
40% CP	125
10% Dolomite Powder	120
20% Dolomite Powder	130
30% Dolomite Powder	134
40% Dolomite Powder	138
50% Dolomite	126

Conclusions of Slump Test

The workability of concrete is increases after adding 30% Ceramic tile Powder or (10 to 40%) of Dolomite Powder.
As per the IS code for slump test all the above values of slump indicate concrete of

Mix Proportions

Specimen	C	S	CA	CP	DP
Concrete	1	1.050	2.08		
10% CP	1	0.945	2.08	0.105	
20% CP	1	0.840	2.08	0.210	
30% CP	1	0.736	2.08	0.315	
40% CP	1	0.630	2.08	0.420	
10% DP	1	0.945	2.08		0.105
20% DP	1	0.840	2.08		0.210
30% DP	1	0.735	2.08		0.315
40% DP	1	0.630	2.08		0.420
50% DP	1	0.525	2.08		0.526

Figure VI: Failure Load of Specimen

Strength of Cube = (Load / area)
= 458900 / 22500
= 20.39 N/mm²

C. Compression Test Results

Specimen	***7days***	***14days***	***28days***
Concrete	***8.47***	***17.13***	***25.39***
10% CP	***8.62***	***17.89***	***26.07***
20% CP	***9.42***	***18.33***	***27.58***
30% CP	***9.83***	***18.56***	***28.07***
40% CP	***9.17***	***16.83***	***29.12***
10% DP	***7.23***	***16.67***	***26.33***
20% DP	***8.98***	***16.74***	***26.98***
30% DP	***9.88***	***18.07***	***28.37***
40% DP	***10.47***	***20.39***	***31.42***
50% DP	***10.83***	***19.89***	***29.87***

Conclusion

1. By using Ceramic Powder the Compressive Strength of the cube was observed to increase by roughly 20% more than Normal Concrete.
2. Similarly Dolomite Powder led to an increase of about 25% after replacing Sand by 40% of its Weight.

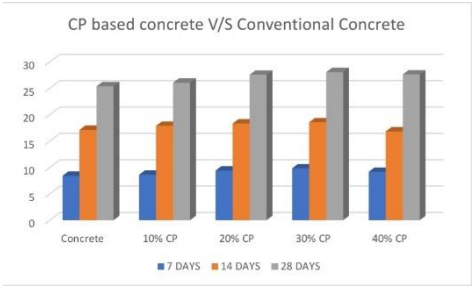

Figure VII: Variation in Comp. Strength Of Concrete for different proportions of Ceramic Powder

Figure VIII: Variation in Comp. Strength of Concrete for different proportions of Dolomite Powder

SCOPE

There is a wide scope in this project. The following studies are yet to be done in this paper.

1. W/C ratio can be varied
2. Different Mix designs methods like ACI, Road Note 4, DOE method can be performed and results of each can be compared with each other.
3. Plasticizers can be added.
4. Cement can also be replaced instead of Sand.
5. Ceramic tile Powder and Dolomite Powder can both be used simultaneously.

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