# PARTIAL REPLACEMENT OF FINE AGGREGATES IN CONCRETE BY CERAMIC POWDER AND GGBS POWDER

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***Abstract: Construction industry is one of the oldest industry in our country. Rapid urbanization has led to a tremendous growth in this industry. This rise has led to an increased in need of construction materials like cement, sand and coarse aggregates. Sand is acquired by digging near river beds which leads to their destruction which in turn affects the environment and living beings in the surrounding areas. To avoid such destruction alternatives need to be found which can replace sand and thus minimize mining activities at river beds. Also, disposing off waste generated from manufacturing processes, service industries, construction and demolition works is also of immense concern. Some of these wastes may include Ceramic powder and GGBS as these are directly emitted into the environment and may cause adverse problems. These materials cannot be disposed off recklessly in the land too as this would damage the underlying soil. Using these materials in concrete helps in saving energy, limiting the amount of toxic gases in the environment and reducing pollution. These wastes can improve the quality ofconcrete. In this project sand is replaced by ceramic powder in the proportions of 10%,20%,30% and 40% by weight of sand and GGBS powder by 10%,20% and 30% by weight of sand.In both cases grade of concrete under study is M20 by IS code 10262. The objective behind this project is to find out the most efficient replacement quantity of these wastes in concrete to attain maximum strength and workability of concrete.***

***IndexTerms: Ceramics, Durability, Pollution, Replacement, Strength and Workability***

## I. INTRODUCTION

Concrete is one of the most commonly used material for construction purpose. Concrete (aka “liquid stone") is a blendof sand, coarse aggregates, cement and water and has helped in building various civilizations. Its origin dates back to thousands of years ago when concrete like materials were made from crude cements. When water and sand were added it became like a mortar like substance which is modernly called concrete today.Excessive use of concrete has led to rise in pollution levels also non-stop digging at river beds has been causing damage to the river bed and the surrounding environment. Hence the intend of this project is to curb these issues and make concrete more environment friendly economic.

## II. LITERATURE REVIEW

For tile waste based concrete, coarse aggregates were replaced by 20mm down size, ceramic powder wastes by 10% ,20%,30% and 40 % and calculation regarding a another specimen of concrete in which sand is replaced by GGBS powder in the proportions of 10%,20% and 30%. The mix proportion was performed by IS 10262 code of practice for mix design. A water cement ratio of 0.50 was maintained throughout the experimentation process. By the use of ceramic tile powder, the self weight of concrete is reduced about 2 to 3% which makes the structure economical.But this paper studied maximum replacements of Ceramic powder waste which can be varied and can be utilized in concrete desirable properties. The concrete specimen which was prepared was of grade M20.

Ceramic powder was procured from a hardware shops and was obtained from tile shops as well. GGBS powder was obtained was obtained through a dealer which sold it at very cheap rate. Cement and other aggregates were obtained from factories.

Firstly, tests on aggregates like water absorption, impact value, specific gravity tests, tests on cement like Fineness test, Consistency test and initial and final setting time test and tests on concrete like slump test was performed before proceeding with the mixing and casting process. The mixing was done as per the calculations of mix design. 3 cube specimens of conventional concrete were casted and tested for 7,14 and 28days. Then 3 cubes specimens of concrete where ceramic powder was used as a replacement material were casted. The proportions of 10%,20%,30% and 40% were casted. 3 cubes for each specimen were casted and tested for 7,14 and 28 days. Thus making a total of 12 cubes of concrete where ceramic powder was used as a replacement material. The same procedure was applied for the concrete specimen where GGBS powder was used to replaced sand. GGBS replaced sand by the proportions of 10,20 and 30% of the weight of sand. Thus casting a total of 9 cubes of GGBS and testing them for 7,14 and 28 days. After completing this research it was observed that maximum strength is obtained when 30% of sand is replaced by sand and the concrete cubes were slightly lighter in weight compared to the cubes made of conventional concrete. Also a 20% replacement of sand GGBS would give good strength gains but not as much as when ceramic powder is replaced. Usage of these materials leads to improvement of workability of concrete.

## III. RAW MATERIALS

Following are the materials and their properties
These materials are procured from shops and factories in the nearby area at quite reasonable rates.
***Cement***: Ordinary Portland cement of grade 53 was used. The following are the properties of cement shown in the table given below.

Table I

| SN | Properties | Result |
|---|---|---|
| 1 | Specific gravity | 3.19 |
| 2 | Fineness | 9.12% |
| 3 | Standard consistency | 26.25% |
| 4 | Initial setting time | 37 minutes |
| 5 | Final setting time | 237 minutes |

Fine Aggregates
Fine aggregates include Ceramic powder, GGBS powder and Sand. Ordinary sand found near construction sites was used whereas Ceramic powder and GGBS were obtained through dealers. Given below are the properties of fine aggregates.

Table II

| SN | Properties | Sand | Ceramic powder | GGBS powder |
|---|---|---|---|---|
| 1 | Specific gravity | 2.610 | 1.945 | 1.260 |
| 2 | Water Absorption | 1.111% | 1.667% | 2.443% |

Coarse aggregates
These were of the size 20 mm and were procured from a local site. Following are the properties of coarse aggregates.

Table III

| SN | Properties | Results |
|---|---|---|
| 1 | Specific gravity | 3.030 |
| 2 | Water Absorption | 0.985% |
| 3 | Impact Value | 3.730% |

## IV. METHODOLOGY

At first various test on aggregates like specific gravity test, Impact value test and water absorption test were performed. The results obtained from specific gravity and water absorption were utilized in the mix design of concrete.
After testing of aggregates, Slump test on concrete was performed to determine its workability. Slump test was performed for conventional concrete. For mix design *IS 10262*(2009) code of practice was referred to and grade of concrete adopted was *M20*, where *20* is the characteristic mean strength of concrete after *28* days of curing. As per the mix design procedure a mix proportion for C: S:CA obtained was *1: 1.79: 3.36* for conventional concrete.
3 cubes of conventional concrete were casted and were tested for *7,14* and *28* days and the result obtained were noted.
Cubes for ceramic powder were casted. Ceramic powder was varied in the proportions *10,20,30* and *40%* by weight of sand. *3* Cubes were casted for each specimen making a total of *12* cubes where ceramic powder was used as a replacement. A reduction of compressive strength of concrete was observed. Hence, there was no need to test the cubes for beyond *40%* replacement. The results were noted.
Similarly, cubes containing GGBS powder in the proportion 20,30 and 30% were casted. 3 cubes were casted for each proportionmaking a total of 9 cubes. These cubes were tested for 7,14 and 28 days and the results were obtained.
After this concrete Slump test was performed for all the proportions of ceramic powder and GGBS making a total of 8 slumps (including the slump prepared for conventional concrete). Size of the mould used was 150mm x 150mm x 150mm. During casting hand mixing was adopted and after mixing was done and the concrete specimen was mildly tamped by a tamping rod before putting it on the vibrating unit for compaction. A weighing machine of the accuracy 0.001g was used to measure weight whenever necessary.

Figure I: Cube specimen kept for curing

Table IV Mixed Proportions

| Sample | C | S | CA | CP | GGBS |
|---|---|---|---|---|---|
| Conventional concrete | 1 | 1.79 | 3.36 | 0.00 | 0.00 |
| 10% Ceramic powder | 1 | 1.62 | 3.36 | 0.18 | 0.00 |
| 20% Ceramic powder | 1 | 1.44 | 3.36 | 0.36 | 0.00 |
| 30% Ceramic powder | 1 | 1.26 | 3.36 | 0.54 | 0.00 |
| 40% Ceramic powder | 1 | 1.08 | 3.36 | 0.72 | 0.00 |
| 10% GGBS | 1 | 1.62 | 3.36 | 0.00 | 0.18 |
| 20% GGBS | 1 | 1.44 | 3.36 | 0.00 | 0.36 |
| 30% GGBS | 1 | 1.26 | 3.36 | 0.00 | 0.54 |

## V. RESULTS AND CONCLUSIONS

Results for Slump test

Table V Slump values

| Sample | Slump (in mm) |
|---|---|
| Conventional concrete | 120 |
| 10% Ceramic powder | 107 |
| 20% Ceramic powder | 115 |
| 30% Ceramic powder | 128 |

| | |
|---|---|
| 40% Ceramic powder | 135 |
| 10% GGBS | 128 |
| 20% GGBS | 145 |
| 30% GGBS | 155 |

Conclusion

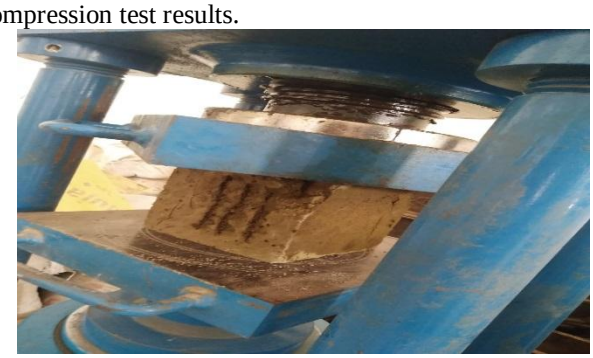
1.After adding 30% of ceramic powder the slump of concrete sample is improved compared to the conventional concrete specimen.

2.After adding 20% of GGBS powder the slump is improved compared to the conventional concrete specimen.

3. All the concrete specimen were of HIGH QUALITY. Hence they had excellent workability.

Figure II: Fallen slump

Compression test results.



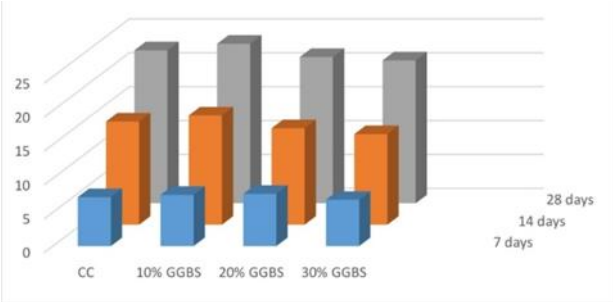
FigureII: Cube underCompression testing Machine

Table VI: Values of compressive strength
On concrete cube specimens

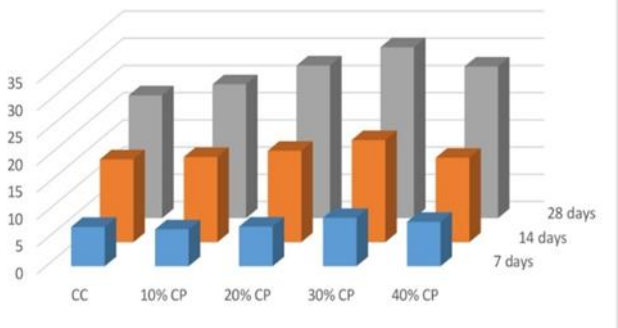
| Sample | 7 days (in MPa) | 14 days | 28 days |
|---|---|---|---|
| Conventional concrete | 7.23 | 15.23 | 22.57 |
| 10% Ceramic powder | 6.78 | 15.67 | 24.62 |
| 20% Ceramic powder | 7.29 | 16.81 | 28.07 |
| 30% Ceramic powder | 8.89 | 16.56 | 31.42 |
| 40% Ceramic powder | 7.93 | 18.78 | 21.59 |
| 10% GGBS | 7.57 | 16.12 | 23.54 |
| 20% GGBS | 7.71 | 14.23 | 26.89 |
| 30% GGBS | 6.83 | 13.37 | 21.07 |

$$\text{Compressive strength} = \frac{Load\ at\ Failure\ (in\ kN)}{Cross\ sectional\ area\ of\ cube}$$

Figure III: Failed concrete specimen




Graph II: Effect of GGBS on strength of concrete




Graph II: Effect of Ceramic powder on strength of concrete

## VI. CONCLUSION

1.The. strength of concrete can be increased to 30% replacement of Ceramic Powder after which the strength of concrete decreases. On adding 30% Ceramic powder strength of concrete increases by roughly 40% relative to the conventional concrete specimen.

2.The strength of concrete can be increased to 20% replacement of GGBS powder after which the strength of concrete decreases. On adding 20% of GGBS powder the strength of concrete can be increased by 20% relative to the conventional concrete specimen.

Scope

By using ceramic powder and GGBS as a replacement material in concrete the nuisance of disposing them is reduced and thus helps to avoid environmental pollution and

also produce a greener concrete.
These materials improve the strength of concrete and reduce its weight. Thus reducing the weight of the structure. Following are the different variations which can be done in the experimentation process of this project to analyze the extent of the benefits which can be obtained by using these replacement materials in concrete.
1. Ceramic powder and GGBS can be used to replace cement instead of sand in concrete to study the strength variation of concrete.
2. Plasticizers and admixture can be added as well to achieve the desired results in concrete.
3. The water-cement ratio can be varied to study the variation in strength of the cube specimen.
4. Different grades and types of cement can be used as well.

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REFERENCES

[1] IS 10262 (2009) code of mix design.
[2] Highway Engineering revised 10th edition by C.E.G. Justo & A. Veereragavan S.K. Khanna.
[3] Concrete Technology (Theory and practice) by M.S. Shetty, S. Chand publications
[4] IS 2386 (Part IV) -1963 Methods of tests for aggregates in concrete.
[5] IS 2386 9Part III)- 1963 (Reaffirmed 2002). Methods of tests for aggregates in concrete.
[6] IS 1199 – 1959 Methods of sampling and analysis of concrete.
[7] G. Sivaprakash, V. Saravana Kumar and Lakhi Jyoti Saikia "Experimental study on partial replacement of sand by ceramic waste in concrete" presented at Int. J. Sci.: 14(SI), (2016). 266-274 ISSN 0972-768X .
[8] Muralidharan. T, Aravind. V, Logesh. B and Manikandan. C "Study on Partial Replacement of Fine Aggregates in concrete Using Ceramic Waster"SSRG International Journal of Civil Engineering (SSRG-IJCE) – Special Issue ICETSST – April 2018.
[9] Dr. K. Ramadevi "A STUDY ON PROPERTIES OF CONCRETE WITH CERAMIC WASTE REPLACED FOR FINE AGGREGATE" International Journal of Civil Engineering and Technology (IJCIET) Volume 8, Issue 8, August 2017, pp. 1730–1737, Article ID: IJCIET_08_08_187 Available online at http://http://www.iaeme.com/ijciet/issues.asp?JType=IJCIET&VType=8&IType=8 ISSN Print: 0976-6308 and ISSN Online: 0976-6316
[10] IS 516- 1959 (Reaffirmed 2004) Indian Standards Methods of test for strength of concrete.
[11] IS 4031 – 1988 (Part V) Method to determine Initial and final setting time of cement.

  