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Research Article

Investigating Composite Cement Concrete Utilizing Recycled Aggregate And Stone Dust

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ABSTRACT

Evolution of technology in our society is still highly pervasive in nature and the upcoming process of globalization significantly affects the state of the environment. Along with the increase in population, unbounded pumping of raw materials for production of materials and urbanization of the environment, there is wide range of increase in harmful emissions and waste generation. Mineral resources are limited significantly. Resources to feed our growing population are limited as well as the materials required to construct buildings and infrastructure. The use of auxiliary cementitious materials such as fly ash (FA) and ground granulated blast furnace slag (GGBS). Recent studies show a steady increase in use of fly ash and blast furnace slag in construction industry as an economical and effective solution for partial replacement of cement. An arduous issue when replacing cement is that the auxiliary materials affect concrete properties variously according to several factors such as the grade of cement, percentage of replacement, curing periods and environment condition. In order to determine how the concrete strength and its rheological properties can be affected by auxiliary material, this study investigates the strength properties of M25 grade of composite cement concrete in which coarse aggregate is replaced with 30% of recycled aggregate and fine aggregate is replaced with 20% & 30% of stone dust. The outcomes indicated that the addition of recycled aggregate and stone dust in composite cement concrete enhances not only the mechanical strength but also workability which eventually improves the properties of concrete.

Keyword's- Composite Cement, Recycled Coarse Aggregate, Stone Dust, Mechanical Strength, Workability.

Introduction

The second most consumed product in the world is concrete. It is estimated that 28 billion tonnes of concrete are manufactured each year. It contributes nearly 8% of the global carbon dioxide emission. Concrete is the leading construction material across the world and is widely used in all types of civil engineering works, including infrastructure, low and high-rise buildings. Concrete manufacturing involve consumption of various ingredients like cement, aggregates, water and admixture. Investigation indicates that 30 billion tonnes of cement are required annually throughout the world. Since limestone is the main ingredient in ordinary portland cement, a huge lack of the material is possible in the next 25 to 50 years. The production of cement releases large amount of carbon dioxide CO_2 to the atmosphere that significantly contributes to greenhouse gas emissions. It is estimated that one ton of CO_2 released into the atmosphere for every ton of production of OPC. In view of this, there is a need to develop sustainable alternatives to traditional cement. The thermal and steel industry generates lots of fly ash and blast furnace slag, which are deposited on the ground. Toxic chemicals leach into the groundwater supply from industrial waste. These problems may be solved by rearranging the components in Cement Concrete. Since there will be reduction in the use of raw material for production of cement, and hence a decrease in carbon dioxide emissions. With its high strength-to-weight ratio, low permeability, resilience to chemicals, and low combustibility, composite cement has become a popular choice among these binders. The abundance and availability of fly ash and GGBS worldwide create opportunity to utilize these by-products, as partial replacement or as performance enhancer for OPC.

Composite cement concrete is a special type of concrete that is manufactured using industrial waste like fly ash and GGBS which are considered as more eco-friendly alternative to Ordinary Portland Cement (OPC) based concrete. By using this type of industrial by-products in concrete industry as a replacement for cement we can reduce the usage of cement which results in minimizing the emission of green houses gases into the atmosphere and also savings in cost. Using recycled aggregate and stone dust from old demolished structure and aggregate crusher plant as a replacement to coarse and fine aggregates is a good practice to conserve natural aggregates. Another practical solutions to conserve natural resources is to use supplementary cementitious material such as fly ash, slag, silica fume etc... as a replacement to cement thereby the microstructure, mechanical and durability characteristics of concrete can be improved.

Objectives

- To produce concrete with composite cement and investigate the strength properties.
- To investigate the effect of recycled coarse aggregate and stone dust on the strength of concrete.
- To determine the optimum percentage of replacement of recycled coarse aggregate and stone dust in the concrete.

Materials Used

1. Cement

Composite Cement (CoC) obtained from a single batch was used trough out this investigation. Composite cement is developed according to the Indian standards IS 16415 : 2015 deals with the composite cement. It states that composite cement is intimate inter grounded mixture of portland cement clinker or OPC with 35-65% by its weight, Gypsum of 3-5% by its weight, Fly Ash of 15-35% by its weight and Ground Granulated Blast Furnace Slag of 20-50% by its weight. The physical properties of Composite cement as determined are shown in table 1.

Table 1 Physical Properties of Composite Cement

S.N.	Properties	Result
1	Grade	-
2	Specific Gravity	3.15
3	Fineness	5.60%
4	Consistency	31%
5	Initial Setting Time	65 min.
6	Final Setting Time	380 min.

2. Coarse Aggregate

Locally available crushed natural stone aggregate of 20 mm nominal size as per IS 383 : 2016 specification is used. The aggregate is angular in shape without any organic impurities. The fineness modulus and specific gravity of coarse aggregate is 7.74 and 2.68.

3. Fine Aggregate

Locally available naturally river sand, passing through 4.75 mm sieve and conforming to Zone III as per IS 383 : 2016 specification. The fine aggregate is without any organic impurities. The fineness modulus and specific gravity of fine aggregate is 2.397 and 2.58.

4. Recycled Coarse Aggregate

Local demolished waste of infrastructure, crushed to 20 mm average particle size is used. The RCA was typically angular in shape without any organic impurities having nominal size of 20 mm as per IS 383 : 2016 specification. The density of recycled coarse aggregate is generally lower than natural coarse aggregate due to the adhered mortar. The specific gravity and fineness modulus is 2.43 & 7.75 respectively.

5. Stone Dust

Stone Dust used in this investigation is obtained from aggregate crusher plant. It is grey in colour, dry in condition, passing completely through 4.75 mm aperture size sieve and retained on 150 μm sieve and conforming to Zone II as per IS 383 : 2016 specification. The fineness modulus and specific gravity is 3.212 and 2.43.

6. Water

Potable water is used to ensure that the water is reasonably free from impurities. Water used in concrete meets the requirements of IS 456 : 2000 as shown in table 4.

Experimental Program

This work is allied with experimental study on strength of concrete on composite cement and optimum percentage of recycled coarse aggregate & stone dust in combination as partial replacement to coarse and fine aggregate for M25 grade of concrete.

The mix design is done by IS 10262:2019 and IS 456:2000. Cubical samples of concrete by replacing 30% of coarse and fine aggregate with different proportion of recycled aggregate and stone dust as shown in table 2 were casted. 3 cubes of 150 x 150 x 150 mm and 3 cylinders of 150 mm x 300 mm were casted in each set for 3, 7 and 28 days of curing. Water Cement ration is taken as 0.486 for M25 grade concrete. Workability, Compressive & Split tensile strength test was conducted for the same.

Table 2 Mix Proportion

Mix	CoC	OPC	NCA	RCA	FA	SD
M1	0%	100%	100%	0%	100%	0%
M2	100%	0%	100%	0%	100%	0%
M3	100%	0%	70%	30%	100%	0%
M4	100%	0%	70%	30%	80%	20%
M5	100%	0%	70%	30%	70%	30%

Experimental Result

1. Slump Test

Concrete workability is defined as the effort required to manipulate a freshly mixed batch of concrete with minimum loss of homogeneity. This property of concrete is generally known to affect the consistency, flowability, pumpability, compatibility of concrete. Slump value of different mixes are shown in table 3.

Table 3 Slump value of different mix

S.N.	Mix ID	Slump Value (mm)
1	M1	40
2	M2	35
3	M3	25
4	M4	28
5	M5	33

2. Compressive Strength

For this test, cubic moulds of 150 x 150 x 150 mm size were used. Compaction was achieved via table vibrator of the hand filled concrete cubes for the compaction. After 24 hours the specimens were demoulded and placed in water tank for different ages for curing.

Number of three specimens was used to get the mean value of each partial percentage for compressive strength and test was operated on compression testion machine having load capacity 5000 KN. Compressive strength tests of cubes werecarried out after curing at 3, 7 and 28 days respectively. The details of compressive strength of concrete are shown in table 4 and figure 1.

Table 4 Compressive Strength (N/mm^2)

S.N.	Mix ID	3 Days	7 Days	28 Days
1	M1	13.91	19.24	29.35
2	M2	13.74	19.05	29.9
3	M3	13.7	18.26	28.65
4	M4	15.42	19.85	29.94
5	M5	16.88	20.43	30.76

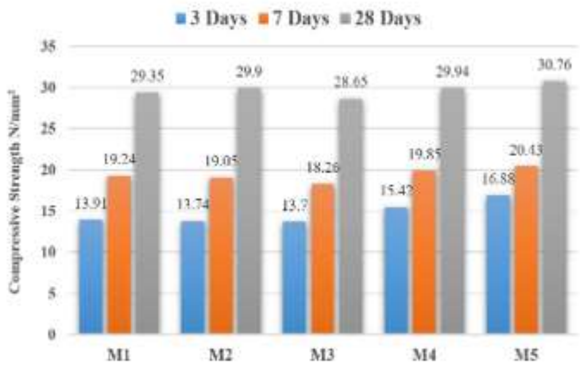

Figure 1 Graph of Compressive Strength for different Mix

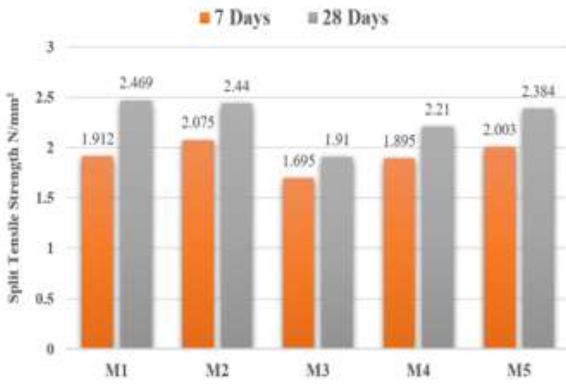

Figure 2 Graph of Split Tensile Strength for different Mix

3. Split Tensile Strength

For this test, cylinder moulds of 150 x 300 mm size were used. Compaction was achieved via table vibrator of the hand filled concrete cylinders for the compaction. After 24 hours the specimens were demoulded and subsequently placed water tank basin for different ages for curing. Number of three specimens was used to get the mean value of each partial percentage for split tensile strength and test was operated on compression testing machine having load capacity 5000 KN. Split tensile strength tests of the cylinders were carried out after curing at 7 and 28 days respectively. The details of split tensile strength of concrete is shown in table 5 and figure 2.

Table 5 Split Tensile Strength (N/mm^2)

S.N.	Mix	7 Days	28 Days
1	M1	1.912	2.469
2	M2	2.075	2.44
3	M3	1.695	1.91
4	M4	1.895	2.21
5	M5	2.003	2.384

Conclusion

Based on the result of the tested specimens and discussion the following conclusion can be drawn –

- The trial mix prepared using the composite cement gave enhanced properties as compare to OPC.
- The use of 30% Stone Dust as partial replacement of fine aggregate with composite cement in the concrete mix shows highest compressive strength and optimum tensile strength.
- The use of stone dust as partial replacement of fine aggregate in concrete mix reduced the overall cost of concrete.
- When 30% recycled coarse aggregate used as replacement of natural coarse aggregate it gives nearly required performance as compare to standard concrete mix. But combination with stone dust it shows better performance than standard concrete mix.
- Use of composite cement can save the natural resources up to 30-40%. As 30-35% of clinkers are used in composite cement, which is its biggest advantage. Its constituents are natural and industrial waste as replacement of clinkers which makes it eco-friendly.

References

1. Choubey UK et al, (2020), “Effects of Stone Dust with Partially Replacing Natural Sand in Properties of Concrete”, International Journal For Technological Research In Engineering, Volume 8, Issue 1.
2. Rahman A et al, (2021), “Study on Performance of Concrete Incorporated With Mineral Admixtures”, International Research Journal of Engineering and Technology, Volume: 08 Issue: 04.
3. Teja VP et. al, (2019), “Experimental Research on Composite Cement with Glass Fibers”, International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-7, Issue-6C2.
4. Kmaldeep MG. et. al, (2019), “Experimental Study on Performance of Concrete by using combination of Fly Ash and GGBS as Blended Material”, International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-7, Issue-6C2.
5. Phul AA et al, (2019), “GGBS And Fly Ash Effects on Compressive Strength by Partial Replacement of Cement Concrete”, Civil Engineering Journal, Vol(5) No.4.

6. Mamatha D et al, (2018), “An Experimental Investigation on Partial Replacement of Cement with GGBS and Fly Ash in Rigid Pavements”, International Research Journal of Engineering and Technology, Volume: 05 Issue: 04.
7. Valinejadshoubi M et al, (2013), “Assessment of the Roles of Various Cement Replacements in Achieving Sustainable and High Performance Concrete”, International Journal of Advances in Engineering & Technology, Vol. 6, Issue 1, pp. 68-77.
8. Pathan V.G. et al, (2012), “Evolution of Concrete properties using Ground Granulated Blast Furnace Slag”, International Journal of Innovative Research in Science, Engineering and Technology Vol. 1, Issue 1.
9. Siddique, R, (2003), “Effect of Fine Aggregate Replacement with class-F Fly Ash on Mechanical Properties of Concrete”, Cement and Concrete Research, Volume 33, Issue 4, Pages 539-547
10. Abbas S.Y. et al, (2015), “Effect of stone dust on compressive strength of concrete an experimental investigation”, International Journal Of Engineering Sciences & Research Technology, 4(2).
11. Abhilash P et. al, “Strength Properties of Fly Ash & GGBS based Geo-Polymer Concrete”, International Journal of ChemTech Research ,Vol.9, No.03 pp 350-356, 2016
12. M.S. Shetty (1982)“Concrete Technology: Theory and Practice” S. Chand & Company Pvt. Ltd., New Delhi.
13. IS 10262 : 2019 Concrete Mix Proportioning Guidelines. Bureau of Indian Standards.
14. IS 456 : 2000 Plain and reinforced concrete code for practice.
15. IS 383 : 1970 Specification for coarse and fine aggregates from natural sources for concrete.