Structural performance of concrete made with waste material.

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Abstract

The developing countries like India, China, Turkey, and South Africa are developing their concrete infrastructure which are using huge natural resources. Cement industry are using a huge amount of natural aggregates. Aggregates occupy 60-70% volume of concrete matrix it is considered as one of the main constituent. Some countries are natural aggregate deficient and some countries use a lot of natural aggregate due to their demand in the construction industry. The natural aggregates are depleting day by day so, for the construction industry it is very difficult to meet the requirements of present generation by these limiting natural resources and fulfil the needs of next generation. The sand extracted from the rivers cause many adverse effect on the environment. Many countries has now banned the extraction of sand from the rivers this will also decrease the fine aggregates in the construction technology.

Key words: *Structure, Waste material, aggregates, structural performance.*

1. Introduction

It has been estimated about 48.3 billion tons of aggregates were produced globally in year 2015[1]. Concrete is not environmental friendly due to its huge consumption of aggregates and its adverse effects after use, as its one of the ingredient is cement it produces huge amount of co2 in to the air. Which cause ozone layer depletion. The concrete industry globally will consumes 8-12 billion tons of natural aggregate after 2012 if the alternative aggregates are not used [2]. Civil engineers nowadays are forced to work on materials which are economic and environmental friendly. From the past studies all the researcher have shown the depletion of natural resources and significance of sustainable development. Sustainable development can be achieved by utilizing by products from the industries. From the last few years there has been large growth in industries which produce a lot of waste some tactics are made to utilize them as a alternate material for the construction. The industrial waste and by products put adverse effect on the environment, the disposal of chemical products can cause many adverse effect in the soil.so by using these products as the alternative of natural aggregates in the concrete construction can minimize the aggregate problems. The use of by-products has enhanced the fresh and hardened properties of concrete. Outstanding research has been published in view of materials like rice husk ash, fly ash, silica fume, Mata kaolin, marble powder, copper slag as a replacement of cement. They can reduce the cost of construction. Copper slag is one of the material which can be used as a replacement of cement, natural fine aggregate, natural coarse aggregate in the construction industry. Copper slag is produced by refining of copper and matte smelting. Copper slag may be granulated copper slag or dense copper slag depend up on the cooling of the molten slag obtained from the furnace. The production of copper slag is approximately 0.36, 0.244, 2.0, and 4.0 tons reported in Iran, Brazil, Japan, and United states,

respectively [3]. Copper slag is rich in iron and contain various types of oxides, which 1 includeSiO2, Al2O3, Fe3O4 [4]. The copper slag has low carbon content and use low energy of consumption it is widely used as a part of cement half or full substitute of fine and coarse aggregate. The copper slag has been used in normal concrete, high performance concrete and in self compacting concrete. It has enhanced the durability and hardened properties of concrete. The chloride penetration shows the maximum resistance, water absorption and sorptivity shows decrease in high performance concrete by using 2% of colloidal nano-silica as a cement replacement with 40%copper slag replacement as a fine aggregate [5]. By utilizing the copper slag as cement replacement has increased the resistance against sulphate attack by decreasing the expansion of the specimen exposed to sulphate exposure [6]. The use of copper slag can decrease the cost of construction. The copper slag has high iron oxide composition its density is higher than other materials. The copper slag can be used as abrasive tool, cutting tools and tiles etc. The copper slag is reused many times paints and rusts get mix in it. Copper slag can be replaced from 0% -100% in the concrete but at higher content of copper slag 80%-100% bleeding and segregation of concrete was observed [7]. The low water absorption characteristic and smooth glassy surface of the copper slag can enhance the workability of concrete four times better than nominal concrete when natural fine aggregate is completely replaced by copper slag. Copper slag is hard smooth, angular. It has low sulphate and chloride content and is not harmful to alkali silica reactions.

From the fast years it has observed a lot of infrastructure has been developed in the construction sector. Which produce a very bad effect on the environment, but the environment impact can be reduced by many producers. A lot of construction is done in many developing countries which uses cement, fine aggregates, coarse aggregates and super plasticizers etc. At the same time various buildings are being demolished which produces the waste materials. If these waste materials in the concrete production theses can reduce the demand of natural aggregate and decrease the impact the natural climate. There is a lot of problem regarding the disposal of waste building materials. These waste material in the production of concrete can reduce the cost of construction.[8] they used recycle concrete aggregates and reused recycle concrete aggregates at different proportion , in self compacting concrete up to 50% recycle aggregates can be used and physical properties were same as that of natural aggregate.[9] study the mechanical behaviour of concrete by using the third generation reuse recycle aggregate concrete substituted the natural aggregate by 100% reuse recycle aggregate concrete. The effect of reuse recycle aggregate concrete reduces the compressive strength of concrete as compared to nominal concrete. But the recycle concrete aggregates shows effective gain in the mechanical strength after 60 days. [10] Observed the mechanical and physical properties of precast concrete by using the reuse recycle aggregate concrete. The reuse recycle aggregate concrete shows the same or greater mechanical behavior as compared to the nominal concrete. [11] uses the reuse recycle aggregate concrete and studies mechanical and physical behavior of the self-compacting concrete the results shows that reuse recycle aggregate concrete enhances the properties than nominal concrete. Precast concrete industry can utilizes the reuse recycle aggregate concrete hence reduces the construction cost. So the use of recycle aggregates in the concrete reduces minimizes the negative impact on environment reduces the problems of waste disposal and enhances the properties of concrete.

2. Methodology

4.1 Equipment and Experimental setup

For the testing of cement various apparatus were used to find different physical properties of cement specified by different IS codes.

Figure 2: Vicat appratus

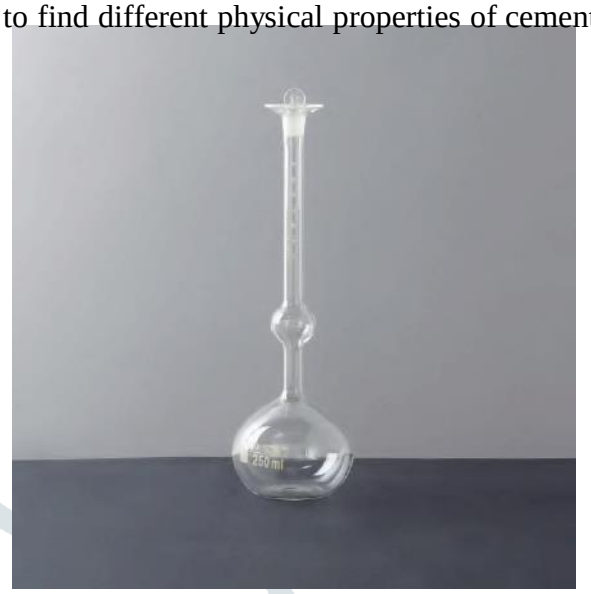

Figure 1: Le-chatlier appratus

Le Chatelier flask shown in figure 2, specified by BIS 4031 part 11 [24]were used to find specific gravity of cement. Vicat's apparatus shown in figure 1, specified by BIS 4031 part 4 [25]and BIS4031 part 5[25] were used to find consistency and setting time of cement respectively. To find physical of aggregates sieves specified by BIS 2386 part 1[26] were used to find particle size distribution. For the specific gravity and bulk modulus, pycnometer and cylinder shown in figure 3 and figure 4 specified by BIS 2386 part 3 [27] were used. The cubes of size (150mm x150mm x150mm) according to BIS 516-1959 [28]were used to determine the compressive strength of control mix and other mixes made with copper slag as a partial and full replacement for fine aggregate and recycle concrete aggregate as partial replacement of coarse aggregate as shown in fig 7. The cubes were well oiled before casting and demoulded after 24h, curing was done in fresh tap water till the age of testing. The cylinders of size 100mm x150mm satisfying the BIS 516-1959 [28]specification are used to determine the splitting tensile strength of control mix and other mixes as shown in fig 5.

Cement Ordinary Portland cement 43 grade was used in this study the basic mechanical and physical specification meet the IS 8112-2013[30] requirements, the specific gravity of cement is 3.21 having finess 2.4% and soundness 1 mm.

3. Results

Table 1: Physical properties of FA

Material	Specific Gravity	Water Absorption (%)	Fineness Modulus	Bulk density Kg/m^3
Fine Aggregates	2.5	2.4	3.0	1660

Table 2: Sieve analysis of sand

IS Sieve Designation	Weight Retained	Cumulative Weight Retained	(%) Cumulative retained	(%) Cumulative passing
10mm	0	0	0	100
4.75mm	2.91	2.91	0.14	99.86
2.36mm	215	217.91	11	89
1.18mm	370	587.9	29.68	70.32
850µ	212	799.9	40.3	59.7
600µ	388	1187	59.9	40.1

Table 3: Sieve analysis of coarse aggregate

IS Sieve Designation	Weight retained	Cumulative weight retained	% Cumulative retained	% Cumulative passing
80	0	0	0	100
63	0	0	0	100
40	0	0	0	100
31.5	0	0	0	100
25	0	0	0	100
20	30	30	3.09	96.91
16	170	200	20.61	79.39
12.5	270	470	48.45	51.55
10	180	650	67.01	32.99

Table 4: Physical properties of coarse aggregate

Material	Specific Gravity	Water Absorption %	Fineness Modulus	Bulk Density Kg/m^3
Coarse Aggregates	2.63	0.9	3.2	1820
Recycle coarse aggregate	2.52	4.2	3.8	1416

4. Conclusion

This study investigates the effect on mechanical and durability properties of concrete by partially replacing sand with copper slag and coarse aggregate with recycle coarse aggregate. To investigate the mechanical and durability properties of concrete various tests are conducted like compressive strength, flexural strength, split tensile strength water absorption and sorptivity. To get the better results on concrete various tests were conducted on materials. Specific gravity, consistency, initial and final setting time tests were conducted to get the physical properties of cement. The result obtained from these tests were with in permissible range of IS codes. For aggregates specific gravity, fineness modulus, bulk density, water absorption and particle size distribution tests were conducted. The results obtained from these tests were in the range given in IS codes.

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