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SPATIAL ANALYSIS FOR THE SUSTAINABILITY OF GLASS AGGREGATE AS REPLACEMENT OF FINE AGGREGATE IN CONCRETE

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Abstract : Concrete is one of the most important construction material in the world and with the rapid development there is instant increase in the consumption of concrete for the construction of building and other structure and this cause the increase in the demands of other construction material such as course aggregate, fine aggregate and cement. The coarse aggregate and fine aggregate are the natural sand gone through the process of cutting and grinding to make them in a desired size and usable. While cutting of big and huge stone cause the loss of ecosystem and disturbance in ecology and cause the environmental degradation. Due this major problem there is requirement of replacement of aggregate with other material. So here I have tried to develop fine aggregate by using waste glass and to ensure suitability certain test were performed on the glass and other tests were performed on the casted and cured concrete cube and on the basis of that final conclusion were made.

IndexTerms **- Waste glass, concrete, compressive strength test, specific gravity.**

I. INTRODUCTION

The construction sector experiences a growing demand for concrete due to rapid infrastructure development. This development accelerates concrete production upwards of 25 million cubic meters each year in India as well as leads to massive extraction of natural resources such as natural aggregate.

The building material used for making concrete are naturally extracted except cement like course aggregate, fine aggregate The extraction of these natural aggregate are from non-renewable resources which ultimately harm environment and ecology. Various research work has been started by the researchers for the proper development and for more sustainability of concrete in India as well as worldwide with an aim to decrease the effect on ecology and environment and to save the raw materials.

Stability of concrete can gain by replacing the building materials used while making the concrete which will ultimately decrease the adverse effect on environment cause while extraction on them these building material include course aggregate, fine aggregate and cement and can be replace by other materials which include recyclable material or industrial waste or industrial by product. Apart from these materials other materials can also be used for the replacement of building material such as fly ash which is a thermal industry waste, inorganic and hazardous by nature with the size of 2.5 particulate matter. Day by day flash is becoming headach for thermal power industries. Studies conducted on this field had confirmed that the cement can be substituted by any other pozzolanic material like flyash in cement can perform better as compare to the results of traditional cement. By this not only the use of amount of cement will decrease but it will also become cost effective and the performance of the cement will improve such as workability and durability and ultimately result in high compressive strength. This type of research also promote the replacement of coarse aggregate by recycling of aggregate from dismantle building or from waste materials. The development of Fine aggregate as compere to course aggregate and cement is very slow and their stability is comparatively is very less. Fine aggregate can be define as that material which can fully pass from 4.75 mille meter sieve and partially retain at 75 micro meter sieve weather it is a natural sand or processed sand. Sand are basically the collection of small sediments which are the results of atmospheric agents such as wind as strome, water as rain or flood. When all these circumstance happens they break a large rock or mountain and pull out small particles which are collectively called sediments. Not only by natural mean sand can also be manufacture, by artificial process by rubbing against a hard substance and this process is called abrasion. Not only by abrasion, sand can also be process by crushing.

II. LITERATURE REVIEW

The importance of fine aggregate and course aggregate in concrete as a building material and the consequences after the removal of sand from concrete and the replacement by crushed glass. This chapter also summarize the study made on the various properties of crushed glass such as mechanical properties and geotechnical properties. It also include the study of silica alkali reaction that took place in concrete and their durable properties and their mitigation method. This chapter explains the basic concept of sand less concrete which include the mix design and their various approach and their various application.

The concrete is mold by replacing sand in it by glass sand due to lower specific gravity and density of concrete. Various test were performed at different mix ratio of concrete and shows the same results as mention above (Topcu et al, 2004)

Park et al. (2004) did test on glass sand concrete of different colour glass. The outcome of the results showed that with the higher waste glass sand content will cause increase in air content at 41.4% of 70% replacement by crushed glass sand. It was recommended that the crushed glass which is to be use in concrete has to be in irregular shape due to this outcome larger surface area will entrapped more air. Moreover in the performed test only that glass sand are preferred whose size are larger than 0.6mm than manufacture or natural sand. Topcu and canbaz (2004) performed a test and get the result that more will be the waste crushed glass sand then there will decreased in the air content up to 27%. The final outcome obtained from the irregular shape and size of crushed glass sand was that water.

Taha et al, (2018) in his conducted test and has replaced the natural sand with crushed waste glass at 0%, 50% partial replacement and 100% complete replacement in concrete. On the above conducted study they deeply investigated the properties of freshly prepared glass concrete. The outcome of study shows that concrete having glass sand of 50% or partial replacement was homogenous and less consistent and concrete having 100% or complete replacement of glass sand showed an adverse result with bleeding and segregation. In comparison with normal concrete to crushed glass sand, concrete without glass shows consistency and homogeneity. Due to a plain surface of sand made from glass result in bleeding and segregation and low water absorption this cause the ultimate decline in the strength by the low adhesive bonding.

Park et al. (2004) partially as well as fully replace the natural or processed sand with glass sand with 30%, 50% and 70% and the compressive strength test was tested on all the sample at 28 days and the strength gain was 99.4%, 90.2% and 86.4% and compared these results with normal concrete strength. This result was achieved may be due to reduction in adhesive strength among the surface area of glass sand and cement and this may also be result in the fineness module of the waste glass sand which also cause the decrement in the compaction.

Taha et al (2008) investigated by performing various compressive test on concrete with a partial or complete replacement of sand with crushed glass sand and the conclusion was derived that the variation in the strength was not identified with the replaced glass Sand. And further more they came to the conclusion that there must be one more test or parameter such as contamination of organic or in organic substance that has to be investigated which is effecting the strength. Kou et al, (2009) conducted a research in self compacting concrete and replace the sand with a percentage by 15%, 30% and 45% the results of the reduction after 28 days of strength was 1.5%, 4.5% 8.2%. And they estimated that the bond cause for the strength between the cement and glass will decrease which is due to increment in the fineness module. Limbachiya, (2009) also did the same replacement up to 50% and studied the compressive strength of that concrete. Terro et al, (2006) conducted the study on compressive strength of fine aggregate replaced sand in a ratio of 10%, 25%, 50% and 100 % along with temperature study at 20^{o}C, 60 ^{o}C, 150^{o}C, 300 ^{o}C, 500 ^{o}C & 700 ^{o}C. Ismail et al, (2009) investigated the development of compressive strength of fine aggregate replaced concrete at a ratio of 10%, 15% and 20% of glass sand. They came with the result that compressive strength results are higher but on the sample tested on 14th day was slightly lower as compared to results. After this result they concluded that the compressive strength on 14th day is low due to the decrement in adhesive strength among the glass particle or glass sand and cement paste. The pozzolanic behaviour or reaction of concrete cause itself to improve the strength at later days such as 28th days.

III. MATERIALS AND METHODS

(a) Materials

To pursue the present research work building material is required are: -

- Portland cement Type I
- Fine Aggregate
- Coarse Aggregate
- Glass

(b) Methods

The methodology adopted in the present work was divided into four parts namely: -

- crushing of glass,
- testing on glass,
- concrete cube casting and curing
- Testing on concrete cube.

The glass was crushed just after the sampling was done and sieve from 4.75 mm sieve. Furthermore, the investigation were done from several aspect such as geotechnical testing etc. the cubes were made by using concrete grade M20, which is a good grade for testing furthermore after curing testing was done on it on specific days and the result were obtained.

IV. RESULTS

(a) Results for geotechnical properties

- The Specific gravity of the glass sand is 2.429
- The Bulk density of the glass sand is 1.55 g/ml^3.
- The result for Grain Size Analysis is, Cu & Cc was found to be 2.27 & 1.016
- The fineness module is 3.
- The water absorption is 0.131%.

(b) Result for compressive analysis test

Table: Result for Compressive Test

Sand ratio / **Testing days**	**25 %**	**50%**	**75%**	**100%**
3 days	7.08	7.50	7.12	6.3
7 days	11.83	11.52	11.46	10.1
14 days	17.00	17.28	16.8	15.9
28 days	18.92	19.03	18.98	16.54

V. CONCUSIONS

The specific gravity, bulk density of the glass sand sample is 2.039 & 1.672 which is lying in the range as per Indian standard. On the basis of sieve analysis test the crushed glass sample was found to be partially evenly distributed. Fineness Module was found to be 3.5 which puts it into the category of coarse sand. Results of water absorption was found to be 0.1% which is very low and negligible.

The M20 grade concrete cubes are casted and are tested at 3, 7, 14 and 28 days of curing. The compressive strength test results shows that the sample containing 25% and 50% glass sand content show good compressive strength on all days but on comparing test results of both the sample, sample containing 75% and 100% glass sand is showing sudden drop in the compressive strength. Overall, it can be concluded that when the glass content is increase by 60% there is drop in the compressive strength on the concrete.

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