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EXPERIMENTAL INVESTIGATION ON THE EFFECT OF FROTH FLOATED SILICA

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ABSTRACT

From Rapid Chloride Permeability Test which was done for the specimens at 90 days curing, the results indicates that with 80% replacement of fine aggregate by froth floated silica the chlorine ion penetrability is very low as compared to other percentages. The FESEM images of conventional as well as 80% of froth floated silica concrete gives a clear idea that the bonding between the aggregates and the cement paste is very good for 80% of froth floated silica concrete than conventional concrete.

The workability results shows that the replacement of fines by froth floated silica increases but in the presence of super plasticizer. The results indicate that when the fine aggregate is replaced by froth floated silica by 80% the compressive strength increased by 19.86%, split tensile strength by 16.29% and flexural strength increases by 28.14% than conventional concrete.

1. INTRODUCTION

1. GENERAL:-

Constructions are going at a large scale all over India. This is mainly due to the infrastructural development which is going on in each and every city. Due to which there is a boom in the construction market. Generally in construction of any structure the most important and demanded material is the concrete. Demand of concrete is growing rapidly with increase in demand of construction which ultimately results in the increasing demand of its ingredients such as coarse aggregate, fine aggregate, cement, etc.

The most ordinarily utilized item compose is squashed stone, making up 40 percent of aggregate 2006 totals request. Rock represents the following biggest offer of interest, trailed by sand and other total materials [4]. A great part of the country's totals supply is given by little, privately based quarry and pit administrators, in spite of the fact that a couple of outside multinationals, for example, CEMEX and Tarmac, work total mining and handling offices in India, also. Development totals request in India is relied upon to ascend at a 7.7 percent yearly pace to 1.6 billion metric tons in 2011, a deceleration from the 2001-2006 period, yet at the same time above anticipated development for the Asia/Pacific locale in general [3]. The demand of aggregate components is given in the Figure 1.2

Continuous industrialization and government intends to extend and update the nation's physical framework will fuel advertise development. For instance, the Indian government has detailed plans to contribute roughly $500 billion for streets and railroads by 2012 [1]. Nonetheless, as the pace of monetary development and development movement ascends all through the area, so will more prominent rivalry for financing from outside speculators, which will hose totals request to some degree. In the present scenario, the utilization of fine aggregate is more which is being over utilized. The river bed is over exploited for extracting river sand which is one of the mass giving component of concrete. Here comes the use of green concrete which is a environmental friendly concrete [2].

Green concrete refers to the concrete which is produced by eco friendly materials that delivers sustainable building structure having long life cycle with low repair cost. The aim of green concrete is to decrease the natural effect of concrete. To ensure this, new and innovative materials are produced [8].The innovative materials considers all periods of construction development's life cycle i.e. basic quality, detail, assembling and support and it incorporates every one of the parts of execution, i.e.

1. Mechanical properties (strength, shrinkage, creep, etc.)
2. Fire resistance (spalling, heat transfer, etc.)
3. Workmanship (workability, strength development, curing, etc.)
4. Durability (Corrosion protection, frost, etc.)
5. Environmental aspects (CO_2 - emission, energy, recycling, etc.)

Froth floated silica is a sustainable material which is finely powdered crystalline silica obtained as a bi-product from cement manufacturing industry by the froth floatation process. Froth floatation is the procedure of specifically isolating hydrophobic materials from hydrophilic. In the cement manufacturing context, froth floatation process

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separates the lime rich part of the limestone from the siliceous part. The lime rich part is used as a cement manufacture and the siliceous part in the form of fine powder is discarded as a waste product and is known as froth floated silica. Froth floated silica is rich in silica which is crystalline white in color [2]. Its silica rich part property empowers smaller scale filling impact which lessens pores in concrete and give better dampness resistivity and consequently strength. Moreover it has more consistent and steady grading than any other extracted aggregates [7].

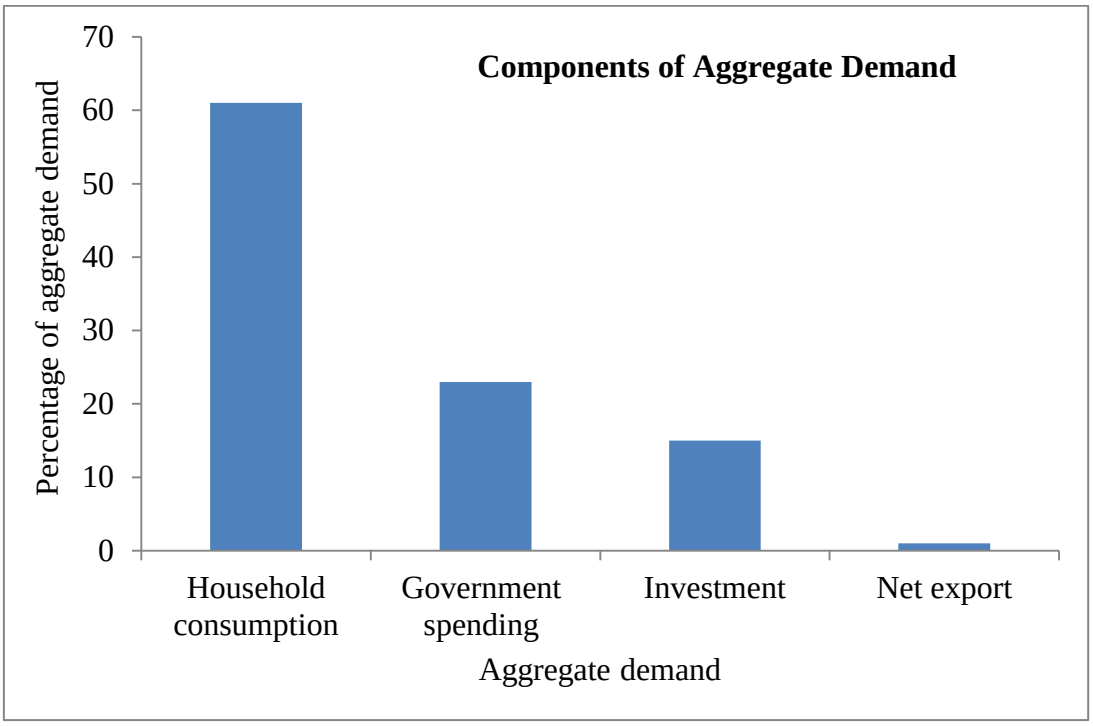

Figure 1.1: Components of aggregate demand

1.1 NEED FOR RESEARCH

- To reduce the depletion of river sand.
- To find a alternative for the fine aggregate.
- To save the energy required in the production of cement.

1.2 OBJECTIVES

- To analyze the effect of froth floated silica as renewal for fine aggregate.
- To study the strength properties and durability characteristics of concrete made with froth floated silica.
- To investigate the concrete's resistance to chloride ion penetration using tests like the Rapid Chloride Permeability Test.

1.3 SCOPE

- Fine aggregates will be replaced by froth floated silica at 20%, 40%, 60%, 80% and 100%.
- M20 grade of concrete will be prepared and tested for compressive strength, split tensile strength at 7, 14 and 28 days. Besides this the flexural strength will be tested for 28 days. The durability tests include RCPT which will be done for 90days and water absorption for 28 days.

RESEARCH SIGNIFICANCE

- Reduction of green house gases such as carbon dioxide, methane, etc.
- Saving the energy i.e., electricity used in the production of cement.
- Lowering the cost of construction.

2. LITERATURE REVIEW

2.1 GENERAL

In this chapter, literatures similar to the current project work are being investigated and analyzed. Based upon the literature survey of the different journals, individual review of the literature survey has been summarized. The analysis of different literature survey includes topics such as the physical and chemical properties of froth floated silica, mechanical properties which were evaluate from the compressive strength, flexural strength and split tensile test of the samples replaced with froth floated silica. Different percentages of froth floatation silica are added to different grade of concrete and were summarized. Further the durability characteristics in terms of alkalinity and water absorption of

partially replaced froth floated silica samples were also investigated in the journals. Since different journals were analyzed to get help in doing this project, so the individual literature survey of the different journals similar to the current project work are given below.

2.2 REVIEW OF LITERATURES

- **Chinnaraju *et al.* (2013),** studied the concrete characteristics by replacing coarse aggregate with steel slag and fine aggregate with eco sand. M40 grade of concrete was prepared and tests were done on hardened concrete. Results showed that the compressive strength was increased after 7 days curing of M40 grade of concrete and with 40% renewal of eco sand, good compaction was attained due to the smaller size of eco sand and when renewal of eco sand was increased, it was found that water absorption is reducing. So the researcher concluded that the optimum level was at 40% replacing of fine aggregate with eco sand.
- **Vishnumanohar (2014),**has studied the physical and chemical properties of finely graded silica (eco sand) and also partially replacing this finely graded silica with fine aggregates. The fine aggregate was partially replaced with 15%, 30%, 45% and 60%. The concrete cubes with the partially replaced finely graded silica was tested for compressive strength test and the research showed that the maximum strength was gained by 15% of fine aggregate replacement with finely graded silica (eco sand) in concrete. Further from the Scanning Electron Microscope analysis of concrete, the researcher found that at a 15% replacement the mix was homogenous. Greater the percentage of fine aggregate replacement, greater was the strength activity index. From the experimental investigation the researcher concluded that 15% replacement level of fine aggregate by finely graded silica was the optimum level and gave good strength characteristics.
- **P. Magudeaswaran et al. (2015),** studied the mechanical properties of the partially replaced fine aggregate samples by eco sand from the compressive strength, flexural strengthand split tensile test. The fine aggregate was changed by eco sand at 30%. From the experimental investigation that was done the researchers found that, in the 30% replacing of fine aggregate with eco sand and 12.5% silica fume and 25% fly ash, the flexural strength was higher. In the case compressive strength test a mix of 70% natural sand, 30% eco sand, 10% silica fume and 20% fly ash has better strength properties after 28 days of curing. Moreover the split tensile test showed that the optimum level strength was obtained with 30% eco sand, 12.5% silica fume and 25% fly ash.

SUMMARY OF THE LITERATURE REVIEW

From the above eight literature survey of different journals having similar work as of the current project the summary can be concluded with these following points :

A. After 20% replacement of fine aggregate with eco fine aggregate, the strength properties of concrete gives optimum results.

B. After review of literature, it is clearly shown replacement of fine aggregate with eco sand gave better results for lower grade concrete such as M20 and M30 than higher grade concrete mix M40.

3. MATERIALS AND METHODOLOGY

3.1 GENERAL

A. Concrete is the most versatile material which is widely used in the construction industry due to its capability to withstand severe environment with sufficient strength and durability. Concrete can be simply termed as the synthesis of coarse aggregate and fine aggregate along with the adhesive material known as cement when mixed with water. Due to the recent trends of sustainable construction with environment friendly techniques, concrete ingredients are being replaced with innovative materials that help to build structures that are green and sustainable in environment.

B. The traditional concrete materials are fine aggregate, coarse aggregate, cement, water and sometimes admixtures. Now-a-days efforts are being made to partially or fully replace these conventional concrete ingredients with alternatives that are environment friendly, which will not only give sufficient structural strength but also provide efficient quality of structures than conventional concrete.

3.2 Froth Floated Silica

Froth floated silica are finely powdered crystalline silica which is obtained as a bi-product from cement manufacturing industry by the froth floatation process. Froth floatation is the process of selectively separating hydrophobic materials from hydrophilic. In the cement manufacturing context, froth floatation process separates the lime rich part of the limestone from the siliceous part. The lime rich part is used as a cement manufacture and the siliceous part in the form of fine powder is discarded as a waste product and is known as froth floated silica. Froth floated silica is shown in the Figure 3.1

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Figure 3.1: Froth Floated Silica

Froth floated silica is rich in silica (around 74%) which is crystalline white in color. Its silica rich part property enables micro filling effect which reduces pores in concrete and provide better moisture resistivity and thus durability. Moreover it has more consistent grading than any other extracted aggregates. The main advantages froth floated silica are are as follows:

- Energy efficient.
- Fire resistant.
- Reduction of dead load.
- Environment friendly.
- Durable.
- Light in weight.
- Low maintenance and low construction cost

Preliminary tests were done to obtain the physical properties of froth floated silica. The specific gravity of froth floated silica came as 2.436 and the fineness modulus of froth floated silica came as 0.93. The physical properties of froth floated silica in the Table 3.1

Table 3.1: Physical properties of froth floated silica

Properties	Result
Specific gravity	2.436
Fineness modulus	0.93

3.3 Methodology

In this project the process of doing the experimental investigation starts right from selecting the title of the project topic to the very end of publishing the paper. The methodology of doing this project work has been divided into different segments. At first title of the project topic was selected considering the necessity of doing innovative findings which will be helpful as environmental friendly techniques in the construction industry. The title of the project was chosen with the idea of doing sustainable construction techniques by the use of waste products which can be re-utilized in making green concrete. After the title was finalized literature review of different journals similar to this project work was studied and survey of all the literatures were done. The literature survey was followed by the collection of materials that constitute the basis of the project materials.

The materials that were collected are cement of OPC 53 grade, froth floated silica, coarse aggregate of nominal size 20 mm, fine sand. As the materials were collected, the mix design was prepared and optimized based on the best fit concrete mix. Then concrete cubes, cylinders and beams were casted with the desired concrete mix and tested for the compressive strength, split tensile strength test and flexural strength test to check the strength giving property of the altered concrete mix. Besides checking the strength of the concrete, the concrete mix was also tested for durability by RCPT, acid resistance and water absorption test. Lastly after getting the test results paper on this project will be published. The flow diagram of the project methodology was given in the Figure 3.2

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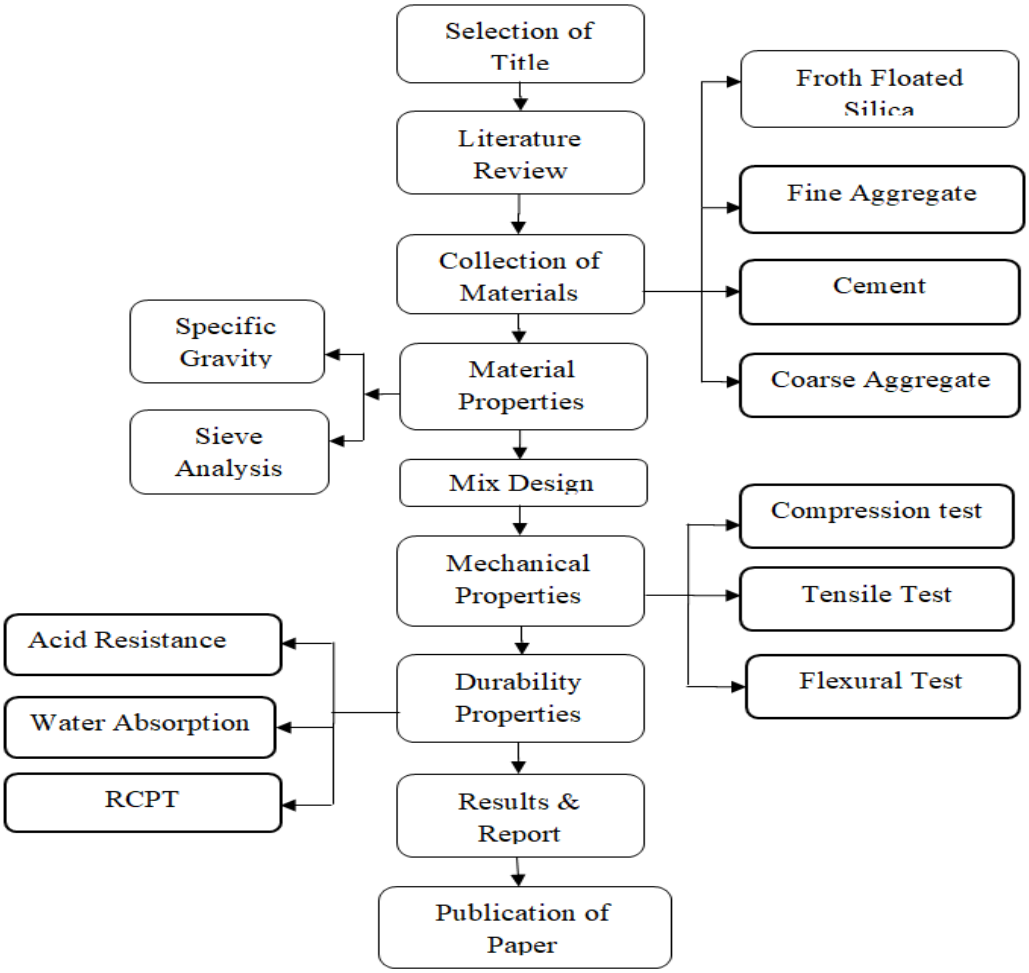

Figure 3.2: Flow diagram of project methodology

3.4 MIX DESIGN

The mix design was done for M20 grade concrete according to IS 10262 : 2009. Mix proportioning of M20 grade of concrete was prepared with 20% replacement of fine aggregate by froth floated silica. According to IS 10262 : 2009, the margin over characteristic strength is given by the following relation :

$$f'_{ck} = f_{ck} + 1.65\ s \quad \text{---------- (Equation 3.1)}$$

where, f'_{ck} = target mean compressive strength at 28 days in N/mm^2,

f_{ck} = characteristic compressive strength at 28 days in N/mm^2 and

s = standard deviation N/mm^2

The standard deviation is given in the Table 3.7 conforming to Table 1 (Clauses 3.2.1.2, A-3 and B-3) of IS 10262 : 2009

4. RESULT AND DISCUSSION

4.1 GENERAL

In this project titled "Experimental investigation on the effect of froth floated silica as a replacement of fine aggregate in concrete", initially the preliminary properties of the replaced concrete ingredients were investigated. The preliminary tests which were done to investigate the physical properties of these materials are specific gravity test and fineness modulus test. Slump cone test was done to know the workability of conventional as well as replaced concrete with different percentages of froth floated silica. Concrete specimens were tested for their mechanical characteristics such as compressive strength, tensile test and flexural test. Moreover to understand the durability of the standard as well as replaced concrete water absorption and RCPT were done.

4.2 PRELIMINARY TEST

To understand the behavior and physical properties of the concrete ingredients as well as the workability of concrete preliminary tests such as fineness modulus, specific gravity and slump cone test were done. The results of the various preliminary tests that were done were given below.

4.2.1 Specific Gravity Test

Specific gravity is the proportion of the mass of a substance to the mass of a reference substance for a same given volume.Specific gravity is usually utilized as a part of industry as a straightforward methods for getting data about the centralization of different materials or of quality control for polymer materials to evaluate the physical changes or to determine the degree of uniformity between samples. Here in this experimental study the specific gravity test was conducted on different concrete ingredients as well as the replaced material that is used in this project and the test results.

5. CONCLUSION

In this project work, froth floated silica is used as a replaced material for fine sand. The main idea of this project was to find whether, concrete with the replaced froth floated silica in case of fine sand had better structural strength, durability characteristics than conventional concrete. Different test methods were led to know the usefulness of froth floated silica as a substitution of fine total in concrete.The main aim of this experimental study was to enhance the characteristic strength and durability of concrete by utilizing froth floated silica as a fine aggregate replacement at 20%, 40%, 60%, 80% and 100% and to find out the optimum percentage replacement.

1. By using 80% froth floated silica as a fine aggregate replacement, the compressive strength increased by 19.86% than conventional concrete.

2. The split tensile strength also increased by 16.29% than standard concrete with the addition of 80% froth floated silica as fine aggregate replacement.

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