EXPERIMENTAL INVESTIGATION ON MECHANICAL AND DURABILITY PROPERTIES OF CONCRETE USING EXPANDED POLYSTYRENE AND SILICA FUME

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Abstract: Recently, safe disposal of post-consumer waste polymers has turn out to be a serious problem because of its non-biodegradable properties and large application. Due to user pleasant properties such as durability, low density, strength and low cost etc. the application of polymer waste annually has been growing steadily. Along with increasing in plastic wastes being disposed into the environment, the problems of disposal must be overcome. Being a very lightweight material, it is not possible to use waste polymers for land filling, which need large land space area. In contact with waste plastics, the land loses its fertility which also leads to environmental pollution. Incineration is another disposal method, but locating sites for new incineration facilities have led to considerable air pollution.

The use of polystyrene polymer is increasing day by day with economic growth. However, this polystyrene polymer is not decomposed and it is causing a serious environmental problem by growing as a solid waste. That's why an alternative process of recycling such materials as a coarse aggregate by partial use in concrete may reduce solid waste and made lightweight concrete and find the physical and mechanical properties of this concrete. The conventional coarse aggregate in concrete will replace with 0%, 10%, 20% and 30% (by weight) of Expanded polystyrene (EPS)and the ordinary Portland cement will replace with Silica Fume as the same percentage. A mix proportion of $M_{40\ and}$ M_{50} with water/cement ratio ranges from 0.35 - 0.56 will use and polystyrene granules will cast, and specimens will test at 7^{th} and 28^{th} days after natural curing.

Index Terms **- Concrete, Expanded polystyrene, Silica Fume, Sulfate Attack, Mechanical Property.**

I. INTRODUCTION

Recently, safe disposal of post-consumer waste polymers has become a serious trouble due to its non-biodegradable properties and large application. Due to user pleasant properties such as durability, low density, strength and cost is low etc. The application of polymer waste yearly has been growing gradually. Along with increasing plastic wastes being disposed into the environment, the problems of disposal must be overcome. Being a very lightweight material, it is not possible to use waste polymers for land filling, which need large land space area. In contact with waste plastics, the land loses its fertility which also leads to environmental pollution. Incineration is another disposal method, but locating sites for new incineration facilities have led to considerable air pollution. In fact, the ecological dumping of plastic products is presently of great concern. In this result, large concentration is being focused worldwide on the environment and protection of the natural resources through recycling of waste polymer resources in the recent years. There are more of research works concerning use of the more than a few kinds of polymer have been published in the last few years. Lots of researchers have been extended to learn special types of aspects of polymer wastes. Using plastic waste materials in concrete as aggregates is considerable as the most sufficient utilization to rise above the problems regarding safe disposal of more and more large quantity of waste plastic materials. The accumulation of waste apart from environmental benefit also produces good achieve on the properties of concrete.

II. PLASTIC WASTE AND MATERIALS

There are lots of plastic wastages now a day like plastic bottles, plastic bags, thermocol, etc. In this study we are using thermocol scrap as an aggregate which is prepared by the expanded polystyrene. Expanded polystyrene will be use as coarse aggregates in this study. Expanded polystyrene is plastic foam materials which have certain advantageous property because of its formation.

It is extremely light and floating, and a good insulator against heat and sound. It can be used as a construction material or as a design element, and it can be molded into lots of shapes for a number of domestic uses as well. It is still in nature and therefore does not affect by any chemical reactions. Since it will not demand to any pests, it can be used without difficulty in the construction industry. It is tough, strong and as well as lightweight material and can be used as insulated panel systems for facades, parapet, roofs and floors in buildings, as flotation material in the building of marinas and pontoons and as a lightweight fill in road construction and railway construction. In most cases, it is in white foam and is composed of little, unified beads.

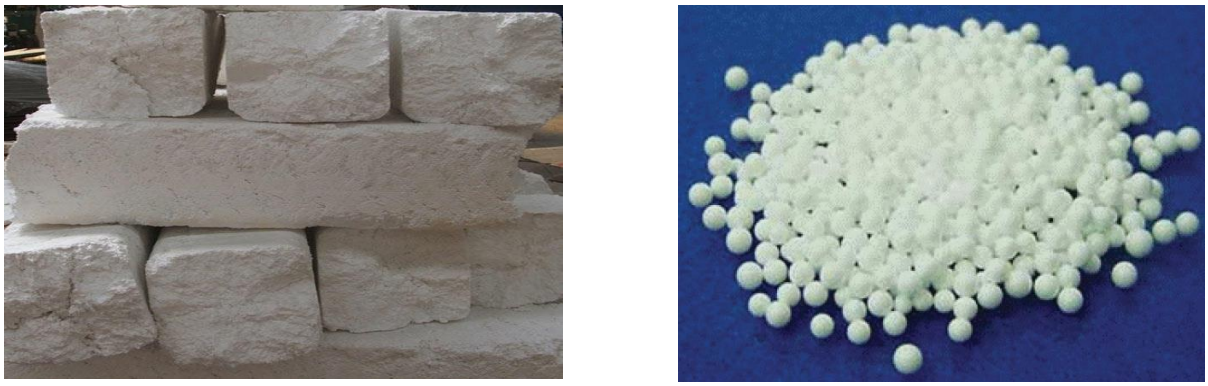

Figure 1. EPS Waste and Expanded Beads

There are lots of Pozzolanic materials like Fly ash, Rise husk ash, High Reactive Met kaolin, silica fume. Here we will use silica fume in this research because good quality Silica fume generally improves workability or at least produces the same workability with less water. It is a byproduct of producing silicon metal or ferrosilicon alloys. It primarily consists of nebulous silicon dioxide (SiO_2). The single particle is very small, around 0.01^{th} the size of regular cement particle. One of the most advantageous uses of its chemical and physical properties, it is an exceptionally reactive pozzolan. Concrete containing with silica fume has very high strength and it can be extremely durable.

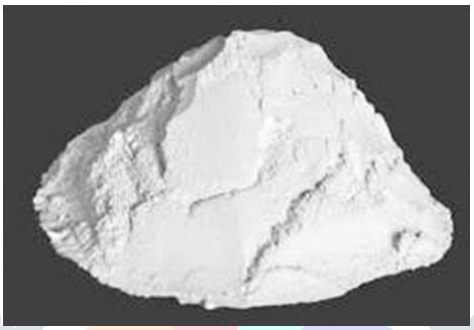

Figure 2. Silica Fume

III. EFFECT OF REPLACING EPS AND SILICA FUME ON MECHANICAL PROPERTIES OF CONCRETE

Two types of samples were prepared samples for strength tests and samples for durability tests. The strength test samples were used to test the concrete in compression, transverse, and split tensile test. Four different percentages of the EPS and Silica fume were used; 0%, 10%, 20% and 30% by weight of coarse aggregate and cement respectively. The 0% sample is used as a control sample in order to study the effect of replacing EPS and Silica Fume to the concrete mix. 6 samples for each percentage were casted. Three of them were used for 7 days test and another three for 28 days for compressive strength, transverse strength and tensile strength. Fig. 3 shows the effect of the EPS and Silica fume on the compressive strength of the concrete.

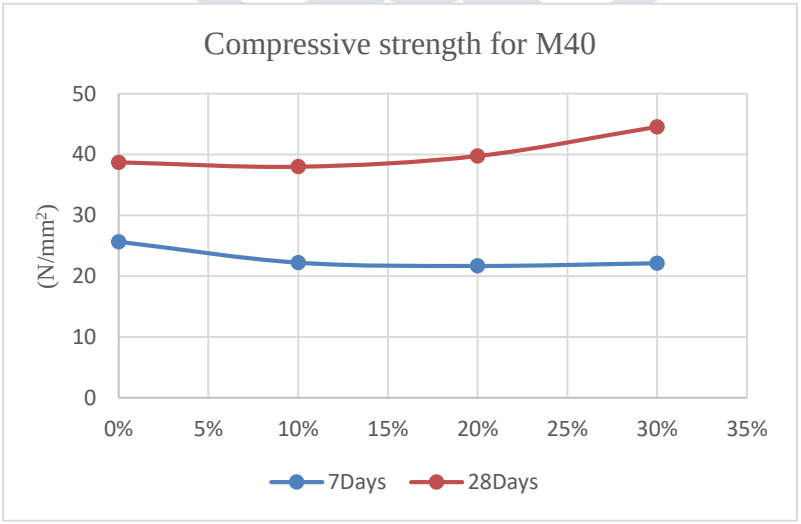

Figure 3. Compressive strength of concrete cubes M40 grade with EPS and Silica fume

At starting increase in percentages of replacing EPS and Silica fume with coarse aggregate and cement respectively decrease in strength at 7 Days but increase in strength at 28 Days. Compare to M40 in M50 grade strength is decrease by replacing EPS and Silica Fume in Concrete. Effect of replacing EPS and Silica fume with coarse aggregate and cement respectively in M50 grade concrete compressive graph is shown in Fig. 4.

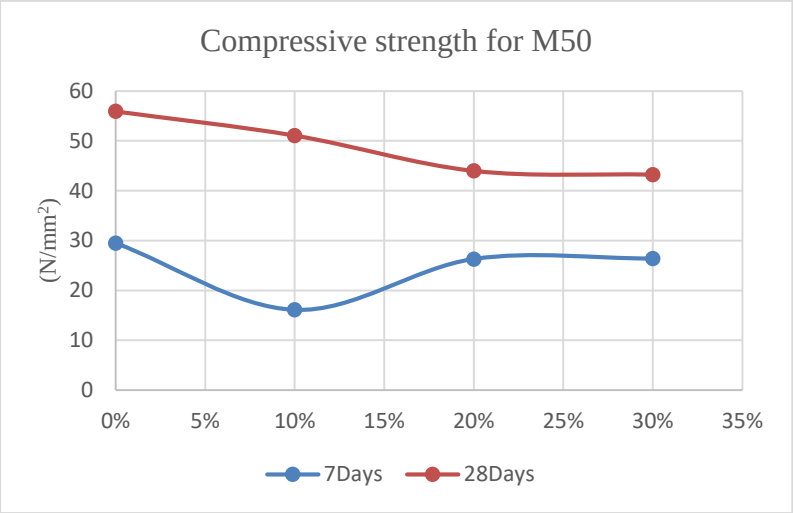

Figure 4. Compressive strength of concrete cubes M50 grade with EPS and Silica fume

Replacing the EPS and Silica fume in the concrete with coarse aggregate and cement for M40 and M50 grade's Flexural strength results is given below in Table 1 and Table 2 and it shows that the increase in the percentages of replacement with decrease in the flexural strength of both grades M40 and M50. Here the results are tested after the 28days of casting. The M40 grade is gives better result than the M50 grade.

Table 1. Flexural strength of concrete at 28 days for M40 Grade (N/mm^2)

M40	Sample-1	Sample-2	Average Strength
0%	1.820	1.759	1.7895
10%	1.754	1.393	1.5735
20%	1.449	1.437	1.443
30%	1.160	1.393	1.2765

Table 2. Flexural strength of concrete at 28 days for M50 Grade (N/mm^2)

M50	Sample-1	Sample-2	Average Strength
0%	1.698	2.237	1.9675
10%	1.288	1.837	1.5625
20%	1.221	0.955	1.088
30	0.710	0.722	0.716

The Split Tensile strength of concrete for M40 and M50 Grade graph is given in the fig. 5 and fig. 6. It shows that split tensile strength decreases with increase in the percentages in M40 grade compare to that in M50 grade its 1st increase and after decrease and after again its increase.

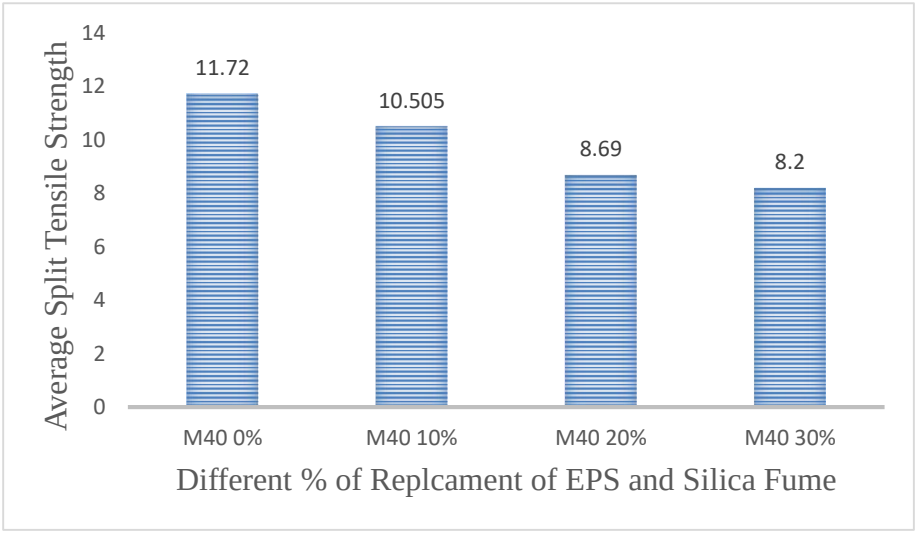

Figure 5. 28 days Split Tensile strength of concrete for M40 Grade

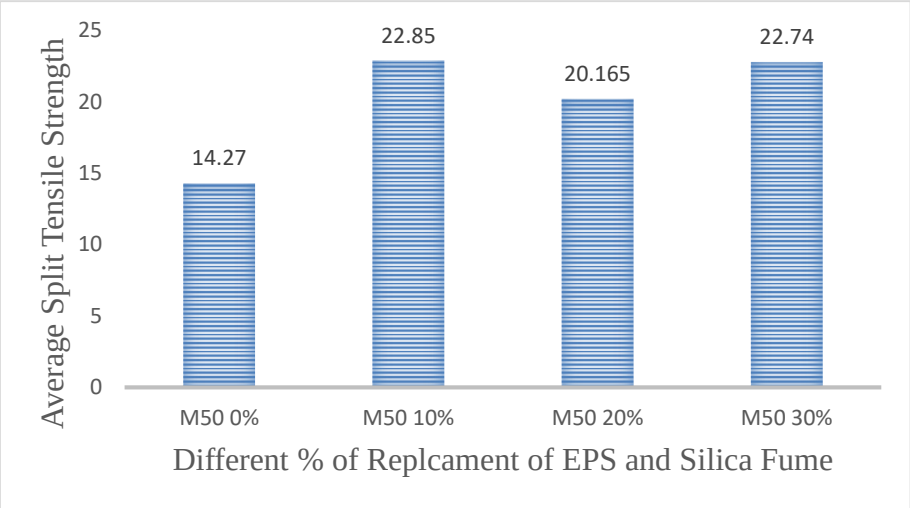

Figure 6. 28 days Split Tensile strength of concrete for M50 Grade

IV. DURABILITY TEST

In this test, the solution is made of Magnesium sulfate($MgSO_4$) powder having a slandered concentration of 5%. To prepare a solution of 5% concentration, it is needed to have 50 grams of Magnesium sulfate($MgSO_4$) powder for every 1 litre of solution. After preparing the solution, the pH of the solution should be measured with the digital pH meter. This initial pH should be maintained till the end, if the pH rises then add water to the solution.

Figure 7. Preparation of sample

First take 1kg $MgSO_4$ and prepare the solution which is given in the fig. 8 and take one barrel which given in fig. 7 and feel up with the solution and up the different percentages cube in the barrel. Before putting in barrel weight all the cube and Same time of preparing test take other same percentages cubes and test its compressive strength.

After the 7 Days empty the barrel and measure its weight and preform a compressive strength and compare with the before 7 Days tested cube results.

Figure 8. Making the solution

V. TEST RESULTS

Here after taking result of all cubes and compare with the before 7 days cubes result the below graph is finding out and in this for M40 grade 10%, 20% and 30% and for M50 20% and 30% of replacing cubes taken

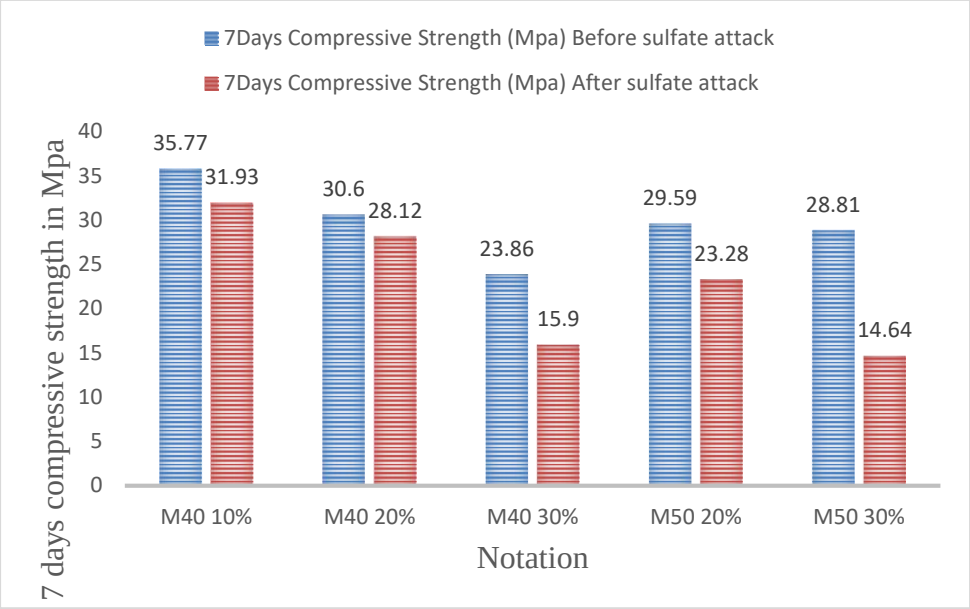

Figure 9 Reduction in compressive strength in EPS and Silica Fume contain concrete after sulfate attack

And its show that the due to sulfate attack compressive strength is decreasing and it decrease more with increase in percentages of replacement.

VI. CONCLUSION

Compressive strength increased for M40 grade with increase in percentage of replacement and at 28 days strength is 44.55 N/mm^2 in the mix proportion of M40 for 30% replacement but it decreased for M50 grade compared to M40 grade and at 10 % replacement in M50 grade gives 51.07 N/mm^2 strength but after replacing more percentages of EPS and Silica fume it more decreased in the compressive strength.

Flexural Strength of concrete in both grades decreased with increase in the percentages of replacement. The grade increase with decreasing of flexural strength more.

After replacing the 10% EPS and silica fume in M50 grade concrete gives more split tensile strength compare to normal concrete after increase in percentage strength is decreasing and for the M40 grade concrete increasing in percentage with decreasing in split tensile strength.

The compressive strength of concrete at the 7 days is decreased certain percentage during the durability study with the use of Magnesium Sulphate.

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