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STUDY ON PROPERTIES OF CONCRETE BY REPLACING FINE AGGREGATE BY EPS BEADS

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Abstract: ***In our day to day life the harnessing waste materials plays a key role in the construction industry. River sand was tradionally used as fine aggregates in concrete. With increasing demand of river sand various alternatives EPS beads is found to be one of the alternative of fine aggregate. EPS (Expanded Polystyrene Beads) is a rigid foam material produced from styrene and pentane has been chosen as alternative of fine aggregate. EPS beads are fire resistant, bacterial resistant, sound proofing despite these advantages it is a closed structure which can be recycled. EPS plays a vital role in packaging industry apart from this they are also used for several applications like manufacturing of sport helmets, chairs etc.. through this application it is known that EPS is one of the material with disposal issues. EPS beads can be recycled. The main feature of EPS beads is light weight and low moisture absorption and is also economical when purchased from industry. This paper presents the results of experiments performed by incorporating EPS beads in concrete as a replacement of fine aggregate. The fine aggregates were replaced by 0%, 1%, 2.5% and 5%EPS by volume and the results shows properties of concrete and were compared with conventional mix. The main objective of this project is to study the properties based on results of compression, flexural, water absorption, split tensile, density, sulphate attack on EPS incorporated concrete and compare with conventional concrete.***

Key words : EPS beads, fine aggregate replacement, compressive strength, sulphate attack test.

I. INTRODUCTION

At present, the world generates 2.01 billion tonnes of solid waste yearly, which adversely affect our environment. Dumping of waste as landfill also causes land pollution, foul smell, spread of diseases etc.., on the other hand if we tend to incinerate those waste it leads in emission of harmful toxic gases and causes air pollution, so to overcome this we have to replace waste products to the fullest. Concrete is a suspension of coarse aggregate in mortar. Mortar is a suspension of fine aggregate in cement paste. There forms an Interfacial Transition Zone(ITZ) between mortar and coarse aggregate.The actual behaviour of concrete is in series and parallel mechanisms. ITZ is due to higher water cement ratio, and they may not be uniform around the aggregates. It is formed when concrete is hydrated due to bleeding. It enhances immediate vicinity of aggregates in mortar. Constituents range in size from microns to several centimeters. Cement and water are hydrating agents. Aggregates act as fillers which are inert constituents. Early times lime mortar has been used for construction purposes which has been replaced majorly by concrete now a days. So far in this preparation of concrete we are in a huge demand of sand, and coarse aggregate etc.. this led to exploitation of natural resouces. Already we are grabbing more amount of sand from river bed which alters the coarse of river and eroding river bank leads to flooding. To overcome environmental issues we have to seek for alterations. Usage of Manufactured Sand (M sand) obtained from construction and demolition waste has been majorly used as an alternative source for river sand adding on this we can also use recycled EPS beads in place of fine aggregate to certain percent inorder to overcome the problems of disposal of EPS beads and exploitation of river sand.

II. MATERIALS

The ingredients of concrete used in this experimental study were Expanded Polystyrene beads (EPS) in sphere shaped rigid form, fine aggregate (Manufactured Sand), coarse aggregate, OPC grade 53 and water. All the materials satisfy provisions as per IS Codes.

A. Cement : Ordinary Portland Cement of grade 53 of Ultra Tech cement conforming to IS 12269 – 2013 have been used. Various tests were performed to ensure the properties of cement as per IS provisions. The choice of the cement content depends on the strength requirements, exposurecondition and the minimum amount of fines required in the mix.

B. Aggregate : Aggregates are filler materials in concrete. In other words suspension of cement in water forms paste, suspension of fine aggregate in paste is termed as mortar, suspension of coarse aggregate in mortar forms concrete. Round, angular grounded stones areused as filler materials in concrete.

C. EPS beads : EPS beads used in this project is obtained by injecting styrene to byproduct of crude oil industry. EPS beads are strong, durable and lightweight that can be used for flooring, wall panels and has a wide range of applications in various sectors. EPS beads are shock absorbent.

III. MIX RPOPORTION

Mix design for conventional concrete was designed as per the guidelines given by IS 10262:2009. This mix design was taken as the reference for the replacement of EPS beads in concrete. EPS beads was replaced as fine aggregate partially with different proportions like 1%,2.5%, and 5% respectively with total amount of fine aggregate. Water cement ratio taken for the mix is W\C = 0.45.

The mix ratio and mix proportions of materials for different percentage of EPS are shown in table below,

Table 1 : Mix Proportion

Material	Cement (kg/m3)	Fine aggregate (kg/m3)	Course aggregate (kg/m3)	Water (Litre)
Mix proportion for 1m3	337	829.7	1128.27	157.69
Ratio by weight	1	2.47	3.35	0.45
Take ratio	1	2.5	3.3	0.45

Fig 1:Mixing

Table 2 : Mix Proportion for cubes

For 6 Cubes	Cement (kg)	Fine Aggregate (kg)	Course Aggregate (kg)	Water (Litre)	Eps Beads (%)
Conventional (M30)	6.82	16.8	22.9	3.07	0
1% Replacement	6.82	16.8	22.9	3.07	1
2.5% Replacement	6.82	16.8	22.9	3.07	2.5
5% Replacement	6.82	16.8	22.9	3.07	5

Table 3 : Mix Proportion for cylinder

For 6 Cylinder	Cement (kg)	Fine aggregate (kg)	Course Aggregate (kg)	Water (Litre)	Eps Beads (%)
Conventional (m30)	10.71	26.394	35.87	5.01	0
1% Replacement	10.71	26.13	35.87	5.01	1
2.5% Replacement	10.71	25.73	35.87	5.01	2.5
5% Replacement	10.71	25.07	35.87	5.01	5

Table 4 : Mix Proportion for beam

For 6 Beam	Cement (kg)	Fine Aggregate (kg)	Course Aggregate (kg)	Water (Litre)	EPS Beads (%)
Conventional (m30)	0.5	1.245	1.7	0.23	0
1% Replacement	0.5	1.232	1.7	0.23	1
2.5% Replacement	0.5	1.213	1.7	0.23	2.5
5% Replacement	0.5	1.182	1.7	0.23	5

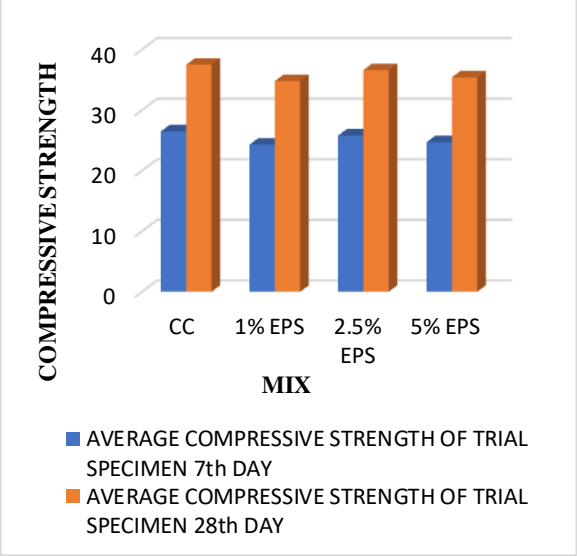
IV. TESTS PERFORMED

A. COMPRESSION TEST The most common test carried on concrete with respect to particular period of time is Compressive strength.
The compressive strength test is carried out in order to determine the probable maximum strength that concrete can acquire under given conditions.
It describes compressive strength which is the capacity of the concrete to tensile strength. Compression strength test describes the strength that concrete can withstand in different stages of hardened state. The test is also called cube test of concrete where the cubes are casted and cured for testing process. The quality of raw materials, w /c ratio, aggregate ratio, relative humidity and curing of concrete mainly affects the compressive strength of the EPS concrete. The EPS concrete specimens with dimensions – [15 cm * 15 cm *15 cm] were casted in required circumstantial conditions. Then the test was carried on these EPS concrete on the day – 7,14 and 28 under the compressive loads by UTM(universal testing machine) to determine compressive strength of concrete. The compressive strength is calculated from the ratio of failure load to the are of application of load. After determining the respective data, the average of the compressive strength of three cubes were taken at each particular day.

TABLE 5: COMPRESSIVE STRENGTH TEST

MIX NUMBER	AVERAGE COMPRESSIVE STRENGTH (N/mm^2)	
	7^{th} day	28^{th} day
CC	26.5	37.5
1% EPS	24.3	34.8
2.5 %EPS	25.8	36.6
5% EPS	24.7	35.4

CHART 1 : COMPRESSIVE STRENGTH



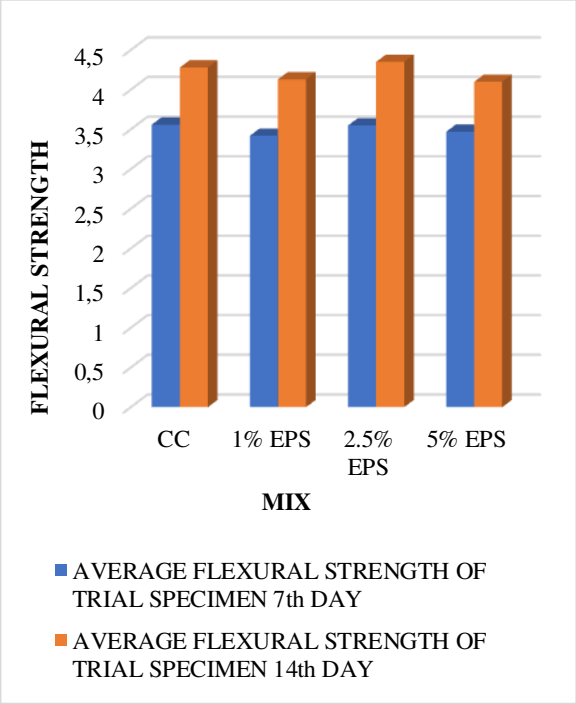
B. FLEXURAL STRENGTH TEST:

The flexural strength is carried out to measure tensile strength of concrete indirectly. This test carried out to determine the resist failure of an un-reinforced concrete beam or slab under bending. Flexural strength determines the force required to demold concrete of specified diameter. The higher the value of flexural strength, the higher the concrete can withstand impacting forces. The test is carried out by curing [150mm * 150mm] concrete beams with the span length of at least three times the depth. Then the specimen is immediately placed in flexural testing machine [ASTM C78]. The load is applied on top of the specimen until the sample fails and the failure load is noted. Flexural strength is the ratio of failure load with respect of effective span length of the specimen to the cross-section area of the specimen. The value of the flexural strength after testing is expressed as a modulus of rupture [MR] in Mpa or psi.

TABLE 6: FLEXURALSTRENGTH

MIX NUMBER	AVERAGE FLEXURAL STRENGTH (N/mm²)	
	7th day	14th day
CC	3.56	4.28
1%EPS	3.42	4.13
2.5%EPS	3.55	4.35
5%EPS	3.47	4.10

CHART 2 : FLEXURAL STRENGTH



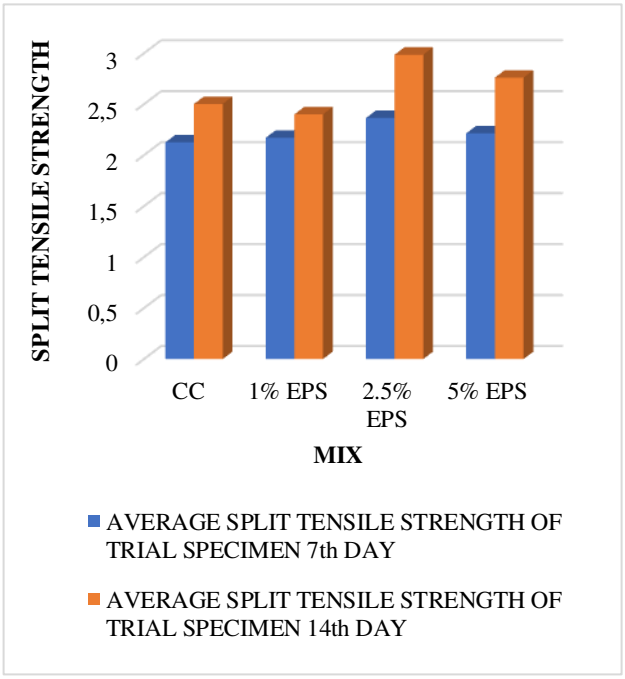
C. SPLIT TENSILE TEST

The split tensile test is carried out in order to determine tensile strength of concrete through cylinder which split through vertical diameter. This test is carried out in order to determine the tensile strength indirectly. In the split tensile test, the specimen is casted which is 300mm length and 150 mm diameter and cured for 7 days. Now the specimen is placed in longitudinal axis which is perpendicular to the load applied. In the split tensile test, the force is applied to the specimen with nominal rate between 1.2 N/M to 2.4 N/M. The specimen is gripped at both ends and now load is applied on the cylindrical specimen. The failure load is noted. The splitting tensile strength is calculated by dividing the twice the maximum load applied by the area of cylinder. Here, splitting tensile strength is closer to true tensile strength and it is greater than 5% to 12% OF Direct tensile strength.

TABLE 7 :SPLIT TENSILE

Mix Number	Average split tensile strength(7th day) (N/mm²)	Average split tensile strength(14th day) (N/mm²)
CC	2.126	2.503
1% EPS	2.171	2.401
2.5% EPS	2.365	2.986
5% EPS	2.214	2.761

CHART 3 : SPLIT TENSILE STRENGTH



D. DENSITY TEST

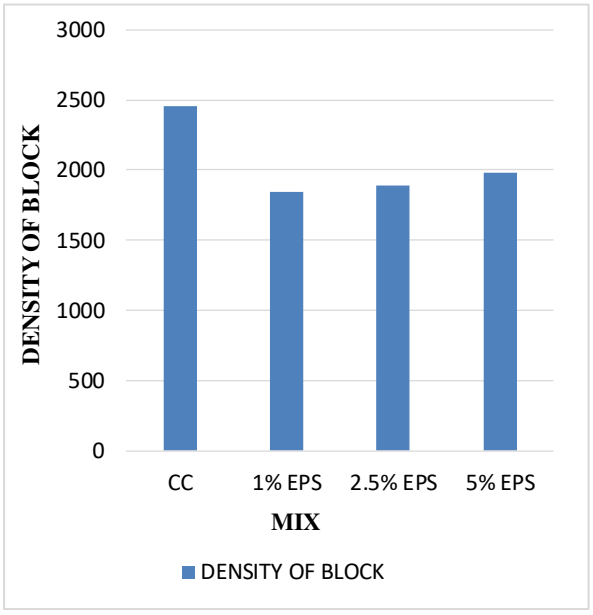
This is the one of the simple test that can be followed in the construction industry both by the skill and unskilled contractors to examine the concrete. Mechanical properties

of concrete are highly influenced by the density of the concrete. A denser concrete has higher strength and less amount of voids and porosity. Through density test, one can determine the concrete density. In the test, the concrete is filled in the container of known volume and is weighed. The volume of the concrete is already noted from the known value of the container and the weighed concrete is noted. From the noted data, the concrete density id obtained by dividing the weight of the concrete to the volume. Generally, the density of the concrete gives good idea to contractor about the strength, mechanical properties and air content in the concrete to the contractor.

TABLE 8 : DENSITY TEST

MIX NUMBER	DENSITY OF BLOCK (kg/m^3)
0%EPS	2459
1%EPS	1845
2.5%EPS	1890
5%EPS	1985

CHART 4 : DENSITY OF A BLOCK



E. WATER ABSORPTION TEST

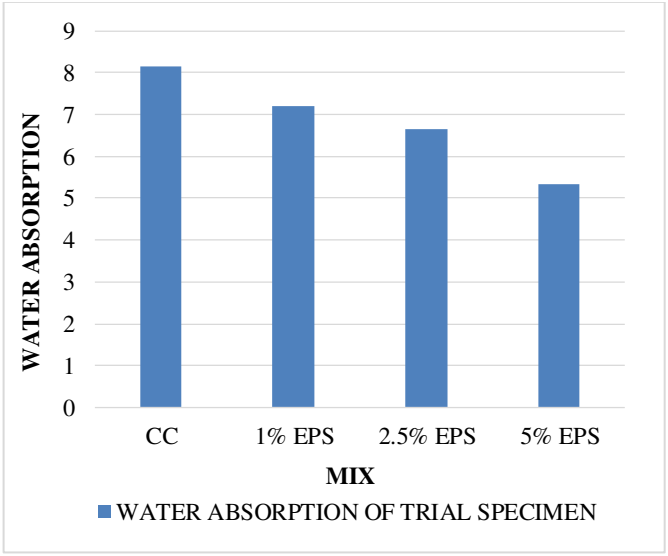
The water absorption test is followed to determine the water tightness or the water absorption capacity of the concrete. In this process of water absorption test, cube casted and then immersed in water for specific time, the specimen is dried for time and it is weighted again. The concrete cube of the 15cm * 15cm * 15cm is casted. After 24 hours from demolding the cube, it is immersed in water for a period of time. At the end of the 28th day the concrete is taken out and extra moisture on the surface of concrete is cleaned and weighed. Later the concrete is oven dried for 48 hours. Now the oven dried specimen is taken out, weighed and the results were noted. Water absorption is determined from the ratio of the difference of original weight to the oven dried concrete to the original weight of concrete.

TABLE 9 : WATER ABSORPTION

MIX NUMBER	WATER ABSORPTION (%)
0%EPS	8.15
1%EPS	7.2
2.5%EPS	6.65
5%EPS	5.35

- **As per IS 2185 Part 1: 2005, the water absorption shall not be more than10%.**

CHART 5 : WATER ABSORPTION



V. CONCLUSION

1) Developing of environmental friendly concrete blocks by using EPS beads ,Which is a effective way of EPS disposal.
2) Three mixes of concrete other than conventional concrete, of three different proportions of EPS beads of 1% ,2.5% and 5% respectively was casted and tested .
3) Compressive strength has reduced accordingly when EPS beads were added.
4) Increase in EPS percentage also resulted in slight decrease of tensile and flexural strength respectively.
5) EPS replaced concrete has shown good resistance to sulphate attack .
6) Water absorption of 2.5%EPS beads concrete was quite low comparatively to other mixes and conventional concrete.
7) EPS beads replaced concrete is seen as an good alternate material in making concrete and great way of EPS disposure.

VI. REFERENCE

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