International Research Journal of Engineering and Management Studies (IRJEMS)
Volume: 03 Issue: 05 | May -2019 ISSN: 2395-0126

SUSTAINABLE PROPERTIES OF STYROFOAM CONCRETE

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Abstract - *The primary objective of this project is to gain sufficient knowledge in waste recyclable polystrene materials in the field of construction. Expanded polystrene is a light weight material that has been used in engineering applications since at least the 1950s. It has good thermal insulation properties with stiffness and compression strength. In this project, partial amount of fine aggregate of concrete is replaced by Styrofoam. The main objective of this experiment is to study the properties, such as compressive strength and flexural strength of Styrofoam concrete blocks. We have tested these properties in cubes, beams and cylinders. All were tested at 7d, 14d and 28d of curing. The results obtained are compared with standard concrete sample.*

***Key Words*: Styrofoam, OPC 53, M-sand.**

1.INTRODUCTION

Styrofoam is expanded polystyrene (EPS) that consists of about 98 % air and 2 % polystyrene. Thanks to its extremely low density, it is primarily used for packaging food and fragile products as well as an insulating material. Although the constant increase in the price of crude oil has a direct impact on the price of EPS also, still the production continues to grow. According to statistics, on a volume basis, EPS forms nearly 7 % of solid waste in landfills in some countries.

Since it is a non-biodegradable material, EPS contributes significantly to the pollution of the environment, and in many European countries these products are being totally banned from landfills, with the originating manufacturer being responsible for their collection, recycling, or disposal. Expanded polystyrene aggregate concrete (EPSAC) or the so called "Styropor beton" was originally developed by BASF in West Germany during the 1950's, shortly after their invention of expanded polystyrene.

In 70's lightweight aggregate concretes (LWAC) with EPS beads began to be developed and applied throughout the world. Since EPS beads are very hydrophobic, ordinary and homogeneous mixing of such concrete was always difficult. The problem was usually solved by previous chemical treatment of beads to increase their stickiness to the cement paste (e.g. epoxy resins, polyvinyl proportionate solutions) or by increasing the cohesion in fresh concrete by adding silica fume or fibres. Expanded polystyrene aggregate concrete made with virgin EPS beads is not widely used. The trademarked term is used generically although it is a different material from the extruded polystyrene used for Styrofoam insulation. The Styrofoam brand polystyrene foam, which is used for craft applications, can be identified by its roughness and the "crunch" it makes when cut.

Due to the hydrophobic behaviour of virgin EPS beads and since they are few dozen times lighter than water, EPS concrete is prone to segregation during mixing and casting. Another reason for poor application is the high cost of virgin EPS beads, the semi-products for producing new packaging and insulating materials - in contrast to recycled EPS which is a cheap waste material.

Polystyrene is a strong plastic created from erethylene and benzine that can be injected, extruded or blow molded, making it a very useful and versatile manufacturing material. Most of us recognize styrofoam a form of foam polystyrene packaging. Polystyrene is also used as a building material, with electrical appliances (light switches and plates), and in other household items. Styrofoam can be used under roads and other structures to prevent soil disturbances due to freezing and thawing.

Styrofoam is composed of 98% air, making it lightweight and buoyant. Dow also produces Styrofoam as structural insulated panels for use by florists and in craft products. Dow insulation Styrofoam has a distinctive blue color.

1.1 OBJECTIVE

- To construct building with simple production methods.
- To promote low-valuable materials in the construction field.
- To provide high thermal and acoustical insulating properties.
- To increase the permeability of the cement paste between the voids.

1.2 SCOPE

- We are using waste recyclable Styrofoam materials in our project.
- Recycling this low-value material eliminates high cost factors in construction.
- Styrofoam concrete blocks will be suitable for both hot and cold climatic conditions.
- To increase the flexural strength of concrete blocks.

2. MATERIALS COLLECTION

2.1 Styrofoam

The general base material which has been used in our project is the styrofoam also known as light weight aggregate or (EXPANDED POLYSTYRENE). The styrofoam materials used in this project were locally available in the form of waste materials in streets, roads and other surrounding areas. We only replace a partial amount of the fine aggregates by styrofoam. Styrofoam can also be readily made available in the markets in the form of plastic cups, small bins and use and throw plates.

Fig -1: Styrofoam

3. RESULT AND DISCUSSION

3.1 FRESH CONCRETE TEST

3.1.1Slump test is used to determine the workability of fresh concrete. Slump test as per IS: 1199-1959 is followed. Slump test is a method used to determine the consistency of concrete. The consistency, or stiffness, indicates how much water has been used in the mix. The stiffness of the concrete mix should be matched to the requirements for the finished product quality.

- Slump is measurement of concrete's workability, or fluidity.
- It's an indirect measurement of concrete consistency or stiffness.

Workability of the concrete in slump cone test is 110mm.

3.2 HARDENED CONCRETE TESTING

3.2.1 Compressive strength test

The specimen is tested by compression test machine after 7 days, 14 days and 28 days curing. Load should be applied gradually at the rate of 140kg/cm² per minute till specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

3.2.2 Flexural test

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending.

3.2.3 Split tensile test

The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tensile due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may cracks.

3.3 FOR 28TH DAY (2%)

Dimensions of the specimen

= CUBE - 150 x 150 x 150mm
= PRISM - 500 x 100 x 100mm
= CYLINDER - 100mm(Dia) x 200mm

Technical Reference = IS516:1959 (Reaffirmed 2011)

Table 1 - For 28th day (2%)

S.no	MIX DETAILS	COMPRESSIVE STRENGTH (N/mm²)	FLEXURAL STRENGTH (N/mm²)	SPLIT TENSILE STRENGTH (N/mm²)
1.	Nominal mix	34.0	4.67	4.26
2.	2% styrofoam replacement	31.8	4.40	4.01

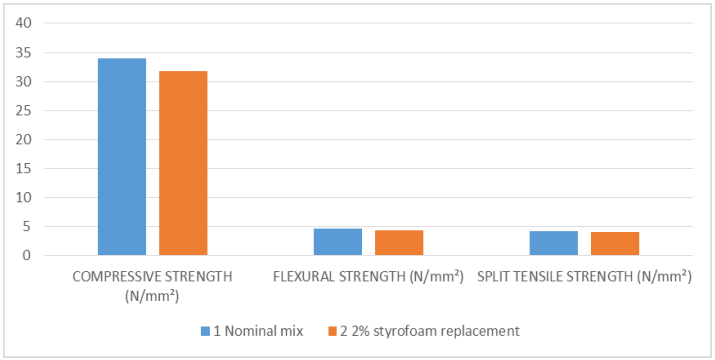

Fig.2- For 28th day (2%)

3.4 FOR 28TH DAY (4%)

Dimensions of the specimen

= CUBE - 150 x 150 x 150mm
= PRISM - 500 x 100 x 100mm
= CYLINDER - 100mm(Dia) x 200mm

Table 2 - For 28th day (4%)

S.no	MIX DETAILS	COMPRESSIVE STRENGTH (N/mm²)	FLEXURAL STRENGTH (N/mm²)	SPLIT TENSILE STRENGTH (N/mm²)
1.	Nominal mix	34.0	4.67	4.26
2.	4% Styrofoam replacement	29.2	4.04	3.88

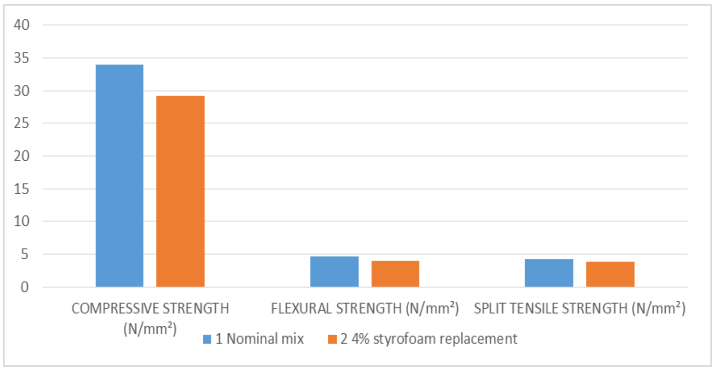

Fig.3- For 28th day (4%)

3.5 FOR 28TH DAY (6%)

Dimensions of the specimen

= CUBE - 150 x 150 x 150mm
= PRISM - 500 x 100 x 100mm
= CYLINDER - 100mm(Dia) x 200mm

Table 3 - For 28th day (6%)

S.no	MIX DETAILS	COMPRESSIVE STRENGTH (N/mm^2)	FLEXURAL STRENGTH (N/mm^2)	SPLIT TENSILE STRENGTH (N/mm^2)
1.	Nominal mix	34.0	4.67	4.26
2.	6% styrofoam replacement	25.6	3.60	3.08

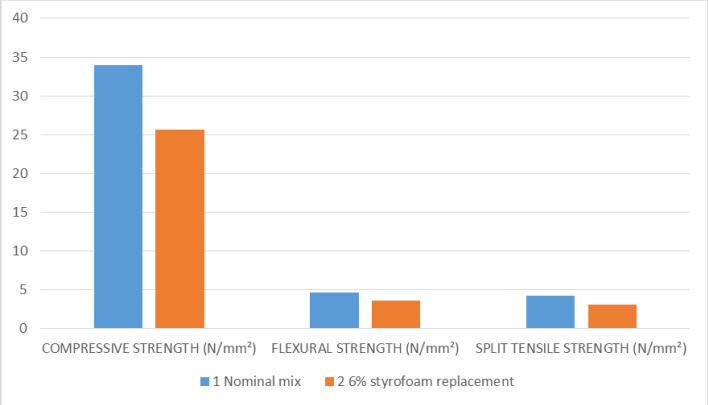

Fig.4- For 28th day (6%)

The results obtained in our project are properly tabulated and discussed. The readings for the replacement of styrofoam in 2%, 4%, 6% are tabulated, the results are quite different from each other. The mix proportions other than the nominal mix are noted down and their values are tabulated. Comparing the values of the mix proportions that we have mixed in our project is not the same for 2%, 4% and 6%.

The tests that we have done in the lab centres are compressive strength test, slump cone test, split tensile strength test and flexural strength test. The readings of the above mentioned test has already been framed in a tabular form.

The nominal mix proportion has good workability but, the replacement of styrofoam in the mix has better workability than the nominal design mix. The compressive strength of the nominal design mix is high when compared to the replacement of styrofoam in 2%, 4% and 6%.

4. CONCLUSION

The results we arrived in our project is different from that of nominal design mix. We can add styrofoam as a replacement for both fine aggregates and coarse aggregates. The experimental study on the sustainable properties of the concrete blocks, has better workability. It also has good compressive strength, split tensile strength and flexural strength.

So we finally conclude that, the usage or replacement of styrofoam in the concrete mix has partial merits. Further study on this project may bring advantages in the construction field.

The replacement of styrofoam in 2% or less than 2% will definitely have good compressive strength, split tensile strength and flexural strength. Moreover, styrofoam has many advantages in other fields rather than building construction. Futher study should be done on the characteristic features and sustainable properties of styrofoam to make its usage much more effective in building constructions.

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