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Flexural Behaviour of Reinforced Polystyrene Concrete Beams

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Abstract: As concrete is one of the most important building materials, it is commonly used in structural engineering. Owing to growing demand for traditional construction materials, there is a need to produce alternative building materials. In recent years waste management has been one of the important subjects, extensive research is being conducted to use the same in the building industry. Various operations to replace the Coarse aggregate were carried out. In this case extended beads of polystyrene were used to partly and fully replace Coarse aggregate. As lightweight concrete compressed polystyrene beads are helpful. It the the dead load, the self-weight and primarily improvises a structure's thermal insulating property. Biodegradable material compared to plastic, including polystyrene in building allows some waste disposal. Concrete is considered to be lightweight as it ranges from 160–1920 kg / m3 in mass. Polystyrene concrete has a greater effect on the environment of building, with decreased concrete density and limited necessary weight. The average volume of coarse aggregate is offset by the polystyrene beads in this factory. Fresh concrete properties were tabulated, with and without the inclusion of polystyrene beads. Measurement of workability, mass, compressive force, crack tensile strength for the cubes and cylinders with and without cement coating. For conventional beams and polystyrene beams flexural strength is calculated.

Keywords: OPC 53 Grade Cement, Conventional Beam, Polystyrene Beam, Flexural Strength Test.

I. INTRODUCTION

Concrete refers to a significant portion of buildings of reinforced concrete (RC). It causes significant dead load on the system. Studies have shown that RC members can be formed with voids, without reducing their power. So voided concrete members may be seen as an enhanced component of the RC. The action of voided members, however, is still unclear, particularly in voided members of the beam which brings with it the need for further studies. Reinforced cement concrete is one of the main elements of the building market. Just a few days, the use of concrete has significantly improved. In this analysis, an effort is made to minimise concrete and the beam 's self-weight by replacing the concrete under the neutral axis. Therefore, concrete has low tensile strength and when a concrete part is exposed to flexure the region under the cross-sectional neutral axis is considered inefficient when it is at the absolute maximum stage of pressure. Lightweight concrete is distinguished by its low density and poor thermal conductivity. The lighter the weight will reduce the total building expense. To substitute coarse aggregate with extended polystyrene beads, the dead load on the structure is also minimised. In this report, an attempt is being made to address the danger of using Extended Polystyrene (EPS), a concrete bead-shaped packaging medium, which otherwise presents a threat to both waste disposal and waste management. The material gives cause for concern to the environmentalists. In this study EPS beads aim to partly absorb coarse aggregates.

GENERAL PROPERTIES OF POLYSTYRENE

Table 1 Properties of Polystyrene

PROPERTIES	STANDARDS
Density of Polystyrene	960 – 1050 kg/cm^3
Melting Point of Polystyrene	100^0 C – 240^0 C
Diameter of expanded Polystyrene	6 - 10 mm
Specific gravity of Polystyrene	0.015

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Fig 1 Polystyrene Beads

II. RESEARCH METHODOLOGY

Literature survey was one of the most prominent work carried out on various topics such as Lightweight concrete, polystyrene concrete, chemical admixtures, mix design, testing methods etc. Mix design for M25 grade concrete was carried out. Complete replacement of Expanded polystyrene with coarse aggregate was done by measuring the volume of CA. Casting and curing of cubes, cylinders and polystyrene beams was done. Mechanical strength property tests are carried out for 7, 14 and 28 days respectively for cubes and 28 days for cylinders and polystyrene beams. Nine cubes were cast out of which three were coated with cement and three were non coated with cement. Six cylinders were cast out of which three were coated with cement and three were non-coated with cement. Six beams with steel reinforcement were cast out of which three are conventional and three are polystyrene. Design of Steel Reinforcement for standard beam size 150×150×500 mm was done and carried out. De-molding and curing of the specimens were done for 7, 14 and 28 days. After curing the cubes and cylinders were tested for its Hardened Concrete Properties. Beams were tested for Flexural Strength after 28 days of curing under Two-Point Loading. Results are tabulated and conclusions are drawn.
The procedure is as shown in the chart below:

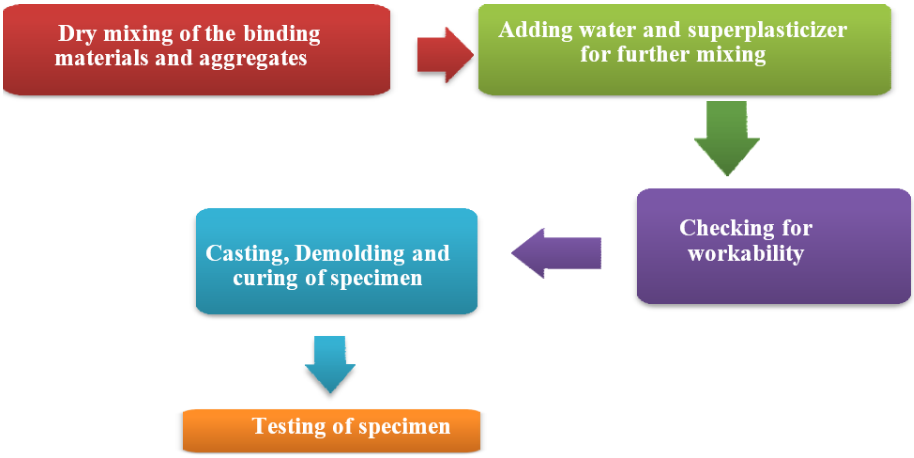

Figure 2 Experimental Procedure Chart

III. EXPERIMENTAL DETAILS

3.1 STAGE 1
CONCRETE MIX DESIGN

Basic products such as cement, coarse aggregates and fine aggregates are made available from the nearest supplier, enlarged polystyrene beads have been gathered, checked and then used as a supplement for cement and aggregates. Mix design for grade M25 is done according to the specifications i.e., in this article. IS 10262: IS 456:2000.

3.2 STAGE 2
MIX PROCEDURE, CASTING AND CURING OF SPECIMENS

Test mixtures were obtained by mixing coarse aggregates with expanded polystyrene beads (non-coated and pre-coated). Cubes were casted and checked on days 7th, 14th and 28th. Cylinders and beams made of polystyrene were casted and checked for 28 days.
Dimension of cube = 150mm×150mm×150mm.

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Dimension of beam = 100mm ×100mm×500mm.
Dimension of cylinder (Diameter=150mm, Height=300mm).

3.3 STAGE 3
TESTS CONDUCTED

1) Compressive strength test of cubes for 28 days.
2) Split tensile test of cylinders for 28 days.
3) Flexural strength test of conventional and polystyrene beams for 28 days.

IV. RESULTS AND DISCUSSIONS

4.1 COMPRESSIVE STRENGTH TEST OF CUBES

Using Compressive Testing Machine (CTM), as indicated by IS 516:1959, compressive quality testing is guided. The compressive test is conducted for 7, 14 and 28 days on 30 cubes, respectively. The results of compressive consistency measures are as follows.

Table 2 Comparison of Compressive strength of cubes

TYPE OF CUBE	COMPRESSIVE STRENGTH OF CUBES IN MPa					
	7th day	Avg	14th day	Avg	28th day	Avg
CONVENTIONAL	19.13	19.40	25.16	24.83		29.84
	19.15		24.22		29.84	
	19.92		25.11			
NON-COATED	5.03	5.03	6.83	6.42		7.738
	4.88		6.18		7.738	
	5.18		6.45			
PRE-COATED	5.28	5.67	7.23	7.12		8.72
	5.95		7.07		8.72	
	5.78		7.06			

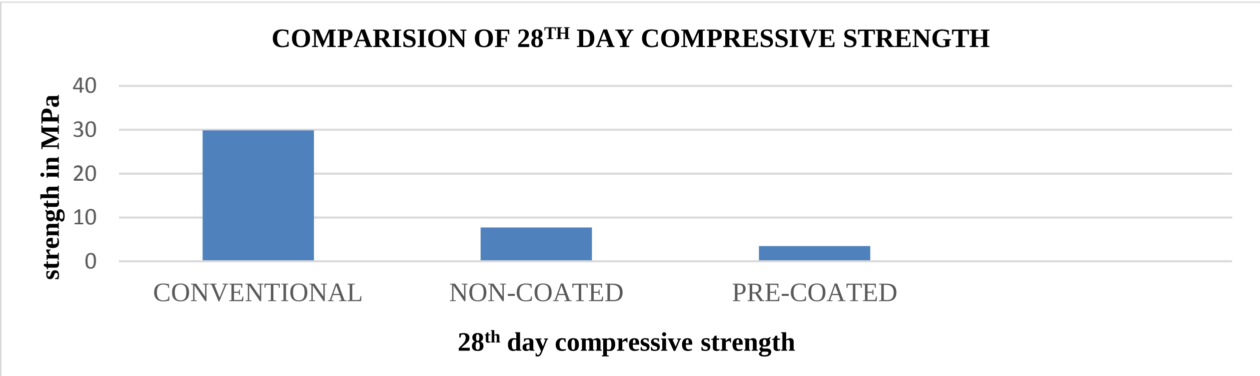

Table 3 Comparison of 28th day compressive strength of cubes

4.2 SPLIT TENSILE TEST OF CYLINDERS

The sample was inserted into the measuring system for compression and the load applied to the specimen 's longitudinal side. After 28 days break tensile is performed at various speeds.

Table 4 Split Tensile Strength of Cylinders

SPLIT TENSILE STRENGTH RESULTS	
TYPE OF CYLINDER	28th DAY STRENGTH IN MPa
CONVENTIONAL	3.1
NON – COATED	1.653
PRE – COATED	2.676

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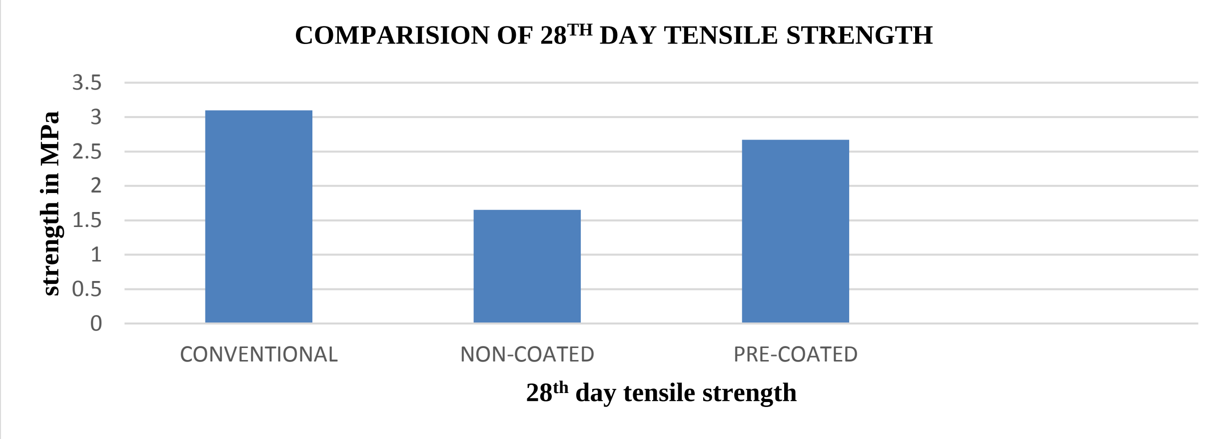

Table 5 Comparison of 28th day Tensile strength of cylinders

4.3 FLEXURAL STRENGTH TEST OF CONVENTIONAL AND POLYSTYRENE BEAMS

The beam was mounted on the universal measuring unit, and up to failure one-point loading was applied. After 28 days of curing, the flexural consistency test is performed on six beams. Flexural efficiency figures are as beneath.

Table 6 Comparison of Flexural strength of beams

SL.NO	BEAM TYPE	FLEXURAL STRENGTH IN MPa	AVG VALUE OF FLEXURAL STRENGTH IN MPa
1	Conventional	13.51	
2	Conventional	16.21	14.63
3	Conventional	12.91	
4	Polystyrene	15.2	
5	Polystyrene	11.2	12.7
6	Polystyrene	11.85	

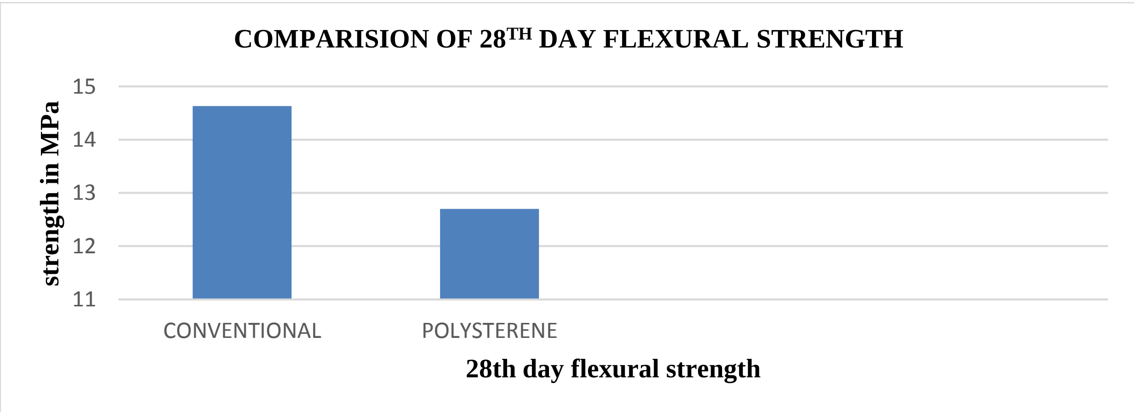

Table 7 Comparison of 28th day Flexural Strength of Beams

Table 8 Average Comparison between Conventional and Polystyrene Beams

SL NO	Beam Type	Avg of First Crack Load (KN)	Avg of First Crack Deflection (mm)	Avg in Yield Load (KN)	Avg in Yield Load Deflection (mm)	Avg of Ultimate Load (KN)	Avg of Ultimate Load Deflection (mm)
1	Conventional	18.8	3.8	19.6	5.9	20.2	8.2
2	Polystyrene	16.8	5.7	18.2	7.5	18.9	8.3

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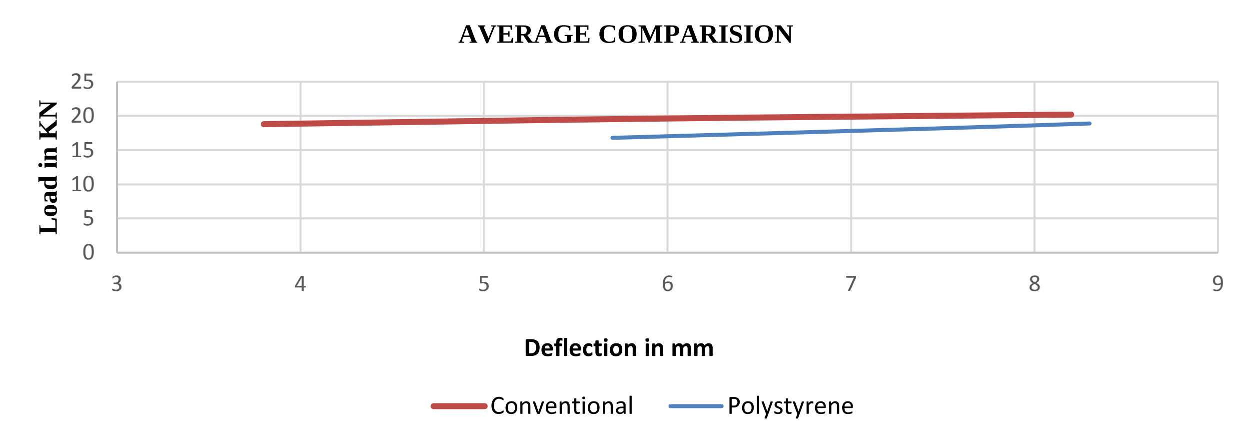

Table 9 Average graph Comparison between the beams

V. CONCLUSION

Full substitution of coarse aggregate totals with expanded supplements of polystyrene renders the concrete thicker than ordinary concrete. Although the strength of non-coated polystyrene concrete is fulfilled as being a lightweight concrete, the effects of pre-coating to polystyrene beads offered greater strength. Compressive strength of pre-coated polystyrene concrete relative to non-coated polystyrene concrete is marginally stronger. It indicated a decrease in volume due to the compressibility aspect of extended polystyrene beads as the samples were taken with respect to 1 m3 of standard concrete. Density reached by stretched polystyrene concrete as lightweight concrete is well beyond the range to satisfy. Since polystyrene is repellent to water it shows weak mortar or concrete bonding. Beams made of steel-reinforced polystyrene have less ductility than conventional concrete beams. Conventional steel-reinforced concrete beams' flexural capability requires more ultimate load compared to polystyrene support.

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