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Experimental Study on Light Weight Concrete Using Polystyrene

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ABSTRACT: Expanded polystyrene waste in a granular form is used as lightweight aggregate to produce lightweight structural concrete. The polystyrene aggregate concrete was produced by partially replacing coarse aggregate in the reference (normal weight) concrete mixtures with equal volume of the crushed polystyrene granules. The coarse aggregate replacement level used was 40%. Basically, polystyrene is disposal material from packaging industry. However, after being processed in a special manner, polystyrene can be expanded and used as lightweight concrete making material. Therefore, the use of expanded polystyrene beads in concrete is not only beneficial for engineering studies but also provide solution for the environmental problem. Experimental results indicate that the polystyrene aggregates can be successfully used to produce a lightweight material. The results also indicate that the workability of polystyrene waste aggregates concrete is good, and the strength characteristics are comparable to those of the conventional concrete.

I. INTRODUCTION

Concrete is an essential material used in construction, in which 65% of its volume is occupied by coarse aggregates. Hence coarse aggregate plays a vital role in concrete. Yearly tones of huge rocks are blasted to get coarse aggregate, which we commonly use in concrete. Since coarse aggregate is responsible for overall strength of concrete, the demand for the same will be large in India in the upcoming years. Depletion of good quality rocks, their accessibility and legal clearance make difficult to get them in abundance in near future.

The three key ingredients for concrete are cement, water and aggregates. Commonly used aggregates are river sand as fine aggregate and natural gravel as Coarse aggregate.

OBJECTIVE OF THE STUDY:

The aim of the present investigation is:

- To replace coarse aggregate with thermocol in concrete manufacturing
- Find out a suitable proportion of thermocol with coarse aggregate to obtain light weight concrete as well as attain maximum compressive strength.

II. METHODOLOGY

Selection of materials, Testing properties, Mix design (IS 10262-1982), Casting specimens, Testing of specimens, Observing and analysing results, Comparison of results, Summary and Conclusion

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III. LITERATURE REVIEW

Properties of Concretes Produced With Waste Thermocol as Fine Aggregate, Asian journal of civil engineering (bhrc) vol. 14, no. 3 (2013) - D. Tavakolia et al...used thermocol wastage in concrete leads to removal of those materials from environment. Besides, decreasing the use of raw materials, using the wastage is considered positive economically. Using thermocol wastage in concrete, with regard to reducing the costs and keeping the environment clean along with wastage management, and ameliorating the strength of structures, is an effective measure in sustainable development.

Engineering Properties of Lightweight Concrete Containing Crushed Expanded Polystyrene Waste by Ben Sabaa and Rasiah Sri Ravindrarajah, in Materials Research Society, December 1-3, 1997, Boston, USA: In this project he suggests the compressive strength was found to be more sensitive to the density than the modulus of elasticity. Drying shrinkage and creep are significantly increased if the polystyrene aggregate content is significant. Partial replacement of normal weight coarse aggregate with polystyrene aggregate changed the concrete properties in the following ways: unit weight, compressive strength and modulus of elasticity were reduced depending on the level of replacement.

Preliminary Study On Concrete With Polystyrene Coarse Aggregate By Mustafa Al Bakri and G. Che Mohd Ruzaidi, School Of Environmental Engineering, Universiti Malaysia Perlis, P.O Box 77, d/a Pejabat Pos Besar, 01007 Kangar, Perlis. The properties of the aggregates were also compared. Experimental results indicate that the polystyrene aggregates can be successfully used to produce a lightweight material. The results also indicate that the workability of polystyrene waste aggregates concrete is good and the strength characteristics are comparable to those of the conventional concrete. From the result he conclude Polystyrene waste can be transformed into useful coarse aggregate and the properties of polystyrene waste coarse aggregate are within the range values for concrete-making aggregates.

IV. MATERIALS FOR CONCRETE

Concrete is a composite material consisting of binder, which is typically cement, coarse and fine aggregates, which are usually stone, sand, water and **polystyrene**. These comprise the constituent materials of concrete. More concrete consumption leads to lack of concrete ingredients.

POLYSTYRENE

Expanded polystyrene waste from the packaging industry, in crushed and graded form, can be used as aggregate in concrete mixtures. Depending upon the amount of expanded polystyrene (density of about 60 kg/m³) aggregate used, lightweight concrete with a wide range of densities from 1000 to 2000 kg/m³ can be obtained for structural and non-structural applications.

PROPERTIES OF POLYSTYRENE

Formula :	(C ₈ H ₈) _n
Density :	1.05g/cm ³
Melting point:	240°C
Radiation resistance:	good
Water absorption over 24 hours:	<0.4

ADVANTAGES OF POLYSTYRENE

Increasing compressive and flexural strength. Reduced permeability. It can be cast into molds with fine detail. It can be transparent. Can also be coloured. Very economical. Can be aerated (with CO₂) to make excellent insulator. Can be foamed between card to make lightweight rigid panels. In its various forms it is usually easy to work. It is versatile - uses range from cutlery to explosives. Can be recycled - thermoplastic so can be remoulded indefinitely. It is very lightweight so we can easily carry and install anywhere. It is moisture resistant.

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MATERIAL PROPERTIES

Specific Gravity Test for Cement

Specific gravity of cement = 3.15

Specific Gravity Test for Aggregates

Determination of specific gravity of fine aggregate

Specific gravity of sand = 2.4

Determination of specific gravity of coarse aggregate

Specific gravity of Coarse aggregate = 2.72

Table:1 MIX PROPORTION

WATER	CEMENT	FINE AGGREGATE	COARSE AGGREGATE
191.61	383 kg	546 kg	1187 kg
0.49	1	1.49	3.42

EXPERIMENTAL PROCEDURE TEST ON FRESH CONCRETE

Table:2 Slump cone test

Description	Slump value (mm)
Normal concrete	147
Thermocoal 40%	134

Table:3 Flow Table Test

Description	Flow value (mm)
Normal concrete	68
Thermocoal 40%	51

TEST FOR HARDENED CONCRETE

Compressive Strength

Normal Conventional Concrete:

Table:4 Compressive Strength for cube at 3 days of curing

S.no	Load (kN)	Size of cube	Compressive Strength(N/mm ²)	Average Compressive Strength(N/mm ²)
1.	320	0.15 x 0.15 x 0.15	14.22	15.00
2.	350	0.15 x 0.15 x 0.15	15.55	
3.	320	0.15 x 0.15 x 0.15	14.22	

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Table:5 Compressive Strength for cube at 7 days of curing

S.no	Load (kN)	Size of cube	Compressive Strength(N/mm ²)	Average Compressive Strength(N/mm ²)
1.	480	0.15 x 0.15 x 0.15	21.33	20.88
2.	460	0.15 x 0.15 x 0.15	20.44	
3.	470	0.15 x 0.15 x 0.15	20.88	

Table:6 Compressive Strength for cube at 28 days of curing

S.no	Load (kN)	Size of cube	Compressive Strength(N/mm ²)	Average Compressive Strength(N/mm ²)
1.	950	0.15 x 0.15 x 0.15	42.22	36.29
2.	700	0.15 x 0.15 x 0.15	31.11	
3.	800	0.15 x 0.15 x 0.15	35.55	

Table:7 Compressive Strength for cylinder at 3 days of curing

S.no	Load (kN)	Size of cylinder	Compressive Strength(N/mm ²)	Average Compressive Strength(N/mm ²)
1.	170	0.15 x 0.3	1.2	1.27
2.	190	0.15 x 0.3	1.34	
3.	180	0.15 x 0.3	1.27	

Table:8 Compressive Strength for cylinder at 7 days of curing

S.no	Load (kN)	Size of cylinder	Compressive Strength(N/mm ²)	Average Compressive Strength(N/mm ²)
1.	350	0.15 x 0.3	2.47	2.53
2.	355	0.15 x 0.3	2.51	
3.	370	0.15 x 0.3	2.61	

Table:9 Compressive Strength for cylinder at 28 days of curing

S.no	Load (kN)	Size of cylinder	Compressive Strength(N/mm ²)	Average Compressive Strength(N/mm ²)
1.	450	0.15 x 0.3	3.18	3.24
2.	460	0.15 x 0.3	3.25	
3.	470	0.15 x 0.3	3.3	

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PARTIALLY REPLACEMENT OF COARSE AGGREGATE BY POLYSTYRENE:

Table:10 Compressive Strength for cube at 3 days of curing

S.no	Load (kN)	Size of cube	Compressive Strength(N/mm ²)	Average Compressive Strength(N/mm ²)
1.	80	0.15 x 0.15 x 0.15	3.55	3.77
2.	85	0.15 x 0.15 x 0.15	3.77	
3.	90	0.15 x 0.15 x 0.15	4.00	

Table:11 Compressive Strength for cube at 7 days of curing

S.no	Load (kN)	Size of cube	Compressive Strength(N/mm ²)	Average Compressive Strength(N/mm ²)
1.	150	0.15 x 0.15 x 0.15	6.67	7.03
2.	160	0.15 x 0.15 x 0.15	7.11	
3.	165	0.15 x 0.15 x 0.15	7.33	

Table:12 Compressive Strength for cube at 28 days of curing

S.no	Load (kN)	Size of cube	Compressive Strength(N/mm ²)	Average Compressive Strength(N/mm ²)
1.	500	0.15 x 0.15 x 0.15	22.22	22.96
2.	520	0.15 x 0.15 x 0.15	23.11	
3.	530	0.15 x 0.15 x 0.15	23.55	

Table:13 Compressive Strength for cylinder at 3 days of curing

S.no	Load (kN)	Size of cylinder	Compressive Strength(N/mm ²)	Average Compressive Strength(N/mm ²)
1.	70	0.15 x 0.3	0.49	0.59
2.	90	0.15 x 0.3	0.63	
3.	95	0.15 x 0.3	0.67	

Table:14 Compressive Strength for cylinder at 7 days of curing

S.no	Load (kN)	Size of cylinder	Compressive Strength(N/mm ²)	Average Compressive Strength(N/mm ²)
1.	140	0.15 x 0.3	0.99	0.98
2.	145	0.15 x 0.3	1.02	
3.	135	0.15 x 0.3	0.95	

Table:15 Compressive Strength for cylinder at 28 days of curing

S.no	Load (kN)	Size of cylinder	Compressive Strength(N/mm ²)	Average Compressive Strength(N/mm ²)
1.	200	0.15 x 0.3	1.41	1.42
2.	205	0.15 x 0.3	1.45	
3.	200	0.15 x 0.3	1.41	

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COMPARISON

Comparison of Normal Concrete And Polystyrene Added Concrete

Table:16 - For Cube:

S.NO	WEIGHT OF NORMAL CONCRETE (kg)	WEIGHT OF POLYSTYRENE MIXED CONCRETE (kg)
1	8.6	6.3
2	8.7	5.8
3	8.5	5.9

Table:17 - For Cylinder:

S.NO	WEIGHT OF NORMAL CONCRETE(kg)	WEIGHT OF POLYSTYRENE MIXED CONCRETE(kg)
1	13.2	10.5
2	13.0	10.4
3	13.2	10.5

Comparison chart of Normal conventional Concrete with Polystyrene added concrete for 3, 7 and 28 days:

Fig:1 - For Cube:

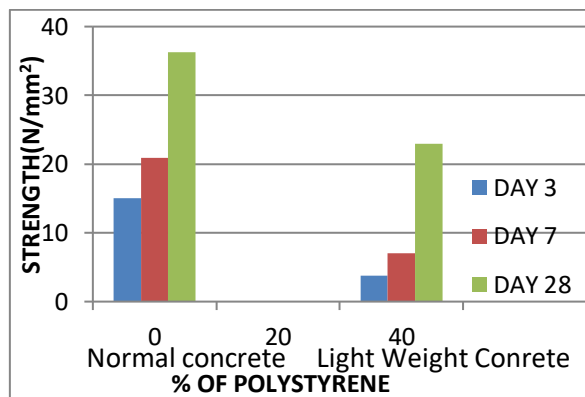


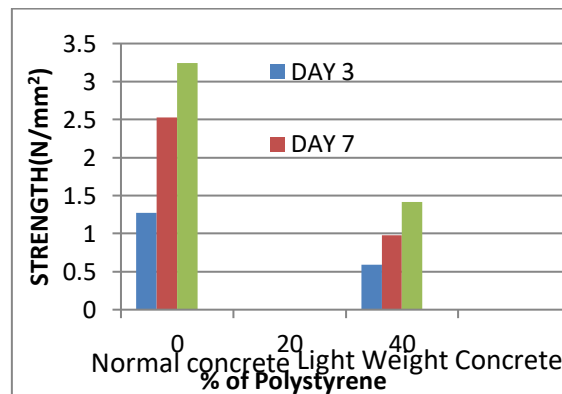
Fig:2 - For Cylinder:

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V. CONCLUSION

In the present Investigation, concrete with 40 percentage replacement of polystyrene was prepared. The grade of concrete prepared for the experimental study was M₂₀. The fresh and hardened properties of concrete were studied. The results show that the strength of light weight concrete is less comparable with normal conventional concrete but the weight of the concrete is less. This shows that the light weight concrete can be used for the partition wall and also for the compound walls.

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