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A STUDY OF COMPRESSIVE STRENGTH OF CONCRETE BY PARTIAL REPLACEMENT OF COARSE AGGREGATE WITH EXPANDED POLYSTYRENE BEADS IN CONCRETE

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Abstract - *The major goal of this work is to examine the characteristics of concrete incorporating Expanded Polystyrene (EPS) beads, including compressive and tensile strengths. Its characteristics are contrasted with those of regular concrete, which is concrete without EPS beads. As a partial replacement for coarse aggregates, EPS beads are employed. The findings indicated that the qualities of hardened concrete are affected by the number of polystyrene beads added to the concrete. When compared to concrete, it was discovered that the compressive strengths of 0.1%, 0.2%, 0.3%, 0.4%, and 0.5 % EPS integrated concrete were 94%, 82%, 75%, 62%, and 52%, respectively. It can't absorb water because it has a closed-cell structure. It is impact resistant and exhibits high sound and thermal insulation properties. Foams made of polystyrene cannot decompose naturally.*

Expandable polystyrene beads are a good example. Aggregates, both coarse and fine

1. INTRODUCTION

A lightweight cellular plastic substance called expanded polystyrene (EPS) is madeup of tiny, spherical particles that are roughly 98% air and 2% polystyrene. For building construction, concrete offers the greatest degree of flexibility. For fundamental structural applications, the Structure self-weight is crucial because it reveals the majority of the load specifics. Lightweight concrete with dependable acceptable compressive strength can be created by partially or entirely replacing thecoarse portion of low-weight aggregate with regular particles. This article makes an effort to address the potential for using Expanded Polystyrene (EPS), a packing substance that is used as beads in concrete and poses a risk to waste management and disposal otherwise. Environmentalists are worried about this substance. In this study, EPS beads are used to replace some of the coarse aggregates. Environmental issues are explored along with a general review ofEPS, its production, and its use. To understand how the polystyrene aggregate behaves, strength metrics are compared to those of traditional concrete. This efforttries to substitute some of the coarse aggregates with expanded polystyrene beads at the rates of .01%, 0.2%, 0.3%, 0.4%, and 0.5%.

2. Literature Review:

Experimental Study on Properties of Concrete by Using Expanded Polystyrene Beads (EPS) as a Partial Replacement of Coarse Aggregate *Prabhunath B. Kulkarni, Prof.G.N.Shet (2022*). It is noted that the workability of EPS BEADS increases with an increase in the proportion of trash. According to the results of the current investigation, concreteretains its strength up to 5% of replacementand starts to deteriorate at 15%. It is feasible to employ leftover EPS beads in concrete to increase its flexural and compressive strengths. As performance indicators for concrete workability and strength in this experimental study, expanded polystyrene beads (EPS Beads) are used in place ofsome coarse aggregate, sand, cement, coarse aggregate, and water.

Expanded polystyrene beads in structural grade concrete with various aggregate particle sizes made of normal weight Elsevier Bogdan Rosca, Vladimir Corobceanu (2020). According to this study, the 7 to 28 days compressive strength ratio varies within the same margins for each examined percentage of replacing normal-weight aggregate with EPS beads for all considered water-to-cement ratios and particle distributions of normal-weightaggregate. Given that the water-to-cement ratios employed in this study are moderate to low-moderate, it is still conceivable to achieve better concrete strengths with lowerratios. Because it has some beneficial qualities, such as low density, low thermal transmission coefficient, insignificant absorption capacity, etc., expanded polystyrene (EPS) material with broad application.

Expanded Polystyrene is Added to Lightweight Concrete to Adjust Proportions (EPS) S. Aishwarya and. M.Gunavel (2020) This study found that whereas compressive strength generally rises with age during curing, densities and strength decreases as EPS beads grow in size. When EPS beads are replaced, the content falls and the split tensile strength declines. Expanded Polystyrene Beads are added at 10%, 20%, and 30% in the currentwork. Their flexural, split tensile, and compressive strengths are investigated. According to the findings, a maximum of 10% of theexpanded polystyrenebeadscanbe replaced by the volume of fine aggregate. It can be utilized for structures made of ordinary concrete, though M25 concrete is preferable. The EPS and M sand's fineness helps to better cement and aggregate bonding, which results in high-quality concrete.

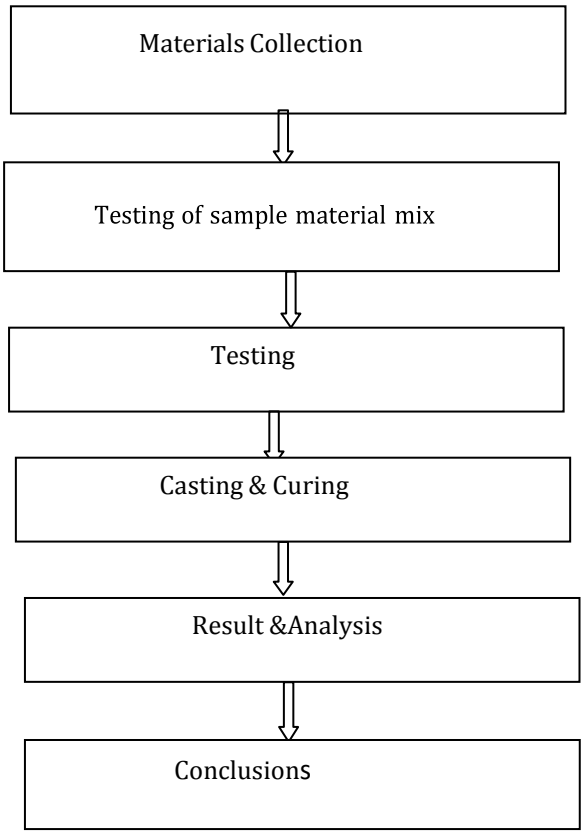
Effect of Expanded Polystyrene (EPS) on Strength Parameters of Concrete as a Partial Replacement of Coarse Aggregates Hitesh Patidar, Mayur Singi, Abhijeet Bhawsar (2019) In this essay, it is claimed that as modern construction techniques advance, so does the daily demand for building supplies. This study contrasts traditional concrete blocks with concrete that has coarse aggregate partiallyreplaced with polystyrene beads. The compressive strength, split tensile strength, and flexural strength for M30 and M40 when coarse aggregate is replaced by 5%, 10%, 15%, 20%, 25%, and 30%. Low water/cement ratios result in very high workability of the mixture. Concrete'scompressive strength is decreased as the amount of EPS beads in the mix isincreased.

3. Scope And Objectives :

1. To assess the workability of concrete containing and excluding EPS in various ratios at various grades.

2. To compare the compressive strength ofconcrete that contains and does not contain EPS in various ratios at various grades.To compare concrete with and without EPS invarious ratios and grades in order toestablish the Split Tensile Strength.

4. Methodology :



Flow chart

Materials and methods:

4.1 Cement: Ordinary Portland Cement (OPC) of grade 43 was employed, and bothits composition and physical characteristics complied with Indian Standard Organization requirements. The mix design of M-25 grade is prepared using regular Portland cement. The cement used was brand-new and lump-free. Using IS 456:2007 As a guide, the water-to-cement ratio for this mix design is 0.42.

4.1.1 Physical properties of Cement:

Table No:- 1

S.NO.	Characterstics	Test Result	Standard Result (As Per Is Code)
1	Consistency	29%	30%
2	Initial setting time	90 min	Not less than 30min
3	final SettingTime	310 min	Not more than 600 min
4	Specific Gravity	3.12	3.15
5	Fineness Modulus	7%	Not more than 10%
6	Compressive Strength	44 N/mm2	Not less than 43 N/mm2

4.2 Sand: Sand is a naturally occurring coarse material made up of rock and mineral particles that have been carefully separated. Its size distinguishes it as being finer than gravel and coarser than silt. In terms of the particle size employed by geologists, sand may also be assigned to a textural class of soil or soil type, i.e., a soilthat contains more than 85% of sand-sized particles (by mass); sand particles range in diameter from 0.0625 mm to 2 mm.

4.3 Aggregate: The primary component of concrete is aggregate. They give the concrete body, lessen shrinkage, and boost the economy. Sand, gravel, crushed stone, slag, recycled concrete, and geosynthetic aggregates are just a few of the coarse particle materials known as "construction aggregate," or simply "Aggregate," that is utilized in construction.

4.4 Water: Cleanliness and the absence ofharmful levels of oils, acids, alkalis, salts, sugar, and organic components are required for the water used for mixing and curing. For mixing concrete, potable water is typically considered sufficient. It isforbidden to mix and cure using seawater. The pH value must be at least 6.

4.5 Expanded Polystyrene Beads: EPS, or expanded polystyrene, is a type of plastic material that contains 98 per cent air and 2 per cent polystyrene. They are made up of tiny, round particles and are light in weight.It is incapable of absorbing water like a closed-cell structure. Inconel has good impact resistance, temperature resistance, and acoustic resistance properties. EPS is a biodegradable substance. The waste products left behind from the packing industry. That causes a transfer problem. Concrete made with pulverized polystyrene is a successful waste transfer method.

4.6 Properties of Expanded polystyrene beads:

Table No:- 2

S.NO	Property	Average value
1	Density	13 kg/m3
2	Compressive strength	0.09 MPa
3	Flexural strength Compressive strength	0.21 MPa
4	Water absorption	4%by volume
5	Specific gravity	0.0182
6	Thermal conductivity	Low
7	Bulk density	18kg/m 3
8	Particle shape	Rounded
9	Appearance	White

The casting of Specimen: Cubes 150mm x150mm x 150mm test specimens will be produced using common moulds. Thespecimens are prepared for casting. Thesamples are remoulded and cured in a watertank for 7 to 28 days after casting for 24 hours. In order to test properties like compressiveandflexural strength, atotal of48 specimenswere cast. 24 cube samples of 150 mm x 150 mm x 150mm dimension will be cast for varied percentages of partial replacement of expanded polystyrene beads with coarse aggregate. The concrete mixes are 0.1%, 0.2%, 0.3%, 0.4%, and 0.5%

when expanded polystyrene beads arepartially substituted for coarse aggregate. With the aid of a machine vibrator, all cubeswill be cast in one lift and consolidated. After the cubes have reached their final set, thecubemouldsareremoved, and

the cubes are kept in the water tank for 7 to 28 days of curing.

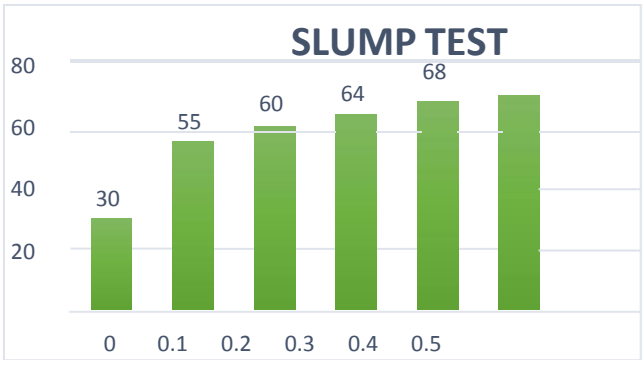
Fig -1 Mixing of EPS BEADS in concrete

5. Testing of specimen: The specimens were taken out of the mould after 24 hours and water-cured for 7 and 28 days, respectively. According to Indian standard specification IS: 516-1959, the specimens were tested for compressive and flexural strength after curing using a compressive testing apparatus with a capacity of 200 KN.The strength of the cube was assessedafter 7 and 28 days. After 28 days, the beamstrength was assessed.

5.1 Slump Test: The percentage of coarse aggregate replaced by polystyrene (as a partial replacement of aggregate) was shown to affect the workability of the mixes, so the higher the replacement ofpolystyrene, the higher the workability. This test was performed to see whether thefreshly laid concrete was workable.According to IS 456:2000, the aggregate size used in testing should not be greater than 20mm.

Table No :-3

S.No	Concrete Mix	Slump Value (mm)
1	Concrete mix M20 grade	30
2	0.1%replacement	55
3	0.2%replacement	60
4	0.3%replacement	64
5 Om	0.4%replacement	68
6	0.5%replacement	70



Graph 1

5.2 Compressive Strength Test: A test is administered in accordance with IS:516- 1959. Concrete and mortar cubes of 150 mm x 150 mm x 150 mm were used for the test, and specimens were removed from thecuring tank after 7, 14, and 28 days ofcuring. Then, surface water was permitted to fall. Afterwards, samples were examinedon a Compression Testing Machine with a 200-ton capacity (CTM). By dividing the highest compressive force by the cross-sectional area, the compressive strength was computed. Compressive strength is assessed after 7 and 28 days. The findings demonstrate that the compressive strength increases as the amount of expandedpolystyrene beads increases from 0% to 5%, but declines as the number of EPSbeadsincreases.We areable tosubstitute up to 5% of the time as a result.

5.3 Split Cylinder Test: The cylindrical specimen has dimensions of 150 mm indiameter and 300 mm in height. Concrete splitting tensile strength is 2P/3.14 DL N/mm2. where p=maximum load applied (KN). diameter (mm) and length (L) (m).

6. Results And Discussion:

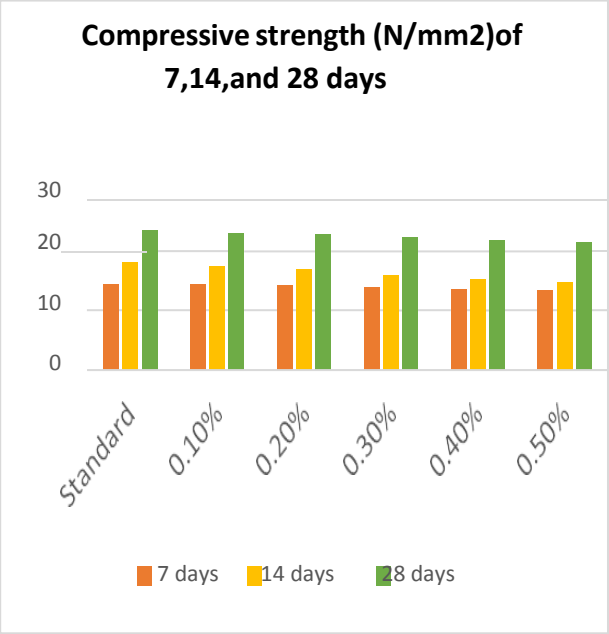
6.1Compressive strength test result:

Compressive strength (N/mm2) of 7,14, and 28 day

Table NO 4

S. No	Con Crete Cube Of Epbs	Comp. Strength (N/mm2) 7 Days	Comp. Strength (N/mm2) 14 Days	Comp. Strength (N/mm2) 28 Days
1	0%	14.40	17.95	23.40
2	0.1%	14.36	17.40	23.02
3	0.2%	14.20	16.90	22.85
4	0.3%	13.85	15.80	22.30
5	0.4%	13.50	15.30	21.76
6	0.5%	13.30	14.70	21.50

Compressive strength is assessed after 7,14, and 28 days. The findings demonstratethat the compressive strength increases asthe amount of expanded polystyrene beads increases from 0% to 0.5%, but declines as the number of EPS beads increases. We areable to substitute up to 0.5% of the time as a result

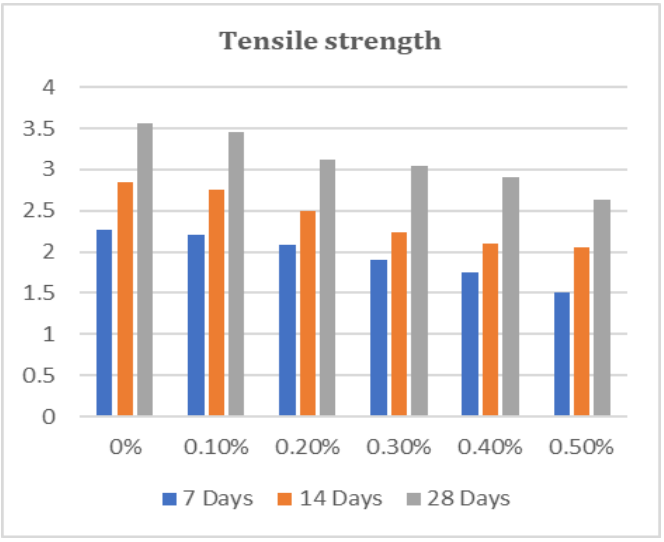


Graph 2

6.2 Tensile behaviour (splitting test)results:

Table No 5

S. NO	Concrete cylinder of EPBs	7 days	14 days	28 days
1	0%	2.26	2.84	3.56
2	0.1%	2.20	2.75	3.45
3	0.2%	2.08	2.50	3.12
4	0.3%	1.90	2.23	3.05
5	0.4%	1.75	2.10	2.90
6	0.5%	1.50	2.05	2.63



Graph 3

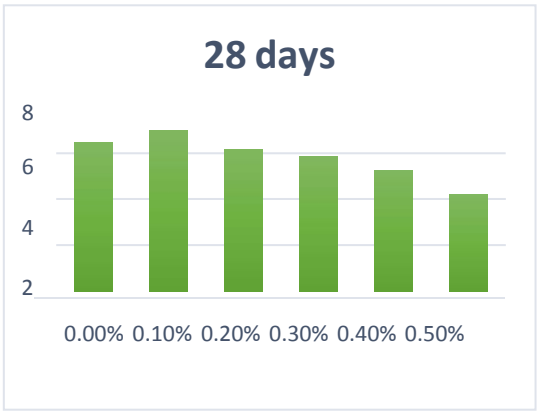
6.3 Flexural Strength Test: IS: 516-1959, Flexural strength is the term used to describe the tensile strength of concrete. Flexural strength is used to estimate the loading at which cracking in a structurebegins to occur.

flexural strength test results :

Flexural Strength at 28 days

Table No 7

S. No	%Of Eps Beads Replacement	Flexural Strength At 28 Days (N/Mm2)
1	0%	6.45
2	0.1%	6.30
3	0.2%	6.15
4	0.3%	5.85
5	0.4%	5.26
6	0.5%	4.20



Graph 4

7 Conclusions :

1. Adding more EPS beads to concrete mixes decreases the material's compressive and tensile strengths.
2. As the amount of polystyrene beadsgrows, workability also rises.
3. While compressive strength typicallyrises with age during curing, densities and strength fall as EPS beads increasein accordance with age.
4. When EPS beads are substituted, the split tensile strength reduces and thecontent does too.
5. As EPS beads were replaced, the content's flexural strength was also reduced.
6. The greatest strength (compressive,split tensile, and flexural) was reached at 0.1% of expanded polystyrene and was shown to decrease for 0.5% of expanded polystyrene; nonetheless, itcan be used for single-story buildings tomake them more affordable and to lower the dead load.

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