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# Partial Replacement of Coarse Aggregates by Expanded Polystyrene Beads with Addition of Coir Fibre in Concrete

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**Abstract:** *With growing construction, there is no shortage of tall buildings and structures. but there is one thing that is getting depleted that are natural sources such as sand and aggregates. These material either require some alternate source or using waste material. The material need to be such that which are causing harm to the environment or available in abundance. EPS Beads is one of the material which is non-biodegradable remains for longer time in the environment without any decomposition or degradation. Also, coconut fibre is a natural source which is constantly getting produced. The use of these materias will also help in making concrete lightweight. This research explains about the study methods for producing lightweight concrete by using Expanded Polystyrene(EPS) Beads with the addition of coconut fibre. The main objective of this study is to determine the workability, compressive strength, tensile strength and flexure strength of lightweight concrete prepared by using polystyrene beads and coconut fibre. The tests will be conducted to find compressive strength, tensile strength and flexural strength. The eps beads will be used for partial replacement of coarse aggregates by volume in the interval of 2%,4%,6%,8%,10%.the coconut fibres will be added as addition by 1% of the weight of cement. The work is done using M25 grade concrete.*

**Keywords:** *Lightweight concrete, EPS Beads, Coir Fibre, Workability, Compressive Strength, Split-tensile Strength, Flexrure Strength*

## I. INTRODUCTION

Concrete is most widely used material all over the world. The increase in the popularity of using environmental friendly, low-cost and light weight construction materials in building industry has brought about the need to investigate how this can be achieved by benefiting the environment as well as maintaining the material required strength affirmed in the standards. In the construction industry, building technology is heading towards an entirely new era because of the usage of industrial wastes in various forms of building material production. For instance, the use of various wastes in building material production has received diligent attention over the past few years. The economic progress in construction depends more on an intelligent use of materials and constant improvement of available materials. Even though the construction industry is revolutionizing in a significant manner in terms of both equipment and materials used, the cost of construction has increased along with the deteriorative impact on environment. The most important objective of this research is to study the properties, including of lightweight concrete containing Expanded Polystyrene (EPS) beads with added coconut fibre. Some important characteristics of polystyrene beads is very light in weight and its weight is almost half of other materials of its kind. Coconut fibre is also easily available and is strongest among natural fibres. Both materials are easily available and can be acquired at low cost.

## II. LITERATURE REVIEW

V.Sai Uday, B.A jitha(2017) their experiment describes the behavioral study of coconut fibre in concrete structure. The addition of coconut fibre in concrete improves various engineering properties of concrete. Coconut fibre is treated as natural fiber before using in concrete. Addition of coconut fibre improves the compressive strength, flexural strength and split tensile strength of concrete. The experiment was conducted on high strength concrete with the addition of fiber with 5 mix proportions (1%,2%,3%,4%, and 5%) by the weight of cement. The compressive strength and split tensile strength of cured concrete evaluated for 3days,7days,28days. The study found the optimum fiber content to be at 1%(by the weight of the cement). This results show coconut fiber can be used in construction.

Aman Mulla and Amol Shelake (2016) investigated to find a concrete mix proportion which gives better results than the Burnt Brick (compressive strength and density), and to study the properties, such as density, compressive strength and splitting tensile strength of lightweight Expanded Polystyrene (EPS) beads concrete. Then its properties are compared with M20 grade conventional concrete. Their conclusions were that EPS concrete gives good workability and could easily be compacted and finished and compressive strength of EPS concrete is less than conventional concrete. The concrete mix have low density and it gives the strength more than

burnt brick so the concrete mix proportion can be useful as lightweight concrete brick in construction work. The concrete mix proportion are also useful as precast concrete members with low density and more workability.

Thomas Tamut et al (2014) investigated the properties, such as compressive strength and tensile strengths of lightweight concrete containing Expanded Polystyrene (EPS) beads. Its properties are compared with those of the normal concrete i.e., without EPS beads. EPS beads are used as partial replacement to coarse aggregates. The results showed that the amount of polystyrene beads incorporated in concrete influences the properties of hardened concrete. At 28 days, it was found that compressive strength of 5%, 10%, 15%, 20%, 25% and 30% EPS incorporated concrete strengths were 91%, 77 %, 71%, 63%, 57%, and 45%, respectively when compared to concrete with no EPS case.

#### A. Objectives

- 1) To find out maximum compressive strength of concrete using EPS beads and coconut fibres at varying contents and to compare it with that of conventional concrete.
- 2) To find out maximum tensile strength of concrete using EPS beads and coconut fibres at varying contents and to compare it with that of conventional concrete.
- 3) To find out maximum flexural strengths of concrete using EPS beads and coconut fibres at varying contents and to compare it with that of conventional concrete.
- 4) To find the workability of concrete made using EPS beads and coconut fibre.

### III. MATERIALS

The material used are

- A. Ordinary Portland cement of 53 grade
- B. Coarse aggregates
- C. Fine aggregates
- D. EPS(expanded polystyrene) beads
- E. Coconut or coir fibre and
- F. Water.

- 1) *Cement*: The term cement is commonly used to refer to powdered materials which develop strong adhesive qualities when combined with water. It is one of the most widely used construction material. Cement is not only binding material in concrete but it also helps in providing strength to the concrete. The binding particle that are present in the cement is due to its chemical composition. The cement used in this work is ordinary portland cement of 53 grade of ambuja cement. The cement for work was provided by the concerned lab where test were performed.

Physical properties of cement

S.NO.	PROPERTIES	TEST RESULTS	IS:8112-1989
1.	Normal consistency	0.32	
2.	Initial setting time	55 min.	Minimum of 30 min.
3.	Final setting time	340 min.	Maximum of 600 min
4.	Specific gravity	3.14	
5.	Compressive strength		
	3 days strength	27.4 Mpa	Minimum of 27 Mpa
	7 days strength	43.8 Mpa	Minimum of 40 Mpa
	28 days strength	55.2 Mpa	Minimum of 53 Mpa

Chemical composition of cement

S.NO.	COMPOSITION	WEIGHT (AVG.%)
1.	CaO	66.67
2.	SiO <sub>2</sub>	18.91
3.	Fe <sub>2</sub> O <sub>3</sub>	4.94
4.	Al <sub>2</sub> O <sub>3</sub>	4.51
5.	SO <sub>3</sub>	2.5
6.	MgO	0.87
7.	K <sub>2</sub> O	0.43
8.	Na <sub>2</sub> O	0.12
9.	Loss of ignition	1.05

- 2) *Coarse Aggregates*: The particles which retains on the sieve and are larger than 4.75mm are termed as coarse aggregates. For a good concrete mix, aggregates need to be clean, hard, strong particles free of absorbed chemicals or coatings of clay and other fine materials that could cause the deterioration of concrete. Gravels constitute the majority of coarse aggregate used in concrete with crushed stone making up most of the remainder. The material for work was provided by the concerned lab where test were performed.

Properties of coarse aggregates

S.No	Description	Test Results
1	Nominal size used	20mm
2	Specific gravity	2.9
3	Impact value	10.5
4	Water absorption	0.15%
5	Sieve analysis	20mm
6	Aggregate crushing value	20.19%
7	Bulk density of coarse aggregate (Poured density)	1687.31kg/m <sup>3</sup>
	Bulk density of coarse aggregate (Tapped density)	1935.3 kg/m <sup>3</sup>

- 3) *Fine Aggregates*: Fine aggregates consists of natural stone or crushed particles passing through 4.75mm size sieve. Natural gravel and sand are usually dug or dredged from a pit, river, lake, or seabed. Aggregates strongly influence concrete's freshly mixed and hardened properties, mixture proportions, and economy. Usually river sand is used as fine aggregates with size of about 0.075mm. The fine aggregates were available at the site provided by the concerned company.

Properties of fine aggregates

S.No	Description Test	Result
1.	Sand zone	Zone-III
2.	Specific gravity	2.60
3.	Free Moisture	1%
4.	Bulk density of fine aggregate (poured density)	1385.16 kg/m <sup>3</sup>
	Bulk density of fine aggregate (tapped density)	1606.23 kg/m <sup>3</sup>

- 4) **EPS Beads:** Expanded polystyrene(EPS) is a lightweight cellular plastics material consisting of fine spherical shaped particles which are comprised of about 98% air and 2% polystyrene. It has a closed cell structure and cannot absorb water. It has a good sound and thermal insulation characteristics as well as impact resistance. Polystyrene foam is a non-biodegradable material. Polystyrene foams are used for a variety of applications because of its excellent set of properties including good thermal insulation, good damping properties and being extremely light weight. From being used as building materials to white foam packaging, expanded polystyrene has a wide range of end-use applications. EPS beads were purchased from furniture shop at PATHANKOT.

Properties of eps beads

S.NO.	PROPERTIES	VALUES
1.	Specific gravity	0.011
2.	Bulk density	6.86kg/m <sup>3</sup>
3.	Particle size(spherical)	4- 8 mm diameter

- 5) **Coir Fibre:** Coir is a versatile natural fibre extracted husk of the coconut fruit. The husk contains 20% to 30% fibre of varying length. After grinding the husk, the long fibres are removed and used for various industrial purposes, such as rope and mat making. It provides excellent insulation against temperature and sound. It has the greatest tearing strength among all natural fibres. Coir fibres were purchased from furniture shop at PATHANKOT.

Physical properties of coir fibre

S.NO.	PROPERTY	VALUES
1.	Length	60-210
2.	Diameter	0.4-0.8mm
3.	Moisture content	10.60
4.	Water absorption at saturation	160%
5.	Density	480 kg/m <sup>3</sup>
6.	Colour	Brown

Chemical properties of coir fibres

S.NO.	NAME	VALUE
1.	Hemi-cellulose	11%
2.	Cellulose	46%
3.	Lignin	43%

- 6) **Water:** Water is also one of the main constituent of concrete. Potable tap water was used in the preparation of concrete. Water used was free from impurities and suspended particles. Water should have normal pH range otherwise it can affect the quality of concrete. The strength of concrete could be affected by use of impure or polluted water

#### IV.METHODOLOGY

The main objective of this study is to determine the compressive strength, tensile strength and flexure strength of lightweight concrete prepared by using polystyrene beads and coconut fibre. The tests will be conducted is to find compressive strength, tensile strength and flexural strength. Based on the previous research work, a comparison of strength properties of fibre reinforced concrete is made with respect to conventional concrete. A grade of M25 concrete mix will be used to prepare concrete. A total of 54 cubes, 54 cylinders and 54 beams were casted and tested.

##### A. Batching

All the materials are collected and their weights are properly done. The measurement of replacement of amount of material is done. After that, the materials were mixed properly with addition of fibre. At last water is added to make a proper workable mixture and then placed into subsequent moulds.

### B. Casting

The mixture of concrete is then tested for slump and placed into moulds. The moulds such as cubes for compression test is properly oiled with grease or oil. The mixture is compacted and placed in moulds by properly following procedure. This process is done for all specimens to be casted for testing. For a mix, three samples are prepared.

### C. Curing

The moulds are kept for 24 hours to dry. After that the moulds are removed and respective specimen is placed in water tank made for curing. The specimens are marked for identification of replacement. The specimens are removed from tank before testing and dried. The specimens are kept for 28 days in the tank.

### D. Procedure For Different Tests

The procedures for various tests are different. The method for testing of different specimen are:

- 1) **Slump Cone Test:** The ideal concrete is the one which is workable in all conditions i.e, can prepared easily placed, compacted and moulded. Slump test is the most commonly used method of measuring consistency of concrete. It is used conveniently as a control test and gives an indication of the uniformity of concrete. Slump test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site of work. It is not a suitable method for very wet or very dry concrete. It does not measure all factors contributing to workability, nor is it always representative of the placability of the concrete. It indicates the characteristic of concrete in addition to the slump value. If the concrete slumps evenly it is called true slump. If one half of the cone slides down, it is called shear slump. In case of a shear slump, the slump value is measured as the difference in height between the height of the mould and the average value of the subsidence. Additional information on workability and quality of concrete can be obtained by observing the manner in which concrete slumps. The Slump Cone apparatus for conducting the slump test essentially consists of a metallic mould in the form of a frustum of a cone having the internal dimensions as under: Bottom diameter : 20 cm, Top diameter : 10 cm, Height : 30 cm and the thickness of the metallic sheet for the mould should not be thinner than 1.6 mm. Weights and weighing device, Tamper (16 mm in diameter and 600 mm length), Ruler, Tools and containers for mixing, or concrete mixer etc.
- 2) **Compressive Strength Test:** Compressive strength is the capacity of a material or structure to withstand axial loads tending to reduce the size. It is measured using the Universal Testing machine. Concrete can be made to have high compressive strength, e.g. many concrete structures have compressive strengths in excess of 50 MPa. Here the compressive strength of concrete cubes for the plain concrete and fibre reinforced concrete are found out using Compression testing machine. The tests shall be made at recognized ages of the test specimens, the most usual being 7 and 28 days. Where it may be necessary to obtain the early strengths, tests may be made at the ages of 24 hours  $\pm \frac{1}{2}$  hour and 72 hours  $\pm 2$  hours. The ages shall be calculated from the time of the addition of water to the dry ingredients. The number of specimens should be at least three specimens, preferably from different batches, shall be made for testing at each selected age. The testing machine may be of any reliable type, of sufficient capacity for the tests and capable of applying the load at the rate specified. The permissible error shall be not greater than  $\pm 2$  percent of the maximum load. The mould shall be of 150 mm size and cylindrical mould shall be of 150 mm diameter and 300 mm height. Other things include weighing device, tools and containers for mixing, Tamper (square in cross section) etc.

The compressive strength is obtained by

Compressive strength = Load/Area in N/sq mm.

- 3) **Split Tensile Strength Test:** Tensile strength is the capacity of a material or structure to withstand tension. The tensile strength of concrete greatly affect the size of cracking in structures. Due to the brittle nature of concrete, it is weak in tension. So, concrete generally develops cracks when tensile forces exceeds its tensile strength. Split tensile test can be done on universal testing machine.

The Split tensile strength is obtained by dividing the recorded load to the bearing area of the specimen

Resultant Split tensile strength =  $2P/\pi DL$  in N/sq mm.

Where P is load at failure,

D is diameter of cylinder

and L is length of cylinder.

- 4) **Flexural Strength Test:** Flexural strength of concrete is considered as an index of tensile strength of concrete. Tensile stresses are likely to develop in concrete due to drying shrinkage, rusting of steel reinforcement, temperature gradients and many other reasons. Beam tests are conducted to determine flexural strength of concrete. In flexural tests on beam theoretical maximum tensile strength is obtained at bottom of beam and is called modulus of rupture, which depends on dimension of beam and position of loading. The tests shall be made at recognized ages of the test specimens, the most usual being 7 and 28 days. Where it may be necessary to obtain the early strengths, tests may be made at the ages of 24 hours  $\pm$  ½ hour and 72 hours  $\pm$  2 hours. The beam moulds shall be 15  $\times$  15  $\times$  70 cm. Alternatively, if the largest nominal size of the aggregate does not exceed 19 mm, specimens 10  $\times$  10  $\times$  50 cm may be used. Weights and weighing device, Tools and containers for mixing, Tamper (square in cross section) etc. are required.

The flexure strength is calculated by the formula

$$F_b = \frac{PL}{bd^2}$$

Where, P= maximum load in N

L= length in mm

b= width in mm

d= depth in mm

## V. RESULTS AND DISCUSSIONS

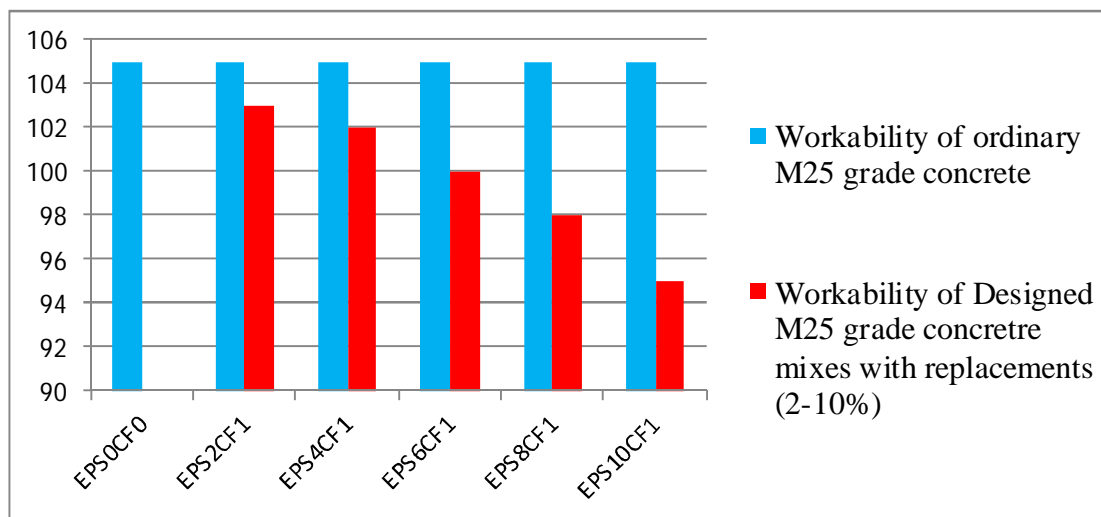
The values of various tests such as slump, compressive strength, tensile strength and flexural strength are compared with normal concrete and the variation is shown in their graphs.

### A. Workability Of Concrete

The test was conducted for fresh concrete prepared before the moulding process. Workability results obtained from slump cone test for M25 grade of concrete is shown in table.

Table : Workability test results for slump cone test in mm

S.No	Mixes	Aggregate Replacements Volume proportions in %	Addition of coconut fibre (by weight of cement)	Workability (mm)
				Grade M25
1	EPS0:CF0	0%	0%	105
2	EPS2:CF1	2%	1%	103
3	EPS4:CF1	4%	1%	102
4	EPS6:CF1	6%	1%	100
5	EPS8:CF1	8%	1%	98
6	EPS10:CF1	10%	1%	95



### B. Compressive Strength

A total of 54 cubes of size 150 x 150 x 150mm were casted and tested for 7 days, 14 days and 28 days testing each for conducting the compressive strength tests.

TABLE: Compressive strength results of M25 grade concrete for 7 days

S.No	Mix Codes	Aggregate Replacement proportions in %	Coconut fibre addition in %	Compressive strength after 7 days in N/mm <sup>2</sup>			Mean cube strength in N/mm <sup>2</sup>
				Cube 1	Cube 2	Cube 3	
1	EPS0CF0	0%:0%		22.59	22.25	23.34	22.72
2	EPS2CF1	2%:1%		23.37	23.44	23.90	23.57
3	EPS4CF1	4%:1%		23.96	24.58	23.82	24.11
4	EPS6CF1	6%:1%		20.37	20.60	19.22	20.06
5	EPS8CF1	8%:1%		19.48	18.49	18.33	18.76
6	EPS10CF1	10%:1%		15.13	16.37	14.98	15.56

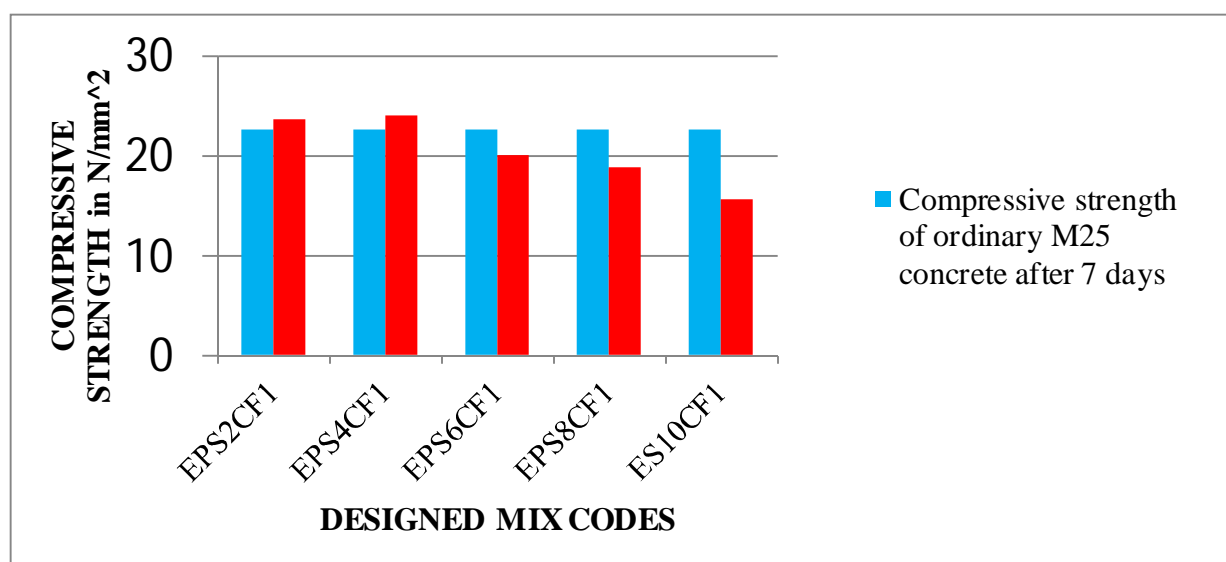


TABLE : Compressive strength results of M25 grade concrete for 14 days

S.No	Mix Codes	Aggregate Replacement proportions in %	Coconut fibre addition in %	Compressive strength after 14 days in N/mm <sup>2</sup>			Mean cube strength in N/mm <sup>2</sup>
				Cube 1	Cube 2	Cube 3	
1	EPS0CF0	0%:0%		29.04	28.60	30.01	29.21
2	EPS2CF1	2%:1%		30.14	30.23	30.83	30.40
3	EPS4CF1	4%:1%		30.20	31.17	30.38	30.58
4	EPS6CF1	6%:1%		26.09	26.39	24.62	25.70
5	EPS8CF1	8%:1%		23.51	23.72	24.98	24.07
6	EPS10CF1	10%:1%		19.42	21.28	19.24	19.98

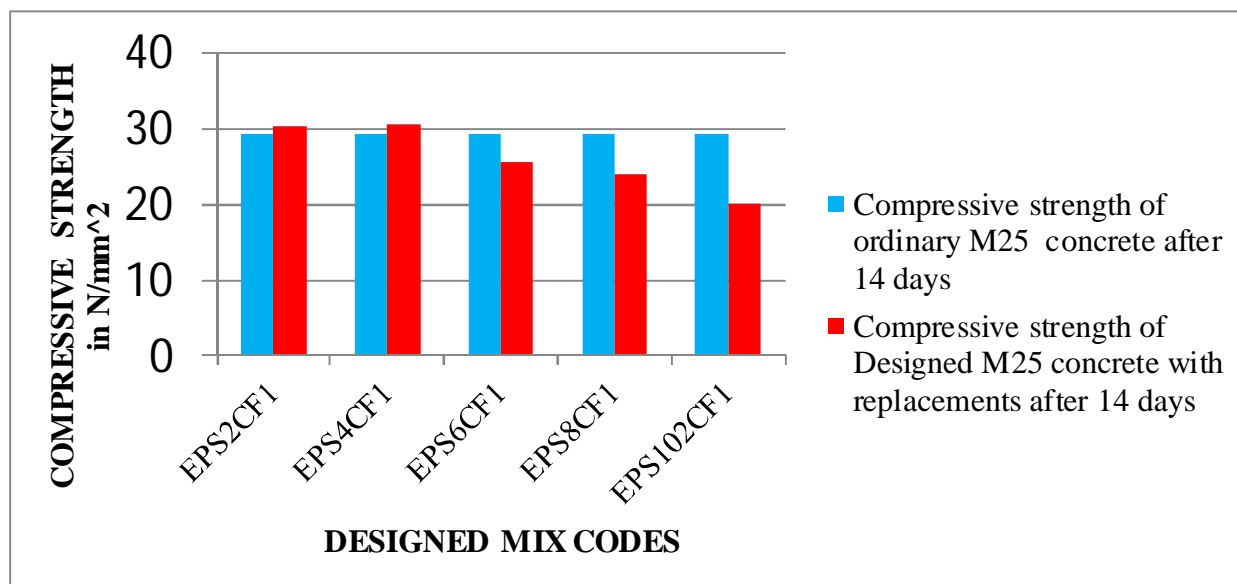
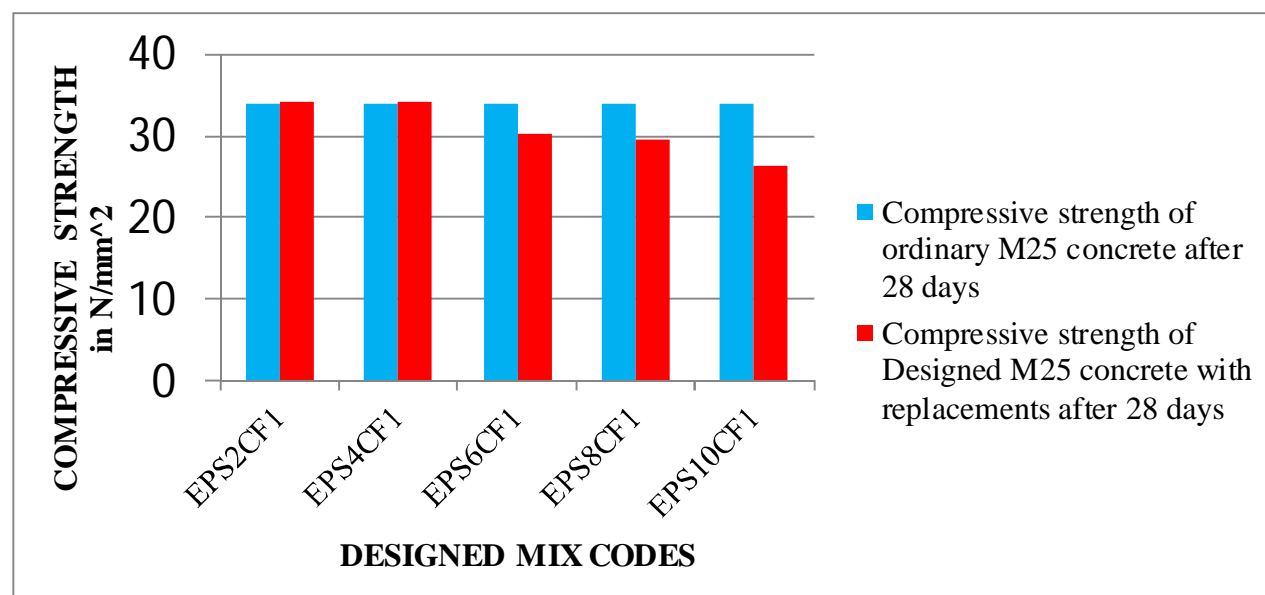


TABLE: Compressive strength results of M25 grade concrete for 28 days

S.No	Mix Codes	Aggregate Replacement proportions in %	Coconut fibre addition in %	Compressive strength after 28 days in N/mm <sup>2</sup>			Mean cube strength in N/mm <sup>2</sup>
				Cube 1	Cube 2	Cube 3	
1	EPS0CF0	0%:0%		33.73	33.21	34.84	33.92
2	EPS2CF1	2%:1%		33.88	33.98	34.65	34.17
3	EPS4CF1	4%:1%		33.84	34.92	34.04	34.26
4	EPS6CF1	6%:1%		30.81	31.16	29.07	30.34
5	EPS8CF1	8%:1%		28.83	29.09	30.64	29.52
6	EPS10CF1	10%:1%		25.53	27.97	25.29	26.26



### C. Split Tensile Strength

The split tensile strength obtained by testing the cylindrical specimen for M25 grade of concrete to all the mixes designed for various replacements are given below:

TABLE : Split tensile strength results for M25 grade concrete for 7 days

S.No	Mix Codes	Aggregate Replacements proportions in %	Coconut fibre addition in %	Split tensile strength after 7 days in N/mm <sup>2</sup>			Mean cube strength in N/mm <sup>2</sup>
				Cube 1	Cube 2	Cube 3	
1	EPS0CF0	0%:0%		2.13	2.27	2.45	2.28
2	EPS2CF1	2%:1%		2.40	2.54	2.73	2.55
3	EPS4CF1	4%:1%		2.51	2.75	2.49	2.58
4	EPS6CF1	6%:1%		2.05	2.17	2.33	2.18
5	EPS8CF1	8%:1%		1.94	2.06	2.23	2.07
6	EPS10CF1	10%:1%		1.72	1.84	1.94	1.83

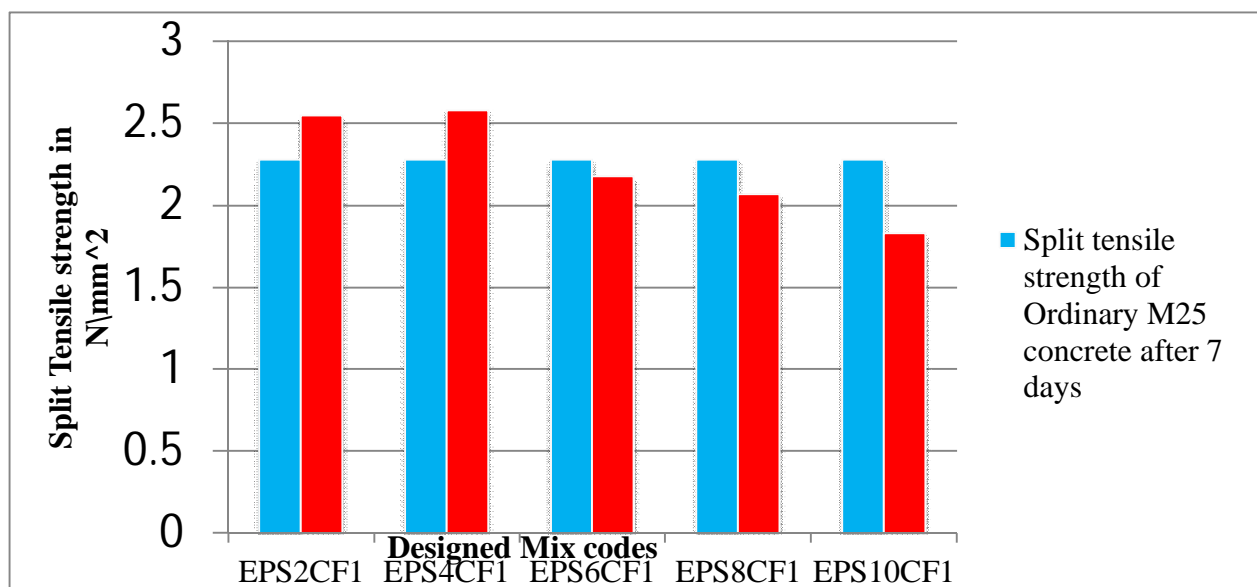


TABLE : Split tensile strength results for M25 grade concrete for 14 days

S.No	Mix Codes	Aggregate Replacements proportions in %	Coconut fibre addition in %	Split tensile strength after 14 days in N/mm <sup>2</sup>			Mean cube strength in N/mm <sup>2</sup>
				Cube 1	Cube 2	Cube 3	
1	EPS0CF0	0%:0%		2.10	2.73	2.46	2.43
2	EPS2CF1	2%:1%		2.64	2.84	2.99	2.82
3	EPS4CF1	4%:1%		2.95	3.07	2.73	2.91
4	EPS6CF1	6%:1%		2.40	2.32	2.71	2.47
5	EPS8CF1	8%:1%		2.19	2.33	2.48	2.33
6	EPS10CF1	10%:1%		1.96	1.93	2.15	2.01

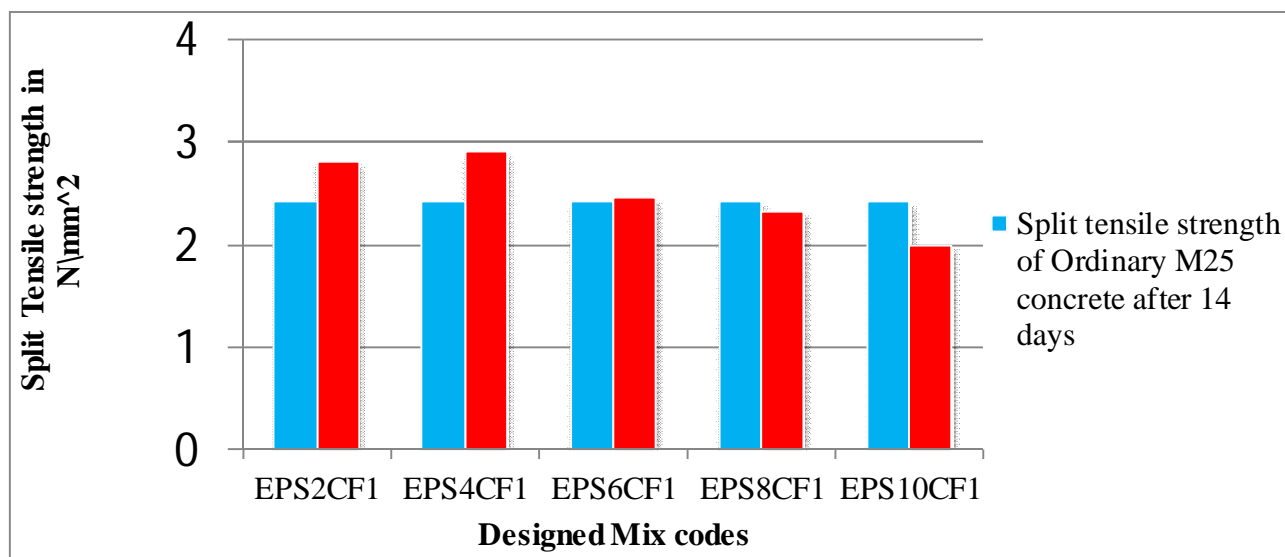
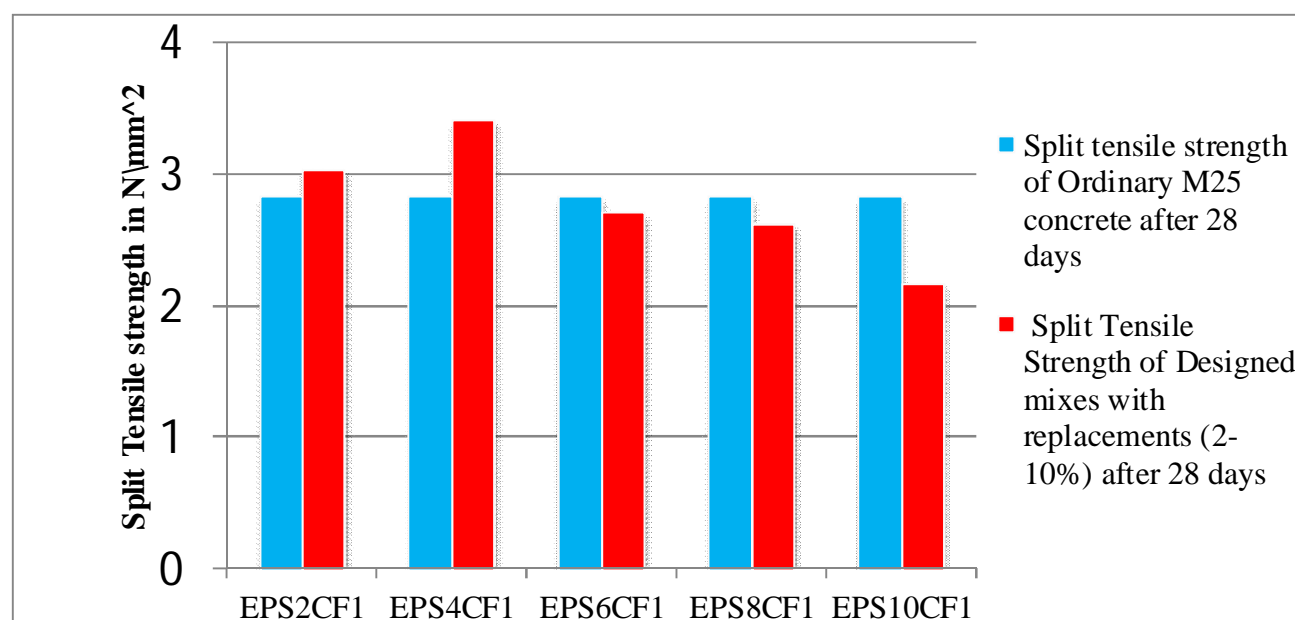


TABLE: Split tensile strength results for M25 grade concrete for 28 days

S.No	Mix Codes	Aggregate Replacements proportions in %	Coconut fibre addition in %	Split tensile strength after 28 days in $N/mm^2$			Mean cube strength in $N/mm^2$
				Cube 1	Cube 2	Cube 3	
1	EPS0CF0	0%:0%		2.76	2.73	3.02	2.83
2	EPS2CF1	2%:1%		2.89	3.02	3.22	3.04
3	EPS4CF1	4%:1%		2.94	3.46	3.83	3.41
4	EPS6CF1	6%:1%		2.63	2.54	2.97	2.71
5	EPS8CF1	8%:1%		2.47	2.65	2.79	2.63
6	EPS10CF1	10%:1%		2.04	2.16	2.32	2.17



#### D. Flexure Strength

The flexure strength test result obtained are as:

TABLE : Flexural strength results of M25 grade concrete for 7 days

S.No	Mix Codes	Aggregate Replacements proportions in %	Coconut fibre addition in %	Flexural strength after 7 days in N/mm <sup>2</sup>			Mean cube strength in N/mm <sup>2</sup>
				Cube 1	Cube 2	Cube 3	
1	EPS0CF0	0%:0%		7.91	8.21	8.01	8.04
2	EPS2CF1	2%:1%		7.97	8.29	8.30	8.18
3	EPS4CF1	4%:1%		8.17	8.42	8.10	8.23
4	EPS6CF1	6%:1%		7.61	7.69	7.86	7.72
5	EPS8CF1	8%:1%		7.51	7.60	7.57	7.56
6	EPS10CF1	10%:1%		7.31	7.27	7.33	7.30

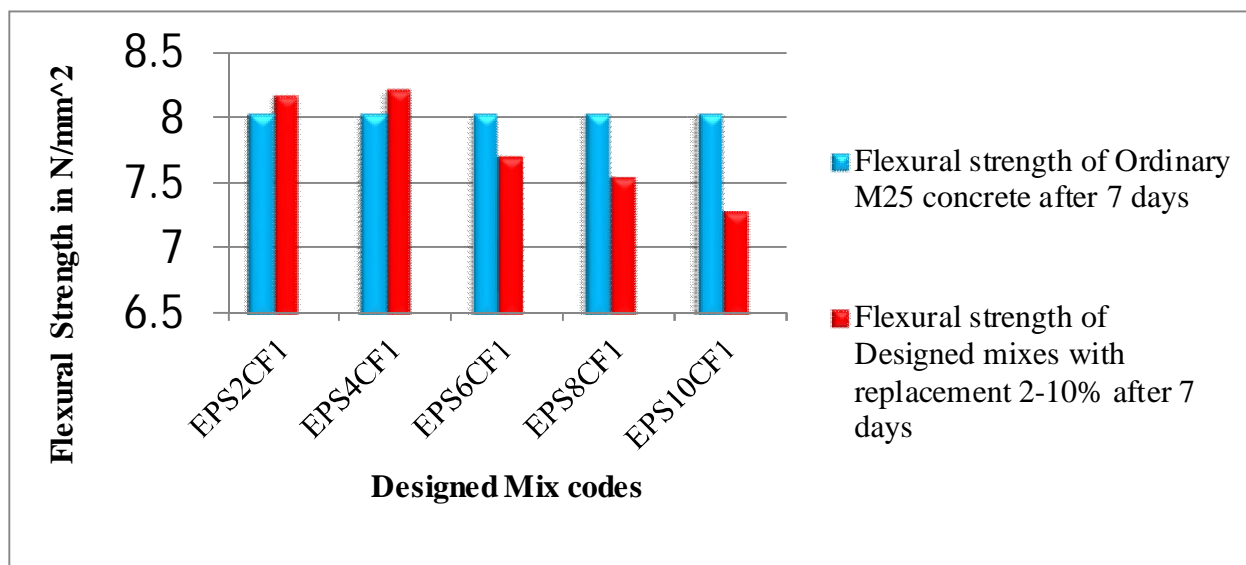


Table : Flexural strength results of M25 grade concrete for 14 days

S.No	Mix Codes	Aggregate Replacements proportions in %	Coconut fibre addition in %	Flexural strength after 14 days in N/mm <sup>2</sup>			Mean cube strength in N/mm <sup>2</sup>
				Cube 1	Cube 2	Cube 3	
1	EPS0CF0	0%:0%		8.01	8.09	8.31	8.13
2	EPS2CF1	2%:1%		7.71	8.12	8.86	8.23
3	EPS4CF1	4%:1%		9.01	8.78	8.98	8.92
4	EPS6CF1	6%:1%		7.97	8.07	8.11	8.05
5	EPS8CF1	8%:1%		7.98	8.02	8.07	8.02
6	EPS10CF1	10%:1%		7.51	7.42	7.83	7.58

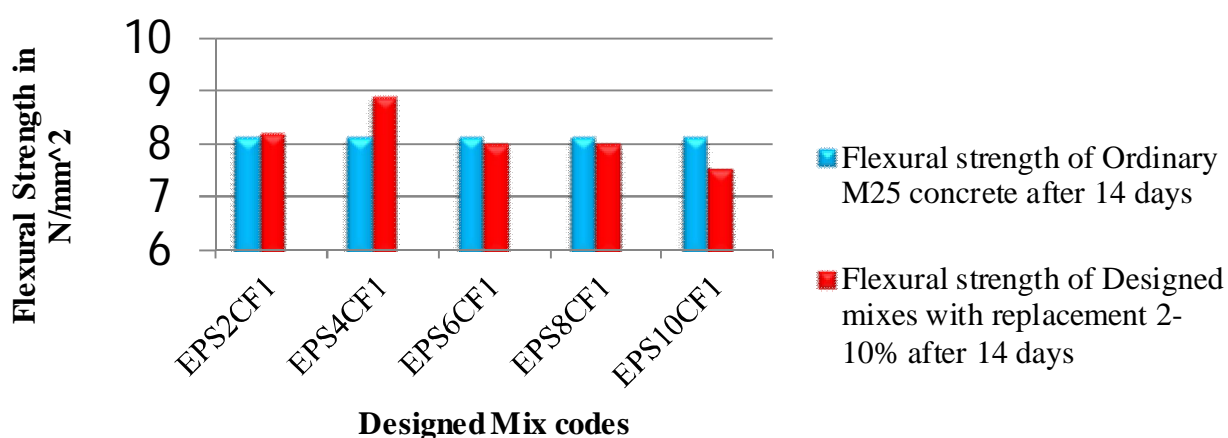
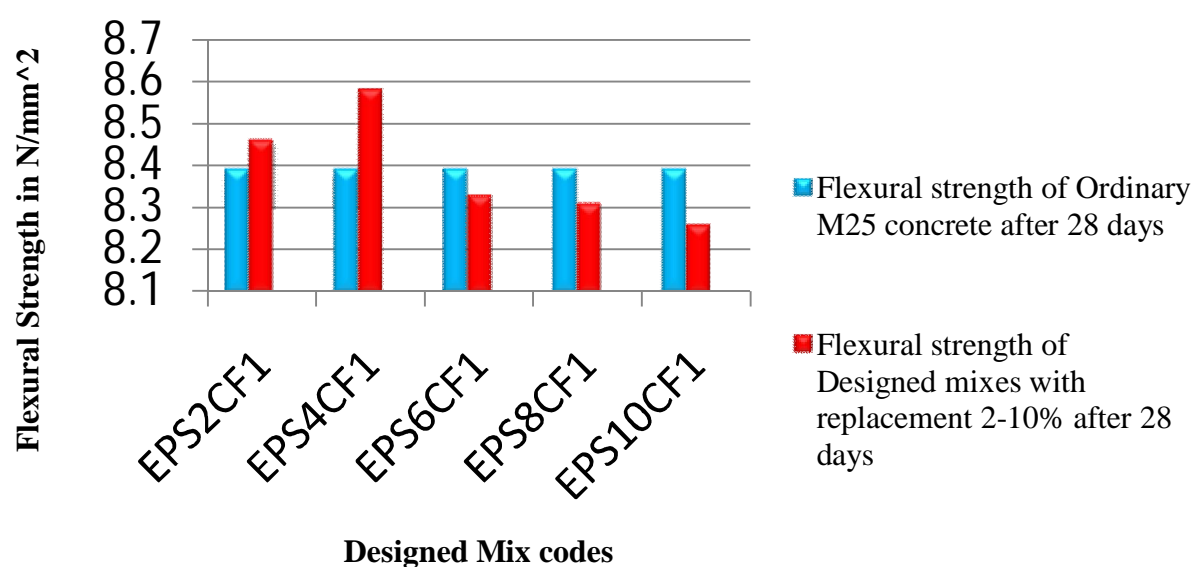


TABLE: Flexural strength results of M25 grade concrete for 28 days

S.No	Mix Codes	Aggregate Replacements proportions in %	Coconut fibre addition in %	Flexural strength after 28 days in $N/mm^2$			Mean cube strength in $N/mm^2$
				Cube 1	Cube 2	Cube 3	
1	EPS0CF0	0%:0%		8.19	8.31	8.67	8.39
2	EPS2CF1	2%:1%		8.14	8.49	8.75	8.46
3	EPS4CF1	4%:1%		8.25	8.63	8.86	8.58
4	EPS6CF1	6%:1%		8.07	8.13	8.81	8.33
5	EPS8CF1	8%:1%		8.10	8.27	8.57	8.31
6	EPS10CF1	10%:1%		7.86	8.31	8.61	8.26



#### E. Slump Cone Test

In general, it was observed that workability of a concrete mix decreased on addition of polystyrene. Workability of the mixes was observed to decrease with increase in percentage replacement of coarse aggregate with polystyrene (as a partial replacement of aggregate) i.e., higher the polystyrene replacement, lower was the workability. The addition of coconut fibre keeps the mixture together which helps in stopping flow of concrete.

#### F. Compressive Strength Test

Compression testing of the cube specimens was carried out in a compression testing machine. A set of three cubes were tested for each of the mix for their compressive strengths at 7, 14 and 28 days of curing. It is observed that, the compressive strength first increases upto 4% replacement, afterwards that there is a downfall of compressive strength. The maximum compressive strength is achieved at 2% and 4 % replacement of coarse aggregates by Eps beads with addition of coconut fibre. The maximum value is obtained at 4% replacement.

#### G. Split Tensile Strength Test

Split tensile tests were carried out, on standard cylindrical specimens of all the EPS based concrete mixes. The test was performed on the cylinders of 150 mm diameter and 300 mm height, as per specifications. The stone aggregates and EPS beads were uniformly distributed in the matrix. It is clear that higher the amount of polystyrene beads in concrete mixture, the lower the tensile strength. But coconut fibres present in the mixture help in maintaining tensile strength. The split tensile strength showed increase upto 2 % and 4% replacement after which the value of split tensile decreases. The split tensile strength also showed maximum strength at 4% replacement with coconut fibre addition.

#### H. Flexure Strength Test

The flexure values of all specimen were obtained and it was observed that the trend of strength increment is similar to that of compressive and tensile strength. The addition of coconut fibre helps in obtaining the higher flexure values at 2% and 4 % replacement of coarse aggregates by eps beads. The flexure value is also maximum at 4 % replacement of coarse aggregates.

### VI. CONCLUSIONS

The following conclusions were drawn from the study.

- 1) Workability results show that workability of concrete decreases a bit with increase in eps beads. The workability of mixture reduces with more eps beads. The beads and coconut fibres are mixable with other concrete aggregates. All the concrete containing eps beads and coconut fibre show good enough workability to be easily compacted and finished.
- 2) Compressive strength result show that with addition of coconut fibre there is increase in compressive strength but replacement of coarse aggregates in higher volume by eps beads decreases strength. After 4% volume replacement there is decrement of compressive strength.
- 3) The maximum compressive strength is achieved at 4% replacement of coarse aggregates by eps beads and 1% addition of coconut fibre.
- 4) The split tensile strength is optimum at 4% replacement and 1% addition. After that it keeps decreasing.
- 5) The flexure strength also showed maximum strength at 4% replacement and 1% addition. The coconut fibres help in increasing strength at low volume replacement.

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