International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 06, June-2019

Analysis of Polyester Fiber-Reinforced Lightweight Concrete using Expanded Polystyrene (EPS) Beads

Anjan B K
Assistant Professor
Department of Civil Engineering
Vidyavardhaka College of Engineering
Mysore 570 002, Karnataka, India

Ram Kumar P
U.G Student
Department of Civil Engineering
Vidyavardhaka College of Engineering
Mysore 570 002, Karnataka, India

Chris Lincy J
U.G Student
Department of Civil Engineering
Vidyavardhaka College of Engineering
Mysore 570 002, Karnataka, India

Vivekananda Swamy
U.G Student
Department of Civil Engineering
Vidyavardhaka College of Engineering
Mysore 570 002, Karnataka, India

***Abstract*— The self-weight of the Concrete structure is increased by the density of concrete (24-25 kN/m^3) which makes it uneconomical. Usage of Expanded Polystyrene Beads (EPS) as a partial substitute to fine aggregate produces Lightweight Concrete but appropriate strength characteristics is not achieved. One of the methods to attain the strength along with lightweight is to introduce the fibre beside EPS beads. The main objective of this investigation is to analyze the behavior of Polyester Fibre-reinforced lightweight concrete using EPS and also to determine the optimum dosage of Polyester-Fibre required to develop the maximum strength. In the present work 40% of EPS beads (by total volume of fine aggregate) is replaced for fine aggregates as optimum dosage and Polyester fibres are varied as percentage by weight of cement in addition to the quantity of cement used. The mechanical properties of the resulting concrete such as compressive strength, split tensile strength and density are studied. From the results obtained it is observed that optimum value of Polyester-Fibre is 0.30% by weight of cement gives an average compressive strength of 26N/mm^2 & split tensile strength of 8 N/mm^2 at the end of 28 days of curing along with the density of 18 kN/m^3. It can be used as plain concrete for structural applications**.

Keywords: Expanded Polystyrene Beads, Lightweight, Polyester fibre and Optimum dosage

I. INTRODUCTION

Increase in the development activities world over, the demand for the construction material is increasing exponentially [1]. This trend will have certainly greater impact on the economic system of the country. With the rapid development and technological increase, the need of substitutes for aggregate in concrete has been increased. Day by day new materials are being used as replacement for aggregates in concrete and there is a considerable need for substitution of fine aggregates which is an important ingredient in a **conventional concrete (0% EPS beads)** mix due to its scarcity in the present scenario [2] and the major problem identified in a conventional concrete is its density which imparts greater dead load to the structure.

Lightweight concrete and replacement for fine aggregate can be achieved by using lightweight aggregate like **Expanded Polystyrene (EPS) beads**. The density of Lightweight Concrete (LWC) ranges from 300kg/m^3 to 1850kg/m^3 which is a versatile building material, generally 20%-40% lighter than Conventional Concrete [3]. The higher brittleness and lower mechanical properties of LWC compared to Conventional Concrete has prevented it from being widely used in the construction industry despite its many advantages, which needs a remedy for efficient use.

The formation of cracks in concrete due to plastic shrinkage and drying shrinkage is the major disadvantage of the conventional concrete [4]. The use of various fibres such as steel fibres, carbon fibres, glass fibres, plastic fibres, coir fibres etc. can increase the load carrying capacity of concrete in tension and flexure [5] and also suppresses the crack formation [6]. In this research work EPS beads of optimum dosage 40% (by volume of fine aggregate) [7] are incorporated as a partial replacement to fine aggregates in the Concrete mix in order to reduce the self-weight of the concrete mix and **Recron 3s Polyester Fibre** is used to improve the tensile and flexural strength, ductility, toughness and to arrest the crack of the concrete. Therefore, authors have been studied extensively to determine the optimum dosage of Polyester-Fibre and for understanding the mechanical properties of Polyester fibre lightweight concrete using EPS beads.

II. MATERIALS AND METHODOLOGY

A. GENERAL

In this research work, an attempt has been made to determine the mechanical properties such as compressive strength and split-tensile strength of concrete mix by incorporating 40 % of EPS beads by volume of fine aggregates throughout the research work along with varying the percentage of Polyester fibre by weight of cement.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 06, June-2019

B. MATERIALS

The methodology and materials used in this research work is as per "Bureau of Indian Standards". The materials used are listed as follows,

Table 2.1: Description of Materials

Particulars	Descriptions	Remarks
Coarse aggregate	20mm and 12.5mm downsize	
Fine aggregate	M-sand Double washed	
Cement	OPC 43 Grade Zuari	
Water	Concrete lab tap water	VVCE
EPS	Expanded Polystyrene Beads (EPS Beads),	M/ S Prajwal insulation packing and specifications shown in Table 2.2
Fibre	Recron 3s Polyester fibre	Manufactured by Reliance Industries and specifications shown in Table 2.3

C. TESTS ON COARSE AGGREGATE

According to IS 383: 2016 and IS 2386: 1963, Grading zone, Water absorption, Specific gravity and Fineness modulus of coarse aggregate was carried out.

D. TESTS ON FINE AGGREGATE

According to IS 383: 2016 and IS 2386: 1963, Grading zone, Water absorption, Specific gravity and Fineness modulus of fine aggregate was carried out.

E. TESTS ON CEMENT

According to IS 4031:1988, tests on Normal consistency, Initial setting time, Final setting time and Specific gravity of cement was carried out.

F. MIX DESIGN

Concrete mix of proportion 1:1.5:3 is designed as per IS 10262:1982 and W/C of the mix is adopted as 0.50 from the results obtained from the trial mix.

G. TESTS ON CONCRETE

As per IS 1199: 1959, Workability test was performed on fresh concrete mix, and as per IS 9031: 1978 and IS 516: 1959, compression test and split tensile test on Hardened Concrete was performed respectively. The test data is listed in Table 3.2 and 3.3.

H. METHODOLOGY

- Cement, M – Sand and Coarse aggregate are weigh batched according to the mix proportion obtained from mix design.
- EPS is measured for the desired proportion (40% by volume of fine aggregate) in a container and is kept constant for all the trials
- M-Sand and EPS beads are dry mixed thoroughly to obtain a homogeneous mix
- Polyester fibre is measured in varied proportion by weight of cement and dry mixed with cement separately
- The dry mix of M-Sand and EPS beads along with that of Cement and Polyester fibres are then thoroughly mixed with the coarse aggregates to maintain a dry homogeneity
- Water is added to the dry mix of all constituents with the W/C ratio of 0.5 considered in mix design and hand mixed till a consistent and homogeneous concrete mix is obtained
- The cube moulds are properly oiled before placing the concrete mix
- Concrete cubes are casted with the aid of Table Vibrator with neat finishing
- After 24 hours, the cubes are demoulded and placed for curing
- The concrete cube specimens with varied polyester fibre content and constant EPS beads content are tested for compression strength for different curing periods
- The concrete cylinder specimens with the above ingredients are tested for split-tensile strength at 28 days

Table 2.2: Specifications of EPS beads

PARAMETER	VALUES
Diameter (mm)	2.00 – 3.00
Specific Gravity	0.044
Water Absorption	Nil

Table 2.3: Specifications of Polyester fibre (Recron 3s)

PARAMETER	VALUES
Length (mm)	6
Diameter (micron)	20
Aspect Ratio	300
Specific Gravity	1.36
Water Absorption (%)	Nil
Modulus of Elasticity (N/mm^2)	17.50 x 10^3
Ultimate elongation (%)	50.00 – 70.00

Source (M/ S Reliance Industries)

III. RESULTS AND DISCUSSION

A. The test results obtained for the workability of concrete for each trial with varied fibre content through the slump cone test is as shown in Figure 3.1. To evaluate the structural strength of the resulting concrete, cube specimen and cylindrical specimen are casted followed by conducting the compressive strength test and split tensile test at the end of 7,14 and 28 days of curing period with the aid of Compressive Testing Machine (CTM) with a capacity of 2000 kN (AIMIL- 2014). The test data are as shown in Table 3.1 and Table 3.2.

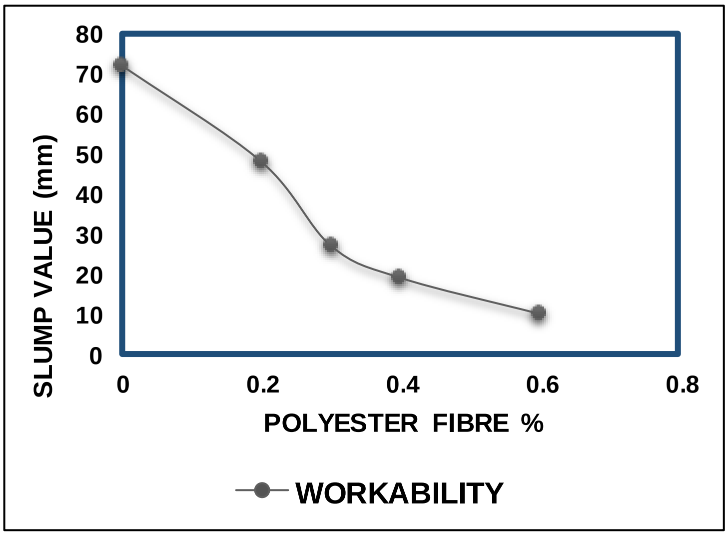

Figure 3.1: Slump variation of concrete for different content of Polyester fibre with 40% EPS beads

The above Figure 3.1 indicates that the workability of concrete reduces as the percentage of Polyester fibre is increased in the concrete mix. This is due to the fact that the fibres tend to bind all the particles strongly thus making the concrete mix stiff enough to resist bleeding and segregation. In this experimental work, a true slump of concrete was obtained in all batch of trials.

Table 3.1: Compressive Strength test results of Concrete

Sl No.	% EPS	% POLYESTERFIBRE VARIATION	COMPRESSIVE STRENGTH (N/mm^2)		
			7 DAY	14 DAY	28 DAY
1	0	0.00	-	-	27.20
2	40	0.00	15.45	16.89	21.43
3	40	0.20	18.08	20.85	22.25
4	40	0.30	19.85	22.36	25.49
5	40	0.40	15.75	18.34	19.39
6	40	0.60	11.58	15.14	18.81

Table 3.2: Split-tensile strength test results of Concrete

Sl No.	% EPS	% POLYESTER FIBRE VARIATION	SPLIT-TENSILE STRENGTH AT 28 DAYS OF CURING (N/mm^2)
1	40	0.30	8.00

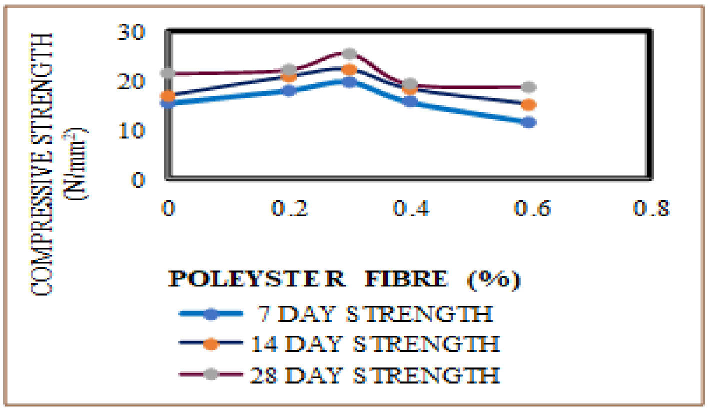

Figure 3.2: Compressive strength of Concrete for fibre variation showing the optimum fibre content with 40% EPS beads

The Figure 3.2 shows the compressive strength variation trend when 40% EPS beads by volume of fine aggregate and fibres of 0%, 0.20%, 0.30%, 0.40 % and 0.60% by weight of cement are added to the concrete mix. For inclusion of 0.30% Polyester fibre by weight of cement, the obtained density and average compressive strength at the end of 28 days of curing was 18.12 kN/m^3 and 25.49 N/mm^2. It can be inferred that the compressive strength of this specimen is 15.93% more than that of control cube (40 % EPS beads). Further the compressive strength has been reduced.

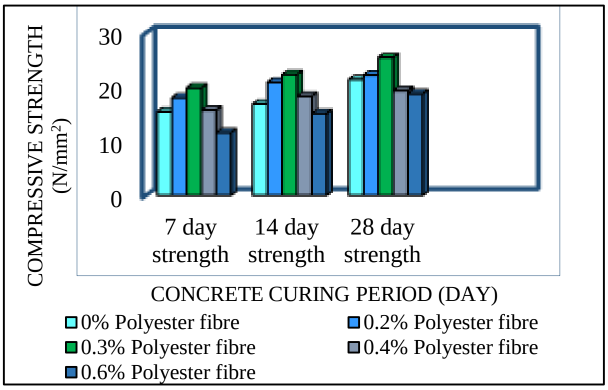

Figure 3.3: Comparison of Compressive Strength of Concrete for each variation of % Polyester fibre with 40% EPS beads at different curing period

The Figure 3.3 shows the compressive strength variation of concrete at 7, 14 and 28 day curing period with varied fibre content. It shows that the compressive strength at 0.30% fibre content is maximum in each case of curing period.

IV. CONCLUSIONS

The major conclusions drawn through this research work are as follows,

- Using 40% EPS beads by volume of fine aggregates, the optimum Polyester fibre content in addition to cement quantity obtained is 0.30% by weight of cement
- The density of concrete obtained is 18.00 kN/m^3

- The split tensile strength of the concrete at the optimum percentage of fibre content obtained is 8.00 N/mm^2
- The maximum compressive strength of the concrete is improved by 15.93% as that of conventional concrete

V. ACKNOWLEDGMENT

Authors would like to express their profound gratitude to Dr. Umesha P K, Professor, Vidyavardhaka College of Engineering for his counsel.

VI. REFERENCES

[1] **Nishma V Mohan, Aswathy L S, Sruthy Sreekumar and Apana A v (2018),** "Strength Characteristic Study of Polyester Fibre Reinforced Concrete", International Journal of Engineering Research and Technology (IJERT), ETCEA – 2K18 Conference Proceedings, Vol. 6, Issue 06

[2] **Amudhavalli N K and Poovizhiselvi M (2017),** "Relationship between Compressive Strength and Flexural Strength of Polyester Fibre Reinforced Concrete", International Journal of Engineering Trends and Technology (IJETT)– Vol. 45, No. 4, pp. 158 - 160

[3] **Sonu Pal, Mishra M K and Pandey V (2016),** "Effects of Surface Treatment of Polyester Fibre on Properties of Concrete, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Issue 05, pp. 236 – 248

[4] **Roshan Gawale, Shubham Mishra and Harshal Sambare (2016),** "Lightweight Concrete by using EPS beads", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 2, Issue. 03, pp. 470 – 476

[5] **Ghugal Y M and Naghate S V (2016),** "Performance of Extruded Polyester Fibre Reinforced Concrete", Journal of Structural Engineering, Vol. 43, No. 3, pp. 247-257

[6] **Amit Rai (2014),** "Applications and Properties of Fibre Reinforced Concrete, Journal of Engineering Research and Applications, Vol. 4, Issue 5 (Version 1), pp.123-131

[7] **Ram Kumar P, Anjan B K and Arjun V (2019),** "Assessment of Lightweight Concrete Using Expanded Polystyrene Beads", International Journal of Innovative Technology and Exploring Engineering, Vol.8, Issue 8, pp. 3234-3237