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PERFORMANCE OF BISFINOL-A EPOXY IN CONCRETE

S.Vinay Babu[1] and N.Venkata Ramana[2]

[1]*Research scholar, JNTUA, Ananthapuramu, Andhar Pradesh (State), India-515002*
[2]*Associate Professor, VTU PG Center, Kalaburagi, Karnataka (State) Inida-585105*

ABSTRACT: *This paper presents the effectiveness of Bisfinol-A epoxy for the cement concrete. The cement concrete is produced with the Bethamcharla stone powder as replacement to cement. For this concrete, the epoxy is varied 0 to 20% with an increment of 5%. The experimental work has planned to evaluate compressive, split, shear and flexural strengths. From the results it is noticed that, 10% epoxy dosage is optimum for the concrete mix to arrive strengths. Few regression models are deduced to evaluate the split, shear and flexural strengths with association of cube compressive strength. The models are provided satisfactory results to obtain experimental strength values.*

***Key words*: Bisfinol-A epoxy, compressive, split tensile and shear strengths, flexural strength, models**

I.INTRODUCTION

The discovery of Portland cement in the 18th century represented a turning point in the history of construction. Products readily utilized before the conception of Portland cement such as lime and clay, though malleable and easy to work, did not achieve a high strength when cured. Now days the research works are moving to improve the strengths of the concrete with addition of available materials such as fly ash, silica fume, rice husk ash etc. however few materials are came to lime light and some are in still under process to know the behavior after addition of those to cement concrete mix. In this way few polymers are also using to enhance the strength and durability of cement concrete. In the varieties of polymers, epoxy is one of the polymers in greater use at present days. The curing response in epoxy resin is exothermic in nature but is of small magnitude. Hence, in the preparation of epoxy based concrete, epoxy can be poured deeply in a mould, without overheating. Epoxy polymer concrete shows good bonding between concrete and metal surfaces and also shows high physical strength. Due to these qualities, epoxy can be used for different types of concrete works where heavy loads and chemical exposure are present.

II. REVIEW OF RECENT PAST WORKS

In this view herein recent past research works were happened on concrete with addition of polymers have been discussed in brief. Y. Ohama and K. Demura [1], Studied the strength development of polyester resin concrete under different curing conditions. The polyester resin concrete was mixed with regular mix proportions containing binders. The cured specimens were subjected to compressive strength test and the outcome showed that the optimal pre curing period before heat curing for polymer concrete is about 10 hours, water cure is applicable for resin concrete

without damaging hydrolysis of polyester resin used, the compressive strength of heat cured resin concrete were high than that of water cured and dry cured concrete O. Elalaoui et al. [2], carried out an investigational program on mechanical and physical properties of epoxy. The compressive strengths for epoxy concrete with 0.4 mm of aggregates were found to be 60 ± 9MPa and the values of flexural strengths for same mixes is 17.57 MPa. It has been declared by the author that the above mechanical properties were attained by the use of 24% epoxy resin. The average particle size of Fine, medium, and coarse silica powder is of 50 to 60µm, 600µm and 1100µm, respectively, had been used as filler in the making of epoxy polymer concrete. Dolomite is used as filler; the particle size of dolomite is less than 4.75 mm. The compressive strength of resulting epoxy concrete was quite high (128.9 MPa) compared to reference concrete (32.5 MPa). Golestaneh et al.[4] conducted experimentations on epoxy polymer concrete and the author predicted that the high compactness of the aggregate and filler in the mixture was most likely the reason for such a high value for epoxy polymer concrete. The maximum value for flexural strength is noted as 22.5 MPa. Haidar et al.[5] studied about the epoxy resin with reinforcement, coarse and fine aggregate named as micro polymer concrete (MPC). It observed that the MPC concrete designed with a polymer content of 9% showed the maximum physical and mechanical properties such as strengths and rigidity. Also for the formation of MPC the percentage of epoxy resin taken was slightly lower than for conventional epoxy polymer concrete.

III. OBJECTIVES

An experimental work has planned to find compressive, split, flexural and shear strengths for the proposed concrete. The concrete is would like to produce with Bethamcharla stone powder as replacement to cement. This Bethamcharla stone powder is available in the Kurnool district, Andhra Pradesh state, which is waste product of stone polishing industry. The layered stone of this, extracted from the deposits and transported to polishing industries to make finish goods/ floor slab stones. During the polishing process the sludge is generated and it thrown outside the factory and it known as waste product. Once it exposed to atmosphere, the water in the sludge is evaporated and remains as powder. In order to utilize this waste in to the concrete, an attempt made for replacement to cement and found as 10% effective (by weight). At present in the experimental work it is planned to evaluate the properties of concrete by varying the dosage of epoxy polymer in the range of 0 to 20% by an increment of 5%. To obtain compressive strength cubes (150x150x150mm) and cylinders (150mm diameter and 300mm length) are used, for split and shear strengths cylinders are used and for flexural strength beams (150x150x750mm) are used in this investigation. Total five concrete mixes are taken and for each mix three specimens are prepared and tested in the laboratory.

IV. MATERIALS AND METHODOLOGY

Cement: Ultratech company cement (PPC) was used which is conforming to IS 8112:1989. The specific gravity of the cement was observed as 3.10. The initial and finial setting times noticed as 35 and 380 minutes respectively.

Fine Aggregate: Locally available fine aggregate is used, which is passing through 4.75 mm. The specific gravity of fine aggregate found to be 2.7.

Coarse-Aggregate: 20mm maximum size of coarse granite aggregate was used and the specific gravity of the aggregate is 2.7.

Bethamcharla stone powder: It is obtained from the stone polishing industry, which is nearby Nandyal, Kurnool district,Andhra Pradesh (state).

Water: Portable water was used for the experimental work.

Bisfinol-A epoxy: Which is obtained from the company of Vruksha Composites,Valasalavakkam, Chennai and also harderer was used along with this epoxy.

V. CASTING AND CURING OF TEST SPECIMENS

The concrete is designed as per IS10261-2009 procedure and arrived mix proportion as 1:1.67:3.17 with water cement ratio of 0.53. The epoxy is used with various dosages for the arrived mixes as said above. The cubes, cylinders and beams are cast in the laboratory and after 24 hours the respective specimens are taken out from the corresponding moulds. Later the specimens were exposed to 7 days water curing and immediately they were exposed to dry curing for 21 days. Here it shows the specimens are subjected to both wet and dry curing. During wet state the hydration process is effective and during dry curing the polymerization is effective, this type of process has been noticed in the previous research work, hence here also same procedure adopted for curing. After curing process the specimens are tested to corresponding test so as to arrive required material strength properties. The compressive and split tensile strengths are arrived from the cube and cylinder specimens and tests are conducted according IS specifications. To obtain shear strength, the cylinder was slotted for a length of 50mm and load applied over the cylinder, from this shear stress is obtained. The shear stress is obtained from the failure load and shearing area of the cylinder specimen. To obtain flexural strength the beam was tested under third point loading. The results of the various tests have been presented in the next section along with the detailed discussion.

VI. DISCUSSION OF TEST RESULTS

The results for various tests have been presented in the Table 1. In this table all the test results are depicted and each of test discussing below.

Cube compressive strength: The compressive strengths are in increasing up to 10% of the chemical and for other dosages the values are decreasing. The 10% dosage of chemical is showing around 23.10% of increment of strength when compared with 0% chemical mix or reference mix. For 5% and 15% of chemical mix is also showing a higher increase of 6.64 and 23.10% when compared with reference mix. But for 20% chemical mix the strength is decreased by 5.69%. Hence by all observations it is noticed the optimum dosage for concrete is 10%.

Cylinder compressive strength: In the present investigation cylinder compressive strength also found along with cube compressive strength. Here also same trend is following towards compressive strengths. When compared with reference mix the 5, 10 and 15% dosage of chemical mixes are showing 10.12, 32.75 and 17.36% higher strengths. The mix with 20% chemical dosage showed lesser strength of 9.40% when compared with reference mix. From all mixes it is observed that the mix with 10% chemical showing more cylindrical compressive strength.

Split Tensile strength: The split tensile strengths are noticed for all mixes. From the results it is observed that, the mixes with 5, 10 and 15% chemical dosage the strengths are increasing by 8.65,25.10 and 12.55 respectively when compared with mix with 0% chemical (reference mix)**.** The mix with 20% chemical dosage, showed 6.50% lesser strength when compared with reference mix. Here also the 10% dosage showed superior performance.

Shear Strength: The shear strength was conducted with the help of cylinders. The shear stress is calculated with the observation of failure load and shear area. For corresponding test values the shear strength is calculated and it is noticed as direct shear strength. Herein also the mixes with 5, 10 and 15% Bisnofil-A epoxy (chemical) dosage the mixes are showing increment strength of 6.16,21.00 and 6.62% when compared with reference mix. However, the mix with 20% chemical dosage it showed lesser strength of 5.9%. It indicates the optimum dosage is 10% for concrete mix.

Flexural Strength: This strength is important during design of elements very particularly for flexure. Most of the times the beams are subjected to flexure, if we are aware of the resistance stress then we can judge the safety of the element. Hence here it is found the flexural strength for various mixes which were prepared by the variable of bisfinol dosage. The mixes with 5,10 and 15% chemical the flexural strengths are increased by 10.04,24.78 and 9.18% respectively with compared with mix of 0% chemical (4.68MPa). Beyond the 15% dosage and for mix with 20% chemical is showing a strength decrement of 5.7% when compared with reference mix. From above all strength tests it is known that, the mix with 10% chemical dosage shown good performance than the other mixes and it can be concluded that, it is optimum dosage for the provided concrete herein.

Regression models

In most of the structural design codes (IS, ACI, BS etc) the various strengths are correlated with cube or cylinder compressive strength. In IS 456-200 code, the strengths have been correlated with cube compressive strength. Hence here it is decided that, the cylinder compressive, split, shear and flexural strengths to make the relation with cube compressive strength. By using the statistics and with the principle of least square the models are generated and same were presented below.

$$f_{cylinder} = 0.78 f_c$$
$$f_{spilt} = 0.25 (f_c)^{0.65}$$
$$f_{Shear} = 0.80 \sqrt{f_c}$$
$$f_{flexure} = 0.83 \sqrt{f_c}$$

The performances of models are tested and the results are presented in Table 2. In same table few values are indicated in the bracket/s, those are indicate the ratio between experimental and regression model strengths of corresponding mixes with respective different strengths. From the table it is noticed that the compressive, split, shear and flexure strength ratios are varying 0.98 to 1.10, 0.96 to 1.08, 0.95 to 1.07 and 0.98 to 1.6 respectively. The models are at most varied about 10%. Hence the proposed models possess the good compatibility with the experimental results.

Table 1: Strength Tests

Sl.No	Chemical Percentage (%)	Compressive Stress (MPa)	Cylinder compressive stress (MPa)	Split tensile stress (MPa)	Shear stress (MPa)	Flexural stress (MPa)
1	00	31.28	24.88	2.31	4.38	4.68
2	05	33.35	27.40	2.51	4.65	5.15
3	10	38.50	33.03	2.89	5.30	5.84
4	15	36.35	29.20	2.60	4.67	5.11
5	20	29.50	22.54	2.16	4.12	4.41

Table 2: Strength results based on model

Sl.No	Chemical Percentage (%)	Cylinder compressive stress (MPa)	Split tensile stress (MPa)	Shear stress (MPa)	Flexural stress (MPa)
1	00	24.40 (1.02)	3.80 (0.99)	4.47 (0.98)	4.64 (1.01)
2	05	26.01 (1.05)	3.90 (1.03)	4.61 (1.01)	4.96 (1.04)
3	10	30.03 (1.10)	4.35 (1.08)	4.96 (1.07)	5.51 (1.06)
4	15	28.35 (1.10)	4.19 (1.01)	4.82 (0.97)	5.01 (1.02)
5	20	23.01 (0.98)	3.66 (0.96)	4.34 (0.95)	4.51 (0.98)
Note: The value in the bracket indicates the strength ratio between experimental to regression model					

VII.CONCLUSIONS

1. The optimum dosage of Bisfinol-A is noticed as 10% to evaluate the compressive, split, shear and flexural strengths
2. The percentage of increase compressive strength with optimum dosage is about 23.10% when compared with the mix without epoxy polymer.
3. The split, shear and flexural strengths are increased by 25.10, 21.00 and 24.78% at optimum dosage, when compared with mix of without polymer.
4. Few regression model are deduced for all the strengths with respect to cube compressive strength and observed that, the models are providing satisfactory results.

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