

# Performance of Bonding Agents by Retrofitting in M30 Concrete

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**Abstract**— The phenomenon of ageing, exposure to severe environment, effect of natural disasters, column failure etc. results in deterioration of structures. It is economically infeasible to replace the deteriorated parts of the structure, but we can retrofit them. The cube and cylinder concrete samples were taken for the experimental investigation program for analyzing the retrofitting techniques and the bonding agents. The bonding agents that were used in the test procedure are multipurpose epoxy concrete 1414 and thixotropic EmacoS88c. The tests that were opted on these concrete specimens are compressive and tensile strength test for the period of 7 to 28 days. After analyzing the test results it is concluded that the multipurpose epoxy concrete 1414 performs better than thixotropic.

**Index Terms**— specimens, epoxy, thixotropic, retrofit, deterioration

## I. INTRODUCTION

There are many reasons that require us to retrofit the existing structures like poor maintenance, increased external loading and natural calamities. The term retrofit implies the strengthening process by using bonding agents.

The rebuilding and seismic retrofitting helps in rubble removal, temporary residence building and first aid activities.

### MIX PROPORTION TAKEN FOR M30 CONCRETE

Water	Cement	Fine aggregate	Coarse aggregate
214.24	571	649	1403
0.375	1	1.1	2.3

Mix ratio = 0.375: 1: 1.1: 2

#### A. Ferro Cement:

Ferro cement consists of wire meshes and cement mortar applied over the layer of metal mesh with closely spaced fine steel rods

#### B. Grout and epoxy injection

Epoxy grouting is preferred due to the property of quick setting, very low shrinkage, high strength and good resistance to chemicals. Main aim is to fill the voids and cracks.

## II. EXPERIMENTAL WORKS AND TEST RESULTS

### A. Materials used:

1. PPC grade 53(cement)
2. River sand (sand)
3. 20mm(coarse-aggregate)

### B. Bonding agents

1. Epoxy concrete 1414 (BA1)
2. Thixotropic EmacoS88c (BA2)

### C. Experimental work

7, 28 days cube and cylinder specimens Compressive and Tensile strength

- Cube mould is of 150\*150\*150mm and a mild steel sheet of 1mm thickness is kept in-between and the cylinder mould size 100\*200 mm
- Half of the mould is filled with concrete and allowed to cure at room temperature for a day. The next day mild steel sheet is taken out and the concrete surface is coated with a bonding agent and the other portion is filled with concrete of same grade. After 7 & 28 days of curing it is tested and result is analyzed.

TABLE I  
TEST RESULTS OF ORDINARY CUBE AND CYLINDER AT 7 DAYS

DAYS	ORDINARY CUBE (N/mm <sup>2</sup> )		ORDINARY CYLINDER (N/mm <sup>2</sup> )	
	COMP (N/mm <sup>2</sup> )	TENSILE (N/mm <sup>2</sup> )	COMP (N/mm <sup>2</sup> )	TENSILE (N/mm <sup>2</sup> )
7	11.55	8.06	6.23	2.52
7	12.23	7.92	5.25	2.05
7	12.04	6.98	5.51	2.2
AVG (N/mm <sup>2</sup> )	11.94	7.65	5.66	2.26

TABLE II  
TESTED RESULTS OF ORDINARY CUBE AND CYLINDER (28 DAYS)

DAYS	ORDINARY CUBE		ORDINARY CYLINDER	
	COMP (N/mm <sup>2</sup> )	TENSILE (N/mm <sup>2</sup> )	COMP (N/mm <sup>2</sup> )	TENSILE (N/mm <sup>2</sup> )
28	36.22	17.5	18.88	7.63
28	37.11	20.8	15.9	6.98
28	36.5	18.9	16.7	6.55
AVG (N/mm <sup>2</sup> )	36.61	19.06	17.16	7.05

TABLE III  
TESTED RESULTS OF ORDINARY CUBE AND CYLINDER (28 DAYS)

DAYS	RESIN	TENSILE (N/mm <sup>2</sup> )	COMP (N/mm <sup>2</sup> )
28	EPOXY(CONCRE SSIVE 1414)	24.44	39.2
28		24	39.6
28		22.8	38.7
AVG (N/mm <sup>2</sup> )		23.74	39.17
7	EPOXY(CONCRE SSIVE 1414)		
7		6.86	13.05
7		6.15	12.2
AVG (N/mm <sup>2</sup> )		6.26	12.58

TABLE IV  
TEST RESULTS OF CUBE USING THIXOTROPIC BONDING AGENT

DAYS	RESIN	TENSILE	COMP
		(N/mm <sup>2</sup> )	(N/mm <sup>2</sup> )
28	THIXOTROPIC	20.44	36.5
28		18.89	37.2
28		18.56	37.63
AVG (N/mm <sup>2</sup> )		19.3	37.78
7	THIXOTROPIC		
7		6.1	12.98
AVG (N/mm <sup>2</sup> )		6.15	12.31

III. CRACK ANALYSIS

The retrofitted cube the crack occurs only at the edge portion because the bonding agents do not allow cracking in centre. Where as in ordinary cube cracks occur at the centres .



Fig.1. Crack analysis on cube

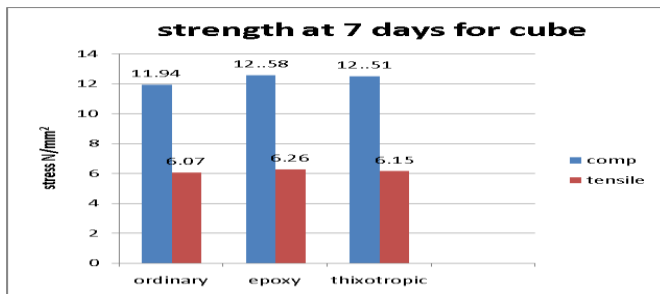


Fig.2 Strength at 7 days for cube

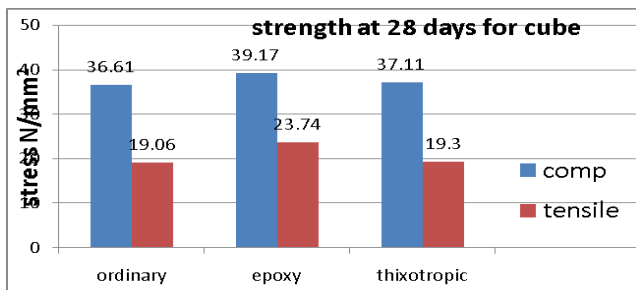


Fig.3. Strength at 28 days for cube

TABLE V  
TESTED RESULTS OF CYLINDER USING THIXOTROPIC BONDING AGENT:

DAYS	RESIN	TENSILE (N/mm <sup>2</sup> )	COMP (N/mm <sup>2</sup> )
28	EPOXY(CONCRESSIVE 1414)	10.85	20.82
28		12.04	22.25
28		11.65	19.18
AVG (N/mm <sup>2</sup> )		11.85	20.75
7	EPOXY(CONCRESSIVE 1414)	3.62	6.2
7		4.66	7.02
7		2.54	6.56
AVG (N/mm <sup>2</sup> )		3.61	6.59
DAYS	RESIN	TENSILE (N/mm <sup>2</sup> )	COMP (N/mm <sup>2</sup> )
28	THIXOTROPIC	8.91	18.96
28		7.01	19.11
28		8.56	18.45
AVG (N/mm <sup>2</sup> )		8.16	18.84
7	THIXOTROPIC	2.3	6.95
7		3.35	7.1
7		2.32	5.87
AVG (N/mm <sup>2</sup> )		2.66	6.64

CRACK ANALYSIS

In retrofitted cylinder the crack occurs at the ends, due to the application of the bonding agent in the centre. But cylinders with no bonding agents, the cracks occur at the centre.



Fig.3. Crack analysis on cylinder

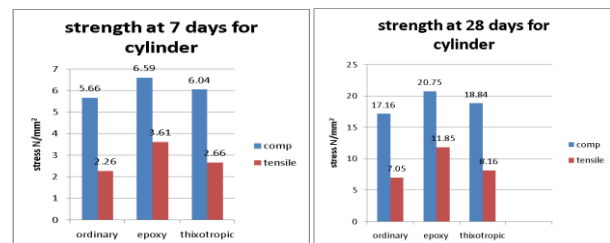


Fig.4. Bar graph of strength at 7 and 28 days for cylinder

#### IV. CONCLUSION

On basis of the literature study, the following experimental works were decided and performed well. The aim is to analyze the performance and investigate the use of bonding agents. From the results it is concluded that multipurpose epoxy (Concresive1414) bonding agent performed well when compared to thixotropic (EmacoS88C) in producing good adherence of new concrete to the old concrete. We finally conclude that multipurpose epoxy (Concresive1414) is more efficient for use.

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