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AN EXPERIMENTAL STUDY ON STRENGTHENING OF REINFORCED CONCRETE BEAMS USING MINERAL BASED COMPOSITE

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ABSTRACT

The concrete is one of the most important construction materials for structures. There is a need for repairing and rehabilitation to strengthen the structures. Strengthening concrete structures is retrofitting. The retrofitting is done by wrapping and strengthening the concrete surface by Glass Fiber Reinforced Polymer sheet (GFRP) using binders. This paper presents the study of flexure deficient, shear deficient and retrofitted preloaded reinforced concrete beams. Retrofitting is carried out by binding U-wrapped GFRP sheet in Flexure and U-wrapped inclined strips in shear region. binder are used namely epoxy and cementitious composites. Epoxies have a good bonding capacity and also good approach to strengthen the structures, but have some disadvantages in the form of incompatibilities with the base concrete. Mineral based composites are being used. The results focused are ultimate load, maximum deflection and crack pattern of control, flexure deficient, shear deficient and preloaded retrofitted beams. From the result, concluded that the load carrying capacity is enhanced in retrofitted beams. In retrofitted shear deficient beams brittle type of shear failure mode is shifted to ductile flexure failure with the development of flexure cracks. It is also inferred that the ultimate load taken by the preloaded FRP wrapped eams are more as compared to control beam.

KEYWORDS: GFRP, EPOXY, METAKAOLIN, FRP,

INTRODUCTION

The aim of the present study is to investigate the behavior of retrofitted reinforced concrete beams. In this, the retrofitting was done by wrapping glass fibre reinforced polymer sheet using epoxy and MBC as binding agent. In this flexure and shear failure were considered and it is strengthened by retrofitting. The result was focused on ultimate load, maximum deflection, maximum bending moment and crack pattern of concrete elements.MBC (Mineral based composites) is defined as a system in which a FRP grid is applied on the surface of the structure to be strengthened with cement based mortar as a bonding matrix. The mineral-based composites can be divided into two main components, namely binder and fibre composite.Introducing an efficient retrofitting technique to strengthen the beam in flexure and shear failure by altering the pattern of the FRP sheets and the binding agent to Make it economical and environmentally viable.

MATERIAL USED

Physical properties of cement:

S. No	Property	Test Results
1	Normal consistency	30 %
2	Specific gravity	3.15
3	Setting time Initial setting time Final setting time	 35 min 230 min
4	Fineness of cement (IS sieve no.9)	4.0%

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5	Compressive strength 1:3 sand mortar cubes At 7 days At 28 days	35 Mpa 53 Mpa

FINE AGGREGATE:

Sand used for the experimental program was locally procured and conformed to Indian Standard Specifications IS: 383-1970. The sand was first sieved through BIS 4.75 mm sieve to remove any particles greater than 4.75mm and then was washed to remove the dust. Fine aggregate was tested as per IS 2386-1963. The fine aggregate belongs to grading zone II.

Properties of Fine Aggregate

S.No.	Properties	Observed value
1	Fineness modulus	3.24
2	Specific gravity	2.64
3	Water absorption	Nil

COARSE AGGREGATE:

The material which was retained on BIS test sieve 4.75mm was termed as coarse aggregate. The broken stone is generally used as a coarse aggregate. Locally available coarse aggregate having the maximum size of 20 mm was used in the work. The aggregate was washed to remove dust and dirt and was dried to surface dry condition. The aggregate was tested as per Indian Standard Specifications IS: 2386-1963

Properties of Coarse aggregate

S.NO	PROPERTIES	OBSERVED VALUE
1	Fineness modulus	6.78
2	Fineness modulus	2.60

METAKAOLIN:

Metakaolin is a clay mineral kaolinite. It is small when compared to cement. The quality and reactivity of strongly dependent of the characteristics of the raw material used. High-reactivity metakaolin is a highly processed reactive alumino silicate pozzolana, a finely-divided material that reacts with slaked lime at ordinary temperature and in the presence of moisture to form strong slow-hardeningcement. It is formed by generally between 650–700°C in an externally fired rotary kiln.

Properties of Metakaolin

S.No.	Properties	Observed value
1	colour	Off-white powter
2	Specific gravity	2.5
3	Particle size	1.5

SUPER PLASTICIZERS:

It is also known as high range water reducers, are chemicals used as admixtures where well-dispersed particle suspensions are required. These polymers are used as dispersants to avoid particle aggregation, and to improve the flow characteristics of suspensions such as in concrete applications.

Properties of Super plasticizers

S.NO	properties	observed value
1	Colour	Light brown liquid
2	Specific gravity	1.08
3	pH	>6

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VISCOSITY MODIFYING AGENT:

Properties of VMA

S.No	properties	Observed value
1	Colour	Colourless Liquid
2	Specific gravity	1.01
3	Chloride ion content	< 2%

MIX DESIGN:

DATA:

Characteristic compressive strength required = 30 MPa
Maximum size of aggregate = 20 mm
Degree of workability = 0.80
Degree of quality control = Good
Type of exposure = Mild
Specific gravity of
Cement = 3.15
Coarse aggregate = 2.60
Fine aggregate = 2.64
Entrapped air = 2.00%

MIX PROPORTION:

Water	Cement	Fine Aggregate	Coarse Aggregate
186 Kg/m^3	502.7 Kg/m^3	482.32 Kg/m^3	1172.67 Kg/m^3
0.37	1	0.96	2.33

TESTING OF SPECIMEN

Compressive Strength of Wrapping Cylinders

S.No		cylinder specimen	Load(KN)		Compresive (N/mm2)	strength
		150mm*300mm	Epoxy	MBC	Epoxy	MBC
			(28 days)	(28 Days)	(28 days)	(28 Days)
1		Control	425.05	365.23	24.22	20.67
2	Control w	ith single wrapping	712.1	512	40.29	2.97
3	control with double wrapping		1148.043	857.11	64.96	48.5
4	1st crack with single wrapping		425.29	313.6	24.07	17.76
5	1st crack with double wrapping		564.6	365.69	31.9	20.69
6	Failure with single wrapping		368.54	276.187	20.85	15.62
7	Failure with double wrapping		413.6	326.69	23.4	18.48

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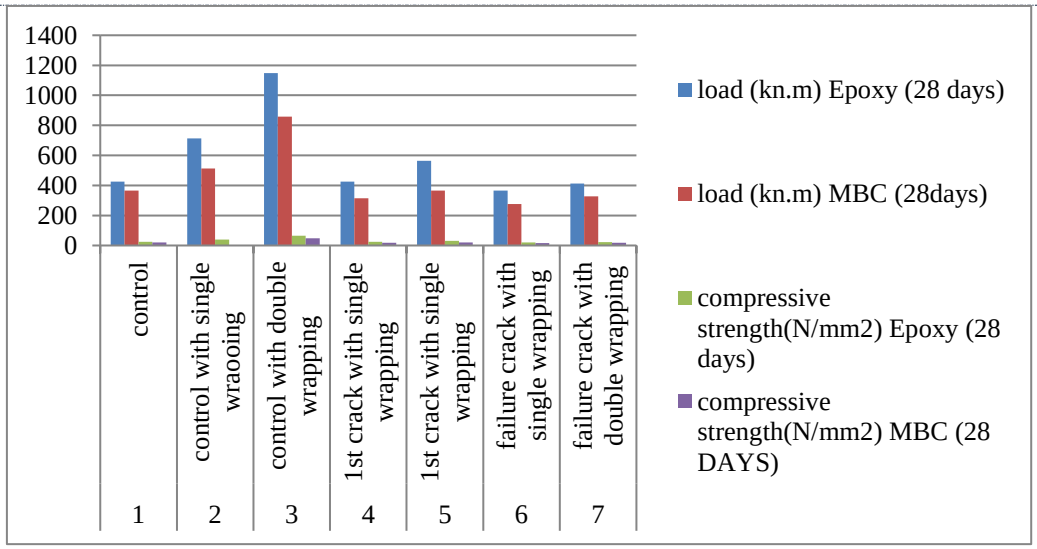

Combined of control with single and double wrap,1st crack with single wrap,2nd crack with double wrap,failure with single wrap and failure with double wrap

DESIGN ON REINFORCED CONCRETE BEAMS

Load Carried By the Flexure Deficient Beam

Specimen	Strengthening	Bonding Agent	Peak load Before Retrofitting (kN)	First cracking sound (kN)	Peak load After Retrofitting (kN)	Maxi Bending Moment (kN.m)
RFDFCE	1 layer of UWrapped	Epoxy	28.5	40.58	58.45	11.69
RFCULE	1 layer of UWrapped	Epoxy	35.15	30.3	54.6	10.54
RFDFCM	2 layer of UWrapped	MBC	24.95	24.2	46.2	8.68
RFCULM	2 layer of UWrapped	MBC	32.25	28.5	40.35	8.04

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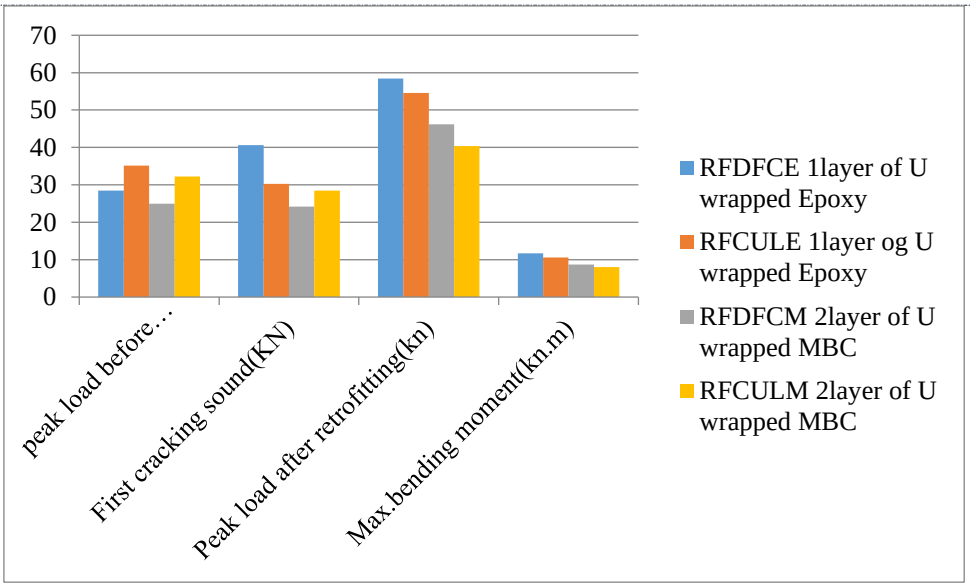
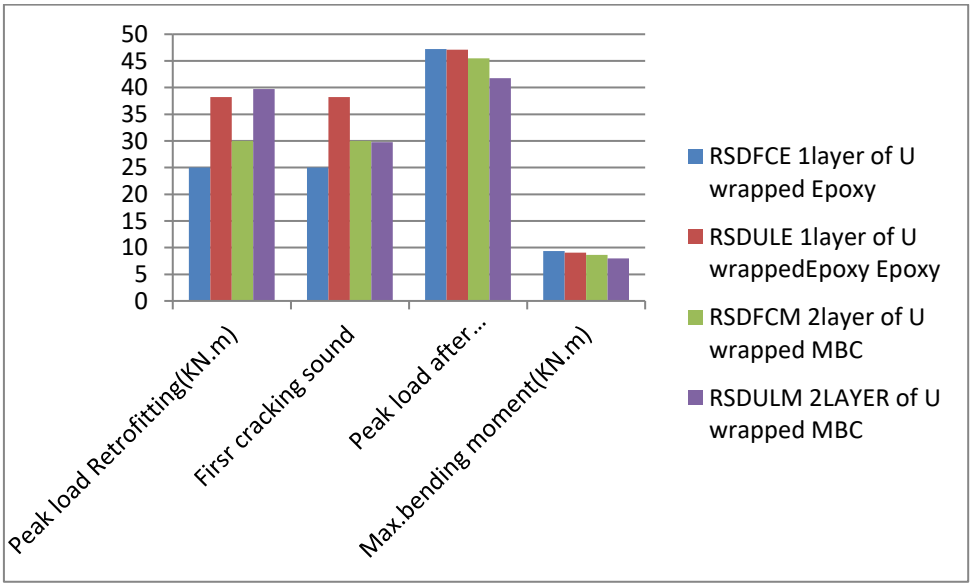


load deflection curve for flexure deficient beam

Load Carried By Shear Deficient Beam

Specimen	Strengthening	Bonding Agent	Peak load Before Retrofitting (kN)	First cracking sound	Peak load After Retrofitting (kN)	Maxi Bending Moment (kN.m)
RSDFCE	1 layer of UWrapped	Epoxy	25	25	47.25	9.36
RSDULE	1 layer of UWrapped	1 layer of UWrapped	38.2	38.2	47.1	9.05
RSDFCM	2 layer of UWrapped	MBC	30	30	45.5	8.65
RSDULM	2 layer of UWrapped	MBC	39.75	29.75	41.75	7.95



LOAD DEFLECTION CURVE FOR SHEAR DEFICIENT BEAM

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CONCLUSION

The work has been carried out for a wrapping and strengthening of concrete surface with Glass fibre sheet using cementitious composites as a binder and it is compared with Epoxy binders. The maximum load, deflection results were observed and load deflection curve of beams were plotted.

Beam members are made flexure deficient by reducing area of steel in tension zone. Beam members are made shear deficient by providing insufficient stirrups. Beams are preloaded upto first few cracks and ultimate load. Preloaded beams are repaired for cracks using polymer mortar and cured.The cured specimens are retrofitted with glass fibre sheets using Epoxy and MBC as binder. The cured beams are tested upto failure. From the result, it is concluded that retrofitting in flexure using MBC as binders increases the ultimate load and delamination is noted in flexure deficient beams. In retrofitted shear deficient beams using MBC as binders, load carrying capacity is enhanced and the brittle type of shear failure mode is shifted to ductile flexure failure with the development of flexure cracks and no delamination is noted. Therefore, MBC can be effectively used as a binder in retrofitting of concrete members.

REFERNCES

[1] Alaee, F. J., and Karihaloo, B. L. 2003. “Retrofitting of reinforced concrete beams with CARDIFRC.” J. Compos. Constr., (73), 174–186.
[2] Blanksvard, T. 2007. “Strengthening of concrete structures by the use of mineral based composites.” Licentiate thesis, Lulea University of Technology, Lulea, Sweden.
[3] Holmgren, J. 2003. “Cementitious composites reinforced with continuouscarbon fibres for strengthening of concrete structures”. Cement and Concrete Composites, 25(3), 387-394.
[4] Stephen Kurtz and P. Balaguru 2001. Fiber Reinforced Cementitious5Matrix Composites for Infrastructure Rehabilitation. Composites & Polycon USA., (127),35–42.
[5] IS: 10262-1982, “Indian Standard Code of Practice for recommended guidelines for Concrete Mix Design”.
[6] IS: 456-2000, “Indian Standard Code of Practice for Plain and Reinforced concrerte
[7] Ohama, Y. 1998. “Polymer-based admixtures”. Cement and Concrete Composites, 20(2), 189-212.
[8] Taljsten, B., & Blanksvard, T. 2007. “Mineral based bonding of carbon FRP to strengthen concrete structures”. Composites for Construction, 11(2), 120-128.
[9] Siavash hashemi and Riadh al-mahaidi., 2008. Cement based bonding material for FRP, IIBC, 30-36.
[10] Bournas. D.A and Triantafillou. T.C. 2008. Innovative seismic retrofitting of old-type RC columns through jacketing: textile-reinforced mortars (TRM) versus fiber-reinforced polymers (FRP), The 14th World Conference on Earthquake Engineering, Beijing, China,1-8.
[11] Francisco J. De Caso Basalo, Fabio Matta and Antonio Nanni., 2009.Fiber Reinforced Cementitious Matrix Composites for Infrastructure Rehabilitation. Composites & Polycon USA, 1–12.