Strengthening of Blended Concrete Beam Using GFRP Sheets

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Abstract - *Now a day it is common observation that structures are not able to give service as additional as they are expected as per design. This is because of conflict of the concrete and steel in concrete cause by environmental factors or due to more given load. The manufacture of portland cement devource considerable energy and at same time gives vast volume of carbon dioxide which cause global warming issue. So, there are situation in which a civil structure will require retrofittig and replacement for cement that is blended concrete due to lack of strength. This paper study the reasonableness of glass fiber reinforced polymer (GFRP) sheets in strengthening of blended concrete RC beam, fly ash used RC beam, and GGBS used RC beam under flexure. Experimental results study the load-deflection analysis and GFRP debonding of the beams increases with GFRP sheets wrapping. Total 63 beam (150×150×700 mm) specimens of M25 grade concrete was cast, out of that 21 beams are without GFRP wrapping, 21 beams are wrapped with bottom GFRP sheets and 21 beams are wrapped with U shape GFRP strips.*

Key Words: **Blended Concrete, GFRP, fly ash Beam, GGBS Beam, Control Beam**

1. INTRODUCTION

In this research work total sixty three reinforced rectangular beams will be casted using M25 grade of concrete. This research work mainly focus on GFRP sheets wrapped on blended concrete, fly ash and GGBS used concrete beams.

1.1 Blended Concrete

The manufacture of portland cement devource considerable energy and at the same time gives a vast volume of carbon dioxide to the air. The weather change due to dangerous atmospheric devation is turned into a noteworthy issue The a worldwide temperature alteration is caused by the release of ozone depleting substances, for example, carbon dioxide (co2), to the air by human activities. The cement industry is responsible for some of the co_2 emissions, in light of the fact that the creation of one ton of portland concrete radiates roughly one ton of co2 into the air. However, cement is still the main binder in concrete construction prompting a search for more environmentally friendly materials. A few endeavors are in advance to supplement the utilization of portland cement in concrete so as to address the a dangerous atmospheric devation issues.

1.1 Strengthening

In recent years repair and retrofit of existing structures such as buildings, bridges, etc., have been amongst the most important challenges in civil engineering. The essential purpose behind reinforcing of structures incorporates redesigning of its protection from withstand under evaluated loads, increment in the heap conveying limit with regards to higher allow loads, wiping out untimely disappointment because of insufficient enumerating, rebuilding of lost in stack conveying limit because of consumption and increment in corruption of structure with age. The method of strengthening reinforced concrete structures by remotely reinforced GFRP fabric was begun in 1980s and has since pulled in analysts around the globe. Strengthening with externally bonded GFRP fabric has appeared pertinent to numerous sorts of structures. now, this technic has used to strengthen such structures as column, beams, walls, slabs, etc. The use of external GFRP reinforcement may be classified as flexural strengthening, improving the ductility of compression members, and shear strengthening.

2. EXPERIMENTAL PROGRAMME

The existing literature on use of FRP as a retrofit material for strengthening of different structural components with special emphasis on fly ash used concrete, GGBS used concrete.

A mix design of M25 grade concrete will adopted to cast the beams in accordance with the IS: 10262-2009 [17]. First, the trial cubes will cast and then test after 28 days curing to determine their respective strength. From the results of compressive strength of cubes the final mix design will adopt.

A total of 63 Reinforced beams will cast with final mix proportion. Out of 63 beams 21 beams are without GFRP sheets, 21 beams are U shape strips GFRP wrapping and 21 beams are bottom GFRP wrapping.

All beams will test for flexural loading.

Experimental program will carried out in two phases. First phase of experiment will to determine the compressive strength of the cubes for trial concrete mixes, and the second phase of experiment will to determine the flexural strength of control beams and then check the enhanced strength of the beam after strengthening them with varying GFRP.

Table -1: Replacement Level for Fly Ash Used Concrete

Fly ash (%)	Cement (%)
0	100
50	50
60	40

Table -2: Replacement Level for GGBS Used Concrete

GGBS (%)	Cement (%)
0	100
50	50
60	40

Table -3: Replacement Level for Blended Concrete

Fly ash (%)	GGBS (%)	Cement (%)
0	0	100
20	30	50
30	30	40

3. MATERIAL USED

3.1 Glass fibre reinforced polymer

It is composed of fibre and matrix, which are bonded at interface. . Every one of these diverse stages needs to play out its required capacity. They are generally utilized for fortifying of common structures. There are numerous preferences of utilizing FRP is lightweight, great mechanical properties, erosion safe, amazing protecting properties, and so forth. Glass Fiber Reinforced Polymers were among the most seasoned and minimum costly of every single composite material. The GFRP fabrics used in the experimental program was procured from **Vishakha enterprises, Pune.**

Table -4: Properties of GFRP

Young's modulus of elasticity	75900 N/mm^2
Specific gravity of fibre	2.56
Tensile strength	2060 MPa
Effective fibre sheet thickness	0.43
Elongation at break	0.04

3.2 Epoxy resin

The most commonly used polymeric resin for strengthening is epoxy resin. The extensive use of epoxy is due for the excellent mechanical properties in the composites and high hot and wet strength properties. ***Goldbond 1893 primer and saturant system*** was used for the strengthening scheme of experimental work. It is a two part specialty epoxy system comprising of a primer part and a saturant part. Goldbond 1893 Primer is comprised of a base and curing agent. Goldbond 1893 Saturant is also comprised of a base and curing agent.

Table -4: Properties of Epoxy Resin

Specific gravity	1.2
Modulus of elasticity (Gpa)	2.6
Tensile strength (Mpa)	35-130
Compressive strength (Mpa)	100-200
Elongation	1-8.5
Poison ratio	0.37

3.3 Fly ash

Fly ash (FA) a side-effect of the burning of pummeled coal in warm power plants. It is a fine grained, fine and shiny particulate material that is gathered from the fumes gases by electrostatic precipitators or sack channels. At the point when Pulverized coal is singed to produce warm, the deposit contains 80 percent for every fly ash and 20 percent for bottom ash.

3.4 Ground granulated blast furnace slag

Ground granulated blast furnace slag (GGBS) is a result from the impact heaters (blast furnace) used to make iron. These work at a temperature of around 1,500 degrees and are nourished with a precisely controlled blend of iron-mineral, coke and limestone. The iron mineral is lessened to iron and the rest of the materials frame a slag that buoys over the iron. GGBS replaces something that is created by an exceedingly vitality concentrated process By correlation with Portland bond, fabricate of GGBS requires Less than a fifth the vitality and delivers not as much as a fifteenth of the carbon dioxide outflows.

3.5 Steel

The steel used for reinforcement confirmed to IS: 432-1982. Maximum carbon content is 0.3% and yield strength is 500 Mpa while ultimate tensile strength of steel is 545 Mpa. Minimum value of ultimate stress ration, which is the ratio of ultimate tensile strength to yield strength, is 1.08 and minimum % elongation of steel is 12%.

4. EXPERIMENTAL SET UP

All 63 beams were tested uniformly one by one under universal testing machine.

Table -5: Mix Proportion For M25 Grade Concrete

Descripsion	Cement	Fine Agg.	Coarse Agg.		Water
			20 mm	10 mm	
Quantities of materials in kg/m^3	413.33	762.98	725.72	398.03	186
Mix proportion	1	1.84	2.71		0.45

4.1 Specimen preparation

The total 63 RC beams were casted that were reinforced with minimum conventional longitudinal and transverse steel as per the IS 456:2000 provision. The beam specimens consisted of size 150 mm x 150 mm x 700 mm long. By minimum reinforcement criteria the longitudinal reinforcement is 8 mm dia. 2 bars and transverse reinforcement is 6 mm dia. bar at 100 mm c/c spacing for holding stirrups 8 mm dia. 2 anchor bars are used.

4.2 Beam Designation System

An identification system consists of five characters which were employed to put a unique name for each confined beam. The first character identifies the beam is controlled, fly ash used, GGBS used or blended concrete followed for the beam. For example,

1. The first alphabet C stands for Controlled, F stands for fly ash used, G stands for GGBS used and B stands for blended concrete.
2. The second alphabet B stands for Beam.
3. The third alphabet W stands for without wrapping, B stands for bottom wrapping and U stands for U strips wrapping.
4. The fourth digit that is number 1,2,3,4,5,6,7,8,9 etc. indicates the number of beam.
5. Last digit indicates percentage of fly ash, GGBS and cement. For example I for fly ash or GGBS =50% & cement=50%, II for fly ash or GGBS=60% & cement=40%, III for fly ash=20%, GGBS=30% & cement=50% and IV for fly ash=30%, GGBS=30% & cement=40%.
6. Example

1. CBW1= controlled beam without wrapping beam no.1
2. FBW1-I= Fly ash used RC beam without wrapping beam no. 1 in which fly ash=50% and cement=50%.
3. GBW1-I= GGBS used RC beam without wrapping beam no. 1 in which GGBS=50% and cement=50%.
4. FBW1-II= Fly ash used RC beam without wrapping beam no. 1 in which fly ash=60% and cement=40%.
5. GBW1-II= GGBS used RC beam without wrapping beam no. 1 in which GGBS=60% and cement=40%.
6. BBW1-III= blended concrete RC beam without wrapping beam no. 1 in which fly ash=20%, GGBS=30% and cement=50%.
7. BBW1-IV= blended concrete used RC beam without wrapping beam no. 1 in which fly ash=30%, GGBS=30% and cement=40%.

5. RESULT

In this experimental program, the behaviour of the beams strengthened with GFRP is investigated. The beams were tested till failure in flexural bending. In this chapter the experimental results of all the beams with layers of GFRP are interpreted. Their behaviour throughout the test is described using data on the load carrying capacity.

Table -6: Load Data for Controlled Beam

Beam designation	Average load in kN	
	Service load	Ultimate load
CBW	55.46	68.33
CBB	56.23	73.33
CBU	52.76	69.06

Table -7: Load Data for Fly Ash Used Beam

Beam designation	Average load in kN	
	Service load	Ultimate load
FBW-I	49.73	67.03
FBB-I	51.94	72.06
FBU-I	52.16	67.96
FBW-II	53.53	61.36
FBB-II	54.03	69.43
FBU-II	51.76	65.03

Table -6: Load Data for GGBS used Beam

Beam designation	Average load in kN	
	Service load	Ultimate load
GBW-I	54.76	75.66
GBB-I	55.90	88.06
GBU-I	57.20	86.86
GBW-II	56.53	74.63
GBB-II	53.30	94.06
GBU-II	56.86	87.73

Table -7: Load Data for Blended Concrete Beam

Beam designation	Average load in Kn	
	Service load	Ultimate load
BBW-III	56.03	71.96
BBB-III	58.13	80.00
BBU-III	54.70	75.56
BBW-IV	55.83	71.06
BBB-IV	57.37	77.93
BBU-IV	58.06	73.53

6. CONCLUSIONS

1. The load carrying capacity of all the strengthen beams were enhanced as compared to the control beam.
2. Bottom wrapping of GFRP sheets takes more load than U strips GFRP sheets and without wrapping.
3. The load carrying capacity of GGBS used concrete beams is more than fly ash used beams.
4. Blended concrete RC beam takes more load than fly ash used concrete and controlled RC beams.

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