Volume : 1 | Issue : 5 | Oct 2012 • ISSN No 2277 - 8160

Research Paper | Engineering

Strengthening of structures using with Glass Fiber Reinforced Polymer Sheet

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ABSTRACT

The use of externally bonded fibre reinforced polymer sheet and strips has recently been effective as an effective tool for rehabilitating and strengthening reinforced concrete columns.This technology is efficient in improving flexural stiffness and strength as well as seismic response.

Fiber reinforced polymer (FRP) composites can be considered a new class of construction material when comparedwith classical materials such as steel, concrete, timber and masonry. The relatively recent and growing interest in FRP in the domain of structural engineering can be traced to its advantageous properties ranging from a very high strengthto- weight ratio, electromagnetic neutrality, excellent fatigue behaviour, to superior durability including corrosion resistance. These properties have, in turn, lead to a broad spectrum of application that can be divided into two general categories: all-FRP members or structures in new construction or in the replacement of existing structural elements, and FRP components in the repair and rehabilitation of damaged or deteriorating structures.

The mix design was carried out for M30 grade concrete as per IS: 10262-2009 which yielded a proportion of 1:1.86: 2.41 with a w/c ratio of 0.45. Cylinders were cast to find compressive &tensile strength. It was found that both compressive & tensile strength increases by wrapping with GRPF sheet.

KEYWORDS: Rehabilitation, repair, strengthen, wrapping, deterioration, glass fiber Reinforced polymer sheet

Introduction

Rehabilitation means to restore. For Civil engineering projects, it is mainly associated with restoring its strength & functionality. Rehabilitation helps to repair it and extend its safe usable life. If proper precaution has been taken then a repaired building can show same strength as the new building. It is economic to repair the building rather than build a new one in most of the cases. Thus Rehabilitation is widely practiced now-a-days. From the range of different techniques used for Rehabilitation in this experimental investigation we have used FRP laminates to strengthen the samples after failure. Fiber-reinforced polymer (FRP) composite sheets are used to repair and strengthen reinforced concrete structural members, especially beams and columns This technique of wrapping the Laminates around the specimens is believed to be simple, does not require excessive labor and does not change the appearance of the structural members. Many reinforced concrete beams have been tested, demonstrating the feasibility and efficiency of this technology for improving flexural stiffness and strength as well as seismic response. Applications of FRP reinforcement, and guidelines for design and construction of externally bonded FRP systems for upgrading concrete structural elements are reported by ACI Committee 440 (1996, 2001).

Scope of work

- To increase the axial compressive strength of RC columns. To increase the capacity of a section by providing sufficient orientation. To put the damaged element of the structure in the good condition.
- To improve the ability of an existing building to withstand seismic forces arises usually from the evidence of damage and poor behaviour during a recent earthquake.
- To bring back the architectural shape of the building so that all services start working and the functioning of building is resumed quickly.

Causes of deterioration of Structures

The rate of deterioration of structure is influenced by the type of materials used & the type of service loads & environments the structure is exposed to.

Following degrading factors have long term effects on the life of the structure.

-Corrosion due to carbonation & chloride ingress
-Alkali aggregate reaction
-Freeze-thaw action
-Abrasion due to mechanical/ hydraulic/ wind forces.
-Loading pattern

1 Carbonation:

In carbonation, the alkaline compounds of the hydrated cement paste matrix react with penetrating CO2 to form carbonates. Carbonation is not generally harmful for concrete itself, but these reactions are accompanied by a drop of the pH of the concrete pore water. Carbonation and chloride penetration are the initiating factors for corrosion of steel reinforcement in R.C.C.

Fig. 1 Typical Corrosion Area

2 Alkali-Silica Reaction:

Siliceous aggregate reacts chemically with alkalis. It is sodium and potassium originated either from the cement or the additives used in manufacturing the concrete or the environment for example, sea water or groundwater with chlorides used for construction. Although alkali-silica reaction develops only in concrete mixes containing reactive aggregates and sufficiently high concentration of alkalis together, permeability of the concrete governs the rate of degradation because excessive gel formation requires a high mobility of alkali irons as well as of water.

3 Sulphate attack:

Sulphates are carrying into the inner sections of concrete either by ionic diffusion or by capillary absorption of sulphate solution and cause disruptive forces leading to cracking or scaling of the concrete.

4 Acid attack:

The major constituents of the hydrated cement paste matrix and the calcareous aggregates are dissolved by the minerals, acids as well as by organic acids, the latter usually being less aggressive than strong mineral acids. Organic acids originate from the soil which is in contact with the foundation or from fruits and crops stored in silos and bunkers or from oil. However, four natural exposure conditions also the attack of mineral acid occurs, such as natural water with an excessive amount of CO2 forming carbonic acid or as a result of the air pollution, H2SO4 in rain, which then exhibits pH values as low as pH 4. The most common acids to attack concrete are H2SO4 and carbonic acids.

5 Freeze-Thaw Action:
Freezing of water in the pore system of concrete causes pits and delamination of near surface region of concrete sections, if the free pore space is sufficient to accommodate the volume increased due to ice formation.

6 Abrasion due to mechanical/hydraulic wind forces:
Moving vehicles at high speeds over bridges have to stop suddenly, at time, causing abrasion. Hydraulic spillways are subjected to rolling boulders over glacis. Wind containing the dust particles keeps heating standing structures causing deterioration.

7 Loading pattern:
Cyclic repetitive loading can cause fatigue and other effects. Long term effects of land such as creep etc. are also known to cause time dependent deformations.

Objective :
The objective of the practical work is to compare the strength of the specimen before repair and strength of the specimen after repair by wrapping with GRPF sheet.

Experimental programme
The mix design was carried out for M30 grade concrete as per IS: 10262-2009 which yielded a proportion of 1:1.86: 2.41 with a w/c ratio of 0.45. The dosage of superplasticizer used was 0.78% (by weight of cement). In this study, 53 grade OPC was used for the experiments. Coarse aggregates with a maximum size of 12mm having a specific gravity of 2.74 and locally available sand with a specific gravity of 2.67 and falling in Zone-II [9] were used.The cement, sand and coarse aggregates were weighed according to the proportion of 1:1.86: 2.41 and dry mixed. Clean portable water was used both for mixing and curing purpose. The required amount of water was added to this dry mix and intimately mixed.Then the mix was placed layer by layer in the cylindrical moulds to cast the specimens. The specimens were prepared both by hand compaction as well by imparting vibrations through vibrating table. The specimens were finished smooth and kept under wet gunny bags for 24 hours after which they were cured for 28 days.

Average crushing load of specimen are to be found out by testing under compressive &tensile load Then by appling 50% of the crushing load is applied to develop the crack in the specimen. Then specimen is repaired with glass fiber Reinforced polymer sheet by wrapping it as shown in the figure 3

Specification of Glass fiber Reinforced polymer sheet
- G.F.R.P has very high tensile strength. About 1020 to 4080 N/mm2
- G.F.R.P are made up of 2000 to 4000 individual filaments which are lightly bonded to make up a strand .
- We have used 2mm thick G.F.R.P sheet having grade 450 , grade resin, catalyst 3 percent & MEKP accelerator

Observations and discussion.
It is observed that the compressiveload obtained for the sample concrete is found to be 60 tons for average of 3 cylinders.

By applying almost 50% of the crushing load minor cracks were observed . These specimen when wrapped by the GRPF , the compressive load was found to be 98 tons, almost 62% there was increase in strength.

It is observed that the tensile load obtained for the sample concrete is found to be 26 tons for average of 3 cylinders. Now a cylinder with minor cracks obtained by applying almost 50% of the crushing load is wrapped by the GRPF and then the tensile load is found to be 28 tons, almost 7.7% increase in strength.

Conclusion
Thus it can be concluded that the damaged element of the structure can again be brought in the good condition by wrapping with GRPF sheet . Thus the objective of the practical work whichis to compare the strength of the specimen before repair and compressive and tensile strength of the specimen after repair by wrapping with GRPF sheet has increased by about 62% and 7%.

Table 1 Cylinder compressive loadbefore repair

	Tonne
1	58
2	61
3	63
Average	60.66

Fig 2 Compression strength of the specimen before repair

Table 2 Tensile strength of the specimen before repair

Sr No	Tonne
1	23
2	28
3	27
Average	26

Fig 3 Tensile strength of the specimen before repair

Fig 4 Specimen is repaired with glass fiber Reinforced polymer sheet by wrapping

Table 3 Compressive Strength after G.F.R.P. Application

	Tonnes
1	97
2	99
3	99.5
Avg.	98.5

Fig5 Compressive Strength after G.F.R.P. Application

Table 4 Tensile strength of the specimen after repair by wrapping with GRPF sheet

	TONNES
1	28.67
2	27.3
3	27.7
Avg.	**27.89**

Fig6Tensile Strength After G.F.R.P. Application

Table 5 Comparisons the strength of the specimen before repair and strength of the specimen after repair by wrapping with GRPF sheet.

	Original strength (tonnes)	After GFRP (tonnes)
COMPRESSIVE STRENGTH	60.66	98.5
TENSILE STRENGTH	26	27.29

REFERENCES

 Handbook of Repair and Rehabilitation of RCC Buildings, Published by Director General (works), Central Public Works Department, Government of India, Nirman Bhawan. | IS 10262:2009 Concrete Mix Proportioning- Guidelines, By Bureau of Indian Standards |