Study on RC Beams Strengthened with FRP and PCM

Lakshmipriya K P and Anima P

Abstract— Reinforced concrete beams needs to be strengthened when the loads applied to the beams are increased or when the existing steel reinforcement in the beams are insufficient or subjected to corrosion or unsafe. The paper summarizes an experimental investigation on Reinforced Concrete beams strengthened with Glass Fibre Reinforced Polymer (GFRP) sheets and Polymer Cement Mortar (PCM) and comparing it with ordinary RC beam. The ultimate load carrying capacity of the beams were obtained and compared with the control beams.

Index Terms— Glass Fibre Reinforced Polymer (GFRP), Polymer Cement Mortar (PCM), RC Beam, SBR Latex, Strengthening, Two Point Loading, Ultimate Load

1 Introduction

REINFORCED-CONCRETE (RC) structures are subjected to deterioration during their service life. Thus rehabilitation works are often required to restore the performance of these deteriorated structures. Several techniques has been for repairs of deteriorated structures. The use of polymer cement mortar (PCM), fiber-reinforced polymer (FRP) and ultra-high-strength fiber-reinforced concrete (UFC) panels are some among them.

Polymer Cement Mortar (PCM) is a cementitious material having better adhesive strength and resistance to aggressive environments compared to ordinary mortar and concrete as a result of polymerization. PCM overlays are generally used to strengthen structural elements such as bridges, slabs, beams and columns. They are being used as the promising repair material for Reinforced Concrete.

FRP composite materials, has been developed into economically and structurally viable construction materials for load bearing elements in buildings and bridges over the last two decades. Nowadays, there are a wide range of FRP composites available (with polyester, epoxy or vinyl-ester matrices) reinforced with glass, carbon and aramid fibers with suitable properties for different applications in civil and structural engineering. In this paper, studies are made using GFRP in economic point of view.

The main objective of this study is to investigate the behavior of RC beam bottom wrapped with GFRP and strengthened by a layer of Polymer Cement Mortar at the bottom tensile portion and compare with normal RC beam.

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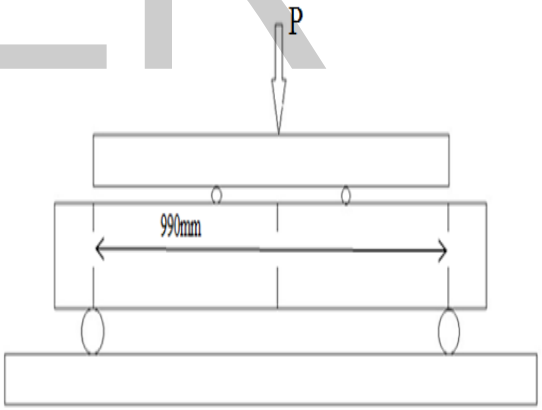
2 Methodology

Reinforced Concrete beams of size 150 mm width, 200 mm depth and 1250 mm length were casted using M25 mix. The beams were designed for flexural failure with 2#12mm bars as the bottom longitudinal reinforcement and 2#8mm bars as the top longitudinal reinforcement. Two legged 8mm stirrups were provided as shear reinforcement at spacing of 130 mm from the supports.

Fig. 1 Schematic Setup for Testing



The beams were subjected to 28 days of water curing. After curing, a set of beams were strengthened with GFRP. GFRP was coated in 8 layers using GP resin and hardener on the bottom surface of the beam. Another set of beams were treated with polymer cement mortar on bottom face. Polymer Cement Moratr was provided at a thickness of 25mm. The cement- fine aggregate ratio was taken as 1:2 and polymer-cement ratio was taken as 0.15. SBR Latex was used as the polymer. The water cement ratio for Polymer Cement Mortar was taken as 0.5.

The beams were further subjected to air curing for 24 hrs and then tested.

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Fig. 2 Beams Treated with GFRP and PCM

3 Results

The modes of failure of beams bottom wrapped with GFRP and bottom treated with polymer cement mortar are shown in fig. 3 and fig. 4 respectively.

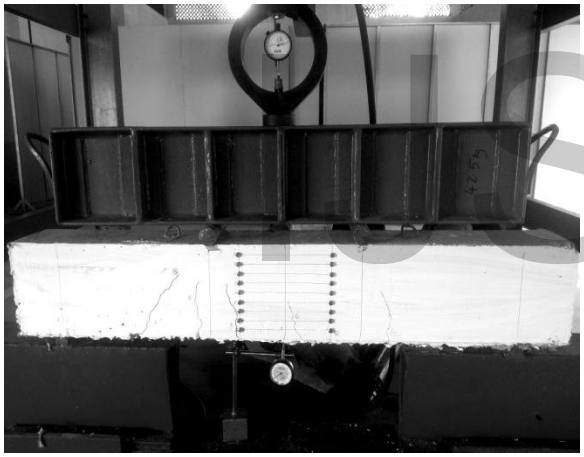

Fig. 3 Failure of Beam Wrapped with GFRP

Fig. 4 Failure of Beam Treated with PCM

The beams which were bottom wrapped with GFRP, the mode of failure was found to be flexural. It was also observed that the length of cracks increased with the increase in load.

The beams which were treated with polymer cement mortar developed only the flexural cracks. The failure was through debonding at the interface of concrete and polymer cement mortar at the support.

4 Discussion

The ultimate loading carrying capacity of control specimen was obtained as 147.15 kN. The ultimate load carrying capacity of beams bottom wrapped with GFRP was obtained as 225.63 kN and that with PCM treatment was obtained as 176.58 kN; both higher than that of the normal RC beam.

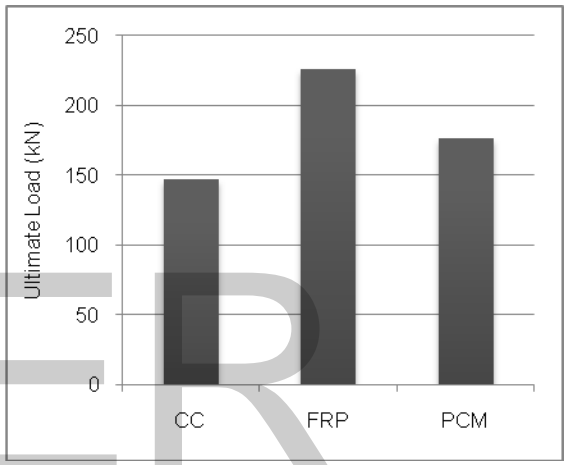

Fig. 5 Ultimate Load Carrying Capacity

5 Conclusions

The research work included the testing of reinforced concrete beams, each having a span of 1250 mm and strengthened in flexure using GFRP and polymer cement mortar. Based on the research, the following conclusions may be drawn

1. The strengthening of RC beams using GFRP increases the load carrying capacity by 53% when compared to control beams.
2. RC beams treated with polymer cement mortar on the tensile portion and subjected to loading after 24 hours also shows an increase the ultimate load carrying capacity (by 20%); but to smaller extend compared with GFRP.
3. The beams strengthened with GFRP failed in flexure.
4. The mode of failure for beams treated with polymer cement mortar was by debonding at the interface rather than by flexure or shear

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