Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte

Band: 79 (1998)

Artikel: Aramid fibers used for bridge repair and strengthening

Autor: Salvaverria, Jorge H. / Casas, Joan R.

DOI: https://doi.org/10.5169/seals-59893

Aramid Fibers Used for Bridge Repair and Strengthening

Jorge H. SALAVERRIA
Research Assistant
Techn. Univ. of Catalunya
Barcelona, Spain

Joan R. CASAS
Prof.
Techn. Univ. of Catalunya
Barcelona, Spain

Summary

The paper presents the experimental tests designed to improve the existing techniques of bridge repair by the combination of external prestressing and aramid fibers (AFRP). The external prestressing substitutes the damaged prestressing steel and aramid strips will play, in the repaired bridge, the role of the corroded reinforcing steel. The first phase comprises the study of the bond characteristics of the composite when applied to a concrete surface considering different epoxi adhesive and placement. The sechond phase consists on the strengthening in shear and bending of a two span (7m + 7m) continuous prestressed concrete box-girder model previously damaged. The original beam was firstly loaded ocurring an important damage. After load removing, the beam is repaired and strengthened using AFRP and loaded again up to failure to compare the ultimate capacity.

1. SCOPE OF THE EXPERIMENTAL TESTS

The experimental work comprises two phases. In phase one the objective is to develop a theoretical model of the interface aramid-adhesive-concrete. To this end, a set of concrete-aramid specimens are considered. In the bottom face of the specimens a strip of aramid is glued using different adhesives and different preparation of the concrete and fiber surface before bonding. With the correct surface preparation before bonding and the most appropiate properties of the adhesive with the composite, the tension in the interfarce is increased to 3.5 MPa; this value is approximatelly the concrete tensile strength. Good bonding properties were obtained in the dynamic tests too, where the specimens resist more than 2 million cycles of a 2 Hz armonic force without debonding of the aramid strip. The force amplitude ranges from 0.3 to 0.7 of the failure load measured in the static tests.

Tests in the undamaged beam. The beam V1 is loaded up to failure. The two loads(Q) are only applied in one of the spans (Figure 1). During the test to failure different variables are continuosly monitored as load increases. The monitoring of slip of prestressing tendon at deviators is very important in order to compare the experimental results with those coming from a theoretical model, where the possibility or not of tendon slip should be considered.

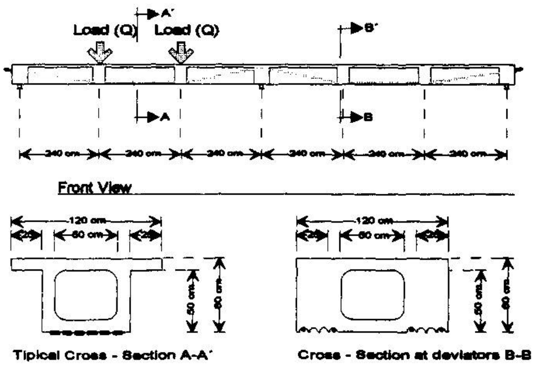

Figure 1. Definition of the two-span prestressed box girder beam.

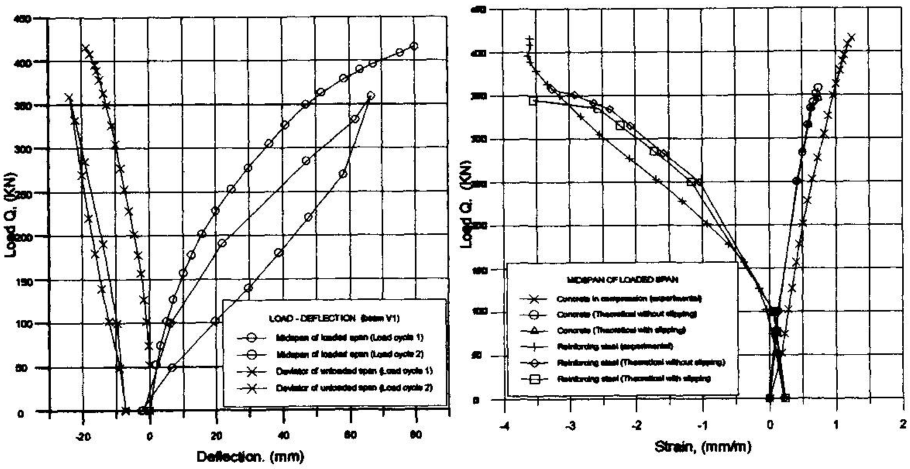

Figure 2. Results in the original undamaged beam in the test up to failure.

Results- In figure 2 are shown some load-deflection curves obtained in the original undamaged beam in the test up to failure. The strains in concrete and reinforcing steel measured with strain gages are presented too.

Repair and strengthening. Severe damage was provoked to the beam in the test up to failure. The repair method tried to simulate as close as possible the repair sequence that will be used in an existing bridge. The original reinforcing steel is replaced by bonding aramid strips (Length: 3000mm., Width: 20 mm., Thickness: 4 mm. each) .

Tests in the repaired beam. The same experimental arrangement and instrumentation as in the undamaged beam were disposed to obtain the experimental results in the same locations monitored in the previous test to compare the behaviour of undamaged and repaired beam.

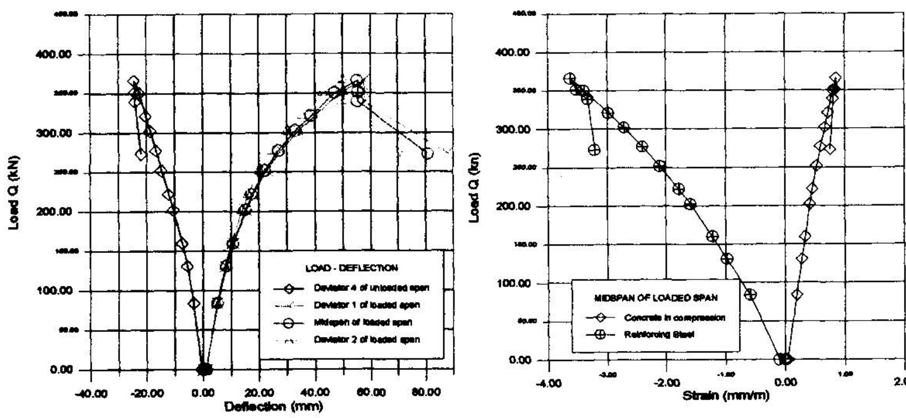

Figure 3. Experimental results in the repaired beam.

Results- (see figure 3) The ultimate load was 360 kN which is very close to the final load 400 kN in the undamaged beam. The final failure was quite brittle. The ultimate load was achieved by the sudden and progressive failure of the bonding between aramid strips and concrete. Once the strips failed, the load carried by them was suddenly transmitted to the prestressing steel that was beyond the yield limit, causing the final rupture of the beam.

2. CONCLUSIONS

The tests show how the repair and strengthening technique based on the use of AFRP strips and external prestressing seems to be very promising even for heavily damaged structures. In fact the ultimate load in the repaired beam was almost 90% the ultimate load in the undamaged beam. The strips externally bonded to the concrete seem to provide some crack control. Due to the brittleness of the rupture of concrete in tension, the failure of bonding concrete-aramid is brittle too, and so is the global failure of the repaired beam. The high tensile strength of the aramid material is under-used.