Monitoring and testing of a timber-concrete bridge

Alfredo Dias [1], Luis Jorge [2], Miguel Ferreira [3], Helder Martins [4]

Abstract This paper presents the monitoring and load testing of the first timber-concrete bridge built in Portugal. A plan of regular inspections was established which comprised two inspections each year, one in the winter time and another in the summer time. After four years in service, a major inspection was undertaken in the structure. Together with it, a load test was also performed. Two types of loading were used, vehicles loads and point loads. Two vehicles were used: a car with a total weight of 11.7 kN representing the large majority of the traffic on that road, and a truck with a load of 290 kN representing the highest load levels that are expected on that road. The point loads were applied in eight locations, always on top of one of the timber beams.

Keywords bridges, monitoring, load test, timber structures

1. STRUCTURAL SOLUTION AND INSPECTION RESULTS

The bridge with single traffic lane was made by a concrete slab cross-section of 500 x 20 cm^2 over four equally spaced GL28h straight glulam beams with a cross-section of 126 x 24 cm^2 (Figure 1). The shear loads between the two materials were transmitted through a connection system comprised of notch details combined with glued-in steel reinforcement steel bars (Figure 1).

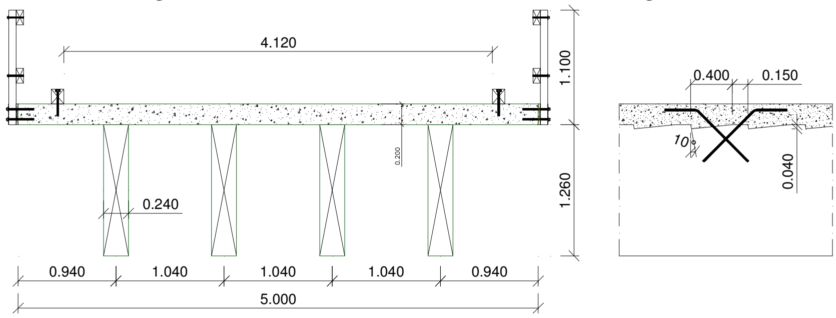

Figure 1 – Underside view of the deck and connection detail

Once the construction was finished, the implementation of the inspection plan was initiated. For the first years the bridge would be visually inspected twice each year, one time in the winter period and another one in the summer period. The inspections were based on a visual checking on various key areas: timber supports, connections, concrete slab and timber members. In four years of inspections the timber members did not show any sign of degradation, expressed by cracks or discoloration

[1] Alfredo Dias, Civil Engineering Department, University of Coimbra, Portugal, alfgdias@dec.uc.pt
[2] Luis Jorge, Polytechnic Institute of Castelo Branco, Portugal, luisfc@ipcb.pt
[3] Miguel Ferreira, Lena Engenharia e Construções, SA, Portugal, miguelpedrosaferreira@gmail.com
[4] Helder Martins, Polytechnic Institute of Castelo Branco, Portugal, helder_martins@ipcb.pt

induced by moisture variations. After four years in service, a major inspection was undertaken in the structure, which included the performance of load tests. The main purpose of the load tests was to assess the bridge performance four years after its construction. In the test two types of loading were used, vehicles loads and point loads. The purpose of the vehicles loads was to assess the bridge behavior under real loads. Two vehicles were used: a car with a total weight of 11.7 kN representing the large majority of the traffic on that road, and a truck with a load of 290 kN representing the highest load levels that are expected on that road (Figure 2).

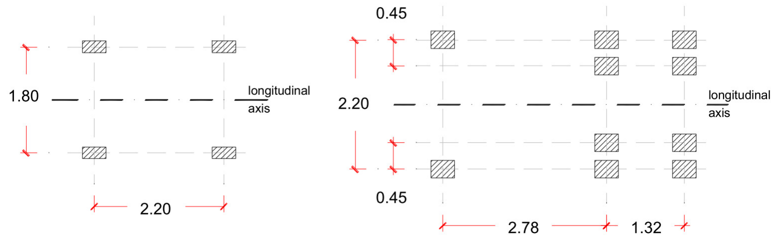

Figure 2 – Squematic representation of the vehicle loads – (a) car load; (b) truck load

In Figure 3 are presented the displacements in the longitudinal direction for the 4 beams, for the car-load and for the truck-load. The test was performed with the vehicle (car and truck) stopped at the midspan.

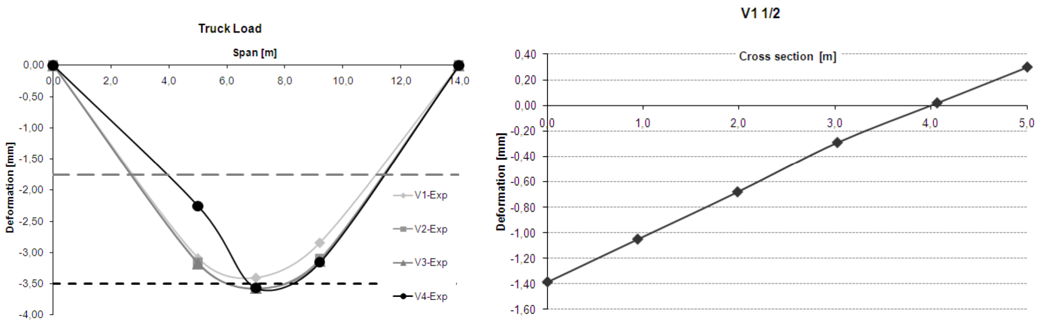

Figure 3 – Displacements in the longitudinal direction for the truck load

In terms of the bridge serviceability behavior it is important to note that the highest deformation measured in the test, for the truck load, was 3.80 mm corresponding to L/3680. Since this type of load is on the upper bound of the loads likely to cross the bridge, it can be concluded that the deformations in service are significantly lower than the values indicated in EC 5 (CEN, 2004), L/400 to L/500.
These results show that the connection system used was appropriate to guaranty a good stress transmission between timber and concrete. On the other hand, it is completely clear that the consideration of low or null transmission of load in the transverse direction, of timber-concrete composite structures, is far too conservative. More appropriate models regarding this aspect, in the particular case of timber-concrete structures, are therefore necessary in order to allow more accurate design solutions.

2. CONCLUSIONS

The complete life-cycle assessment over 100 years period, indicated in the regulations, is yet hard to perform for timber, as well as it is for concrete and steel structures. Nevertheless, considering all measures taken to ensure the durability of the superstructure and foundations, it is expected that this structure can fulfill this requirement if all the predefined maintenance procedures are applied. Timber bridges can then be considered feasible options to replace old concrete or steel bridges without replacing old foundations and abutments, due to favorable combination of low weight, good aesthetics and competitive costs. Pleasant aesthetics over the new railway tracks or motorways could be achieved, considering also the opportunity for prefabrication and some advantage on its lightweight for speeding the construction period. Above all, the construction of the first timber roadway bridge in Portugal in the last 30 years is expected to contribute to the increase of confidence in timber as a construction material, feasible also for road bridges.