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HOW TO MAKE THE LARGEST FOOTBRIDGE OVER A MOTORWAY IN SPAIN… (IN TIMBER)

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Summary

In Spain, timber is a material rarely used in construction. Despite wood has been used in construction for thousands of years, today is considered a short life matirial, which is suitable only for provisional purposes. Therefore, when a few years ago, due to the width extension of the A8 motorway, an old conventional metallic footbridge had to be replaced, the “timber option” proposed by our company Media Madera, was not really what is said to be “a winning bet”

Keywords: timber construction; footbridges; design methods; planning strategy; assembly processing

1. Why use timber for today’s bridges?

1) Timber is a material durable. The prejudice that it has a short life or is suitable only for provisional purposes is disproved by the many historical timber structures that survive. When timber construction kept in suitable conditions, mainly dry and ventilated. Additionally, chemical preservative treatments may be applied as a second line “insurance” against design or construction failures that could ensure a good durability even for the worst conditions

2) Timber has a surprising very high strength-to-weight radio. It can offer lightweight structural solutions resulting in benefits such as reduced foundation loads and ease of lifting prefabricated elements during transportation and assembly.

3) Timber is a sustainable material. As a natural and renewable building material, timber has excellent ecological attributes. It acts as a carbon sink and has low embodied energy. The energy needed to convert trees into wood and hence into structural timber is significantly lower than that required by other structural materials such as steel and concrete.

2. Designing the bridge:

The motorway has a width of 60 meters, and it must also be necessary to leave a clearance of at least 5,5 meters above the road. Besides, this motorway supports a very heavy traffic. The need to interrupt traffic during bridge placement limited access to the site to just a few hours at night. Hence, design has to give priority to make the assembly as quickly as possible. To achieve this, the bridge had to be completely prefabricated in elements off site, which could be transported and assembled in the easiest and fastest possible way

Design begins with the placement of a completely straight deck, in the simplest possible way, as access to this initial straight deck was too high on the floor, bending the board, we could reduce this distance and maintain at the same time, the clearance above the road.

Placing a roof is probably the best way to keep dry the structure and ensure long life service. Most ancient wood bridges still in service in Europe are covered bridges. So, with the placement of uprights between the roof and the deck the basic design of the footbridge were configured: the main truss, sixty meters long, three meters of effective width and five point five meters above the road.

Structure had to resist the weight of pedestrians and the rest of the standard requirements. Spanish Standard for designing of road Bridges IAP-11 specifies a 0,5 MPa live load for pedestrian bridges and it is necessary to consider also the overloads of snow over the roof and wind

With the incorporation of a double arch the central part of the system was settled, the deck is hanged from the arches by the uprights, which works as tension, above the arch as columns.

A numerical model allowed us to check the effectiveness of the proposed structure: Stress caused by vertical loads are evenly distributed, with a predominance of axial forces, the cross sections obtained for the timber elements for these stresses are reasonable and we can set points with zero bending moments, points where we could design simple connections which can be assembled quickly on site.

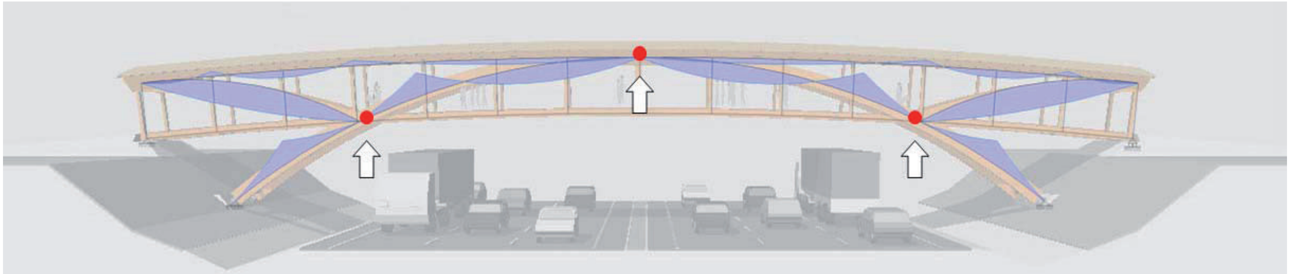

Fig. 1. Bending stress diagrams

So, taking advantage of these points of zero bending, we could divide the bridge into four modules which could be prefabricated. Each module of the bridge was completely prefabricated in the factory, there was loaded onto trucks and transported directly to the worksite where two large cranes were necessary to lift each module. A temporary structure placed in the middle of the motorway was used during the assembly. In this way, both principal modules could be placed independently so they could be afterwards connected.

Fig. 2. Assembly sequence of the footbridge

Fig. 3. Finished bridge