Technology improvements for the strengthening of existing metallic bridges using fibre reinforced polymers (FRPs)

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Respect to the past, transport infrastructures owners are nowadays getting more and more aware that their bridges age, progressively losing their capacity to meet the performance levels which they originally were designed for. In fact, not surprisingly, construction materials, as all the other materials, deteriorate over time.

Almost seventy percent of European railway metallic bridges are more than fifty years old, with a significant percentage either beyond its service life or close to it. From this seventy percent, more than one third was built before the beginning of the 20th century and is still in service.

European metallic bridges have experienced increasing traffic demand and, consequently, have been exposed to a large number of stress cycles that have prompted the fatigue problems they presently suffer from. Fatigue is the main cause of degradation for metallic bridges, combined with corrosion and lack of adequate maintenance. In this context, strengthening techniques are crucial to bring them up to modern standards requirements.

Traditional strengthening techniques used for either restoring or increasing the load bearing capacity of metallic bridges are based on the application of steel plates, either by bolting or welding them to the bridge bearing structure. Unfortunately, steel plates add further loads to the bridge and are susceptible to corrosion and fatigue.

The use of externally bonded fibre reinforced polymers (FRPs) patches overcomes several of the difficulties associated with the use of traditional steel plates. In fact, FRPs are not affected by corrosion and, thanks to their lightweight, are easy to handle, resulting in their rapid installation which helps reducing drastically traffic disruptions.

Despite the significant opportunities provided by FRPs, the use of these materials to strengthen metallic bridges is not as developed as it is for concrete bridge strengthening. The number of studies currently available, from both the theoretical and experimental point of view, is still limited. These studies are mainly focused on strengthening tensioned elements or those regions of flexural members subjected to tensile stresses, with the aim of reducing the stress levels of these elements in service conditions.

To prove the effectiveness of the use of FRPs to strengthen metallic bridges, their behavior must be further studied. Strengthening strategies to enhance fatigue life, shear capacity, buckling resistance, capacity of connections, cracked metallic structures, long terms effects, durability and anchorage strategies are topics that must be addressed by future research works.

This thesis aims to contribute to fill the knowledge gaps that presently exist in the use of FRPs in strengthening metallic bridges, promoting the use of this technology among practitioners and bridge owners as an effective tool to manage the problem placed by transport infrastructures ageing.

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