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2012/13 Undergraduate Research Grant Scheme – Executive Summary

Project title:
Structural interaction between wearing surface and cellular GFRP bridge decking

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University of Bristol

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Project summary:
Glass Fibre Reinforced Polymer (GFRP) bridge decks show great potential for economic use in structural engineering applications. Their lightweight and modular nature permits efficient construction, whilst high environmental resistance minimises maintenance requirements.
Past research has identified that local, as opposed to global, response to tyre loading is critical to long-term behaviour. Furthermore, the properties of GFRP are irregular and uncertain at critical locations, limiting the effectiveness of Finite Element Analysis and underlining the need for physical testing.

The aim of this project was to identify a method of accurately and efficiently representing tyre loading (i.e. closely modelling the imposed Contact Pressure Distribution (CPD)). Current methods of modelling are either inaccurate or impractical, thus an alternative loading system was urgently needed.

This project proposed a solid, curved loading plate that was both suitable for high frequency fatigue testing and an accurate representation of the imposed tyre CPD, thus closely modelling the local response to tyre loading. The concept of the curved loading plate was to machine a specific profile on to a metal plate and then to apply that plate to the GFRP deck. The plate curvature corresponded to the deflected shape of the same GFRP deck under a given tyre CPD. This method also permitted modelling the variation of tyre size and inflation through changes in curvature.

This project has shown that curved loading plates can be used to accurately model a given tyre CPD and that this is a much closer approximation of tyre loading than the conventionally used flat plate. The research has also shown that the CPD is highly sensitive to both changes in curvature of the loading plate and to damage in the deck, highlighting the importance of deck specific loading plates and the ability of the curved loading plates to act as a damage detector.