Seismic testing of FlexiArch™

Masonry arch bridges are one of the oldest forms of bridge construction and have been used for thousands of years. They were originally built of stone or brick, but modern rigid arch bridges are built of reinforced concrete or steel. The introduction of these new materials allows arch bridges to be longer than previously achieved with lower rise-to-span ratios and, with reinforced concrete as the main material, can either be cast on site or manufactured as precast. However, a common problem with such bridges is corrosion of the reinforcement, which can lead to high repair and maintenance costs. Therefore a bridge with no or low amounts of reinforcement is a significant step change and should provide bridges with improved durability and whole life performance.

The FlexiArch™ is a patented system for the rapid construction of an arch, based on modern precast concrete methods, which in service performs like a conventional masonry arch. The patent holder, Professor Adrian Long FREng of Queen's University Belfast, has worked closely with Macrete Ireland Ltd for nearly 10 years on the development of the system. Two Knowledge Transfer Partnerships (KTPs) between Queen's University and Macrete have had significant input from Professor Long, Dr Su Taylor and Dr Daniel McPolin.

The method of construction (see Figure 1) utilises precast concrete voussoirs in combination with polymeric reinforcement and a concrete screed so that when lifted it takes up the prescribed arch geometry under gravity forces. Thus no centering is required and construction is very rapid. The system is very sustainable as it has no corrodible reinforcement and the flat-pack FlexiArch elements can readily be stacked during storage and for transportation to site.

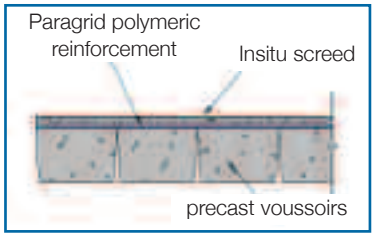

Figure 1 (top): *The key elements of the FlexiArch design.*
Figure 2 (above): *Construction of a FlexiArch Bridge.*

In their current KTP, Macrete and the University are aiming to create FlexiArch design tools, and develop a range of complex-geometry FlexiArch systems for new bridges, and to strengthen existing bridges. However, the rest of this article discusses a collaboration with the University of California, Irvine, which is supported by a Royal Academy of Engineering Global Research Scheme Award to Dr Su Taylor at Queen's.

To date, there has been no physical monitoring of the system under seismic loading. The collaboration aims to test the FlexiArch bridge system under seismic loading and to model its behaviour. It is anticipated that the 'FlexiArch' will perform at least as well as conventional masonry arches which have been in service in seismic areas of the world for centuries.

This partnership will enhance the knowledge of the behaviour of FlexiArch under seismic loading and make use of advanced sensor technology for structural health monitoring. Figure 2 shows the FlexiArch rings being installed to form an arch bridge, and shows other elements of the design. The research will use intelligent data interpretation to predict damage via full-scale testing at Irvine, and to establish the behaviour under seismic loading to validate predictive modelling.

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