Active Aerofoil Stabilisation of Long Span Bridge Decks

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Summary

This paper describes some of the research, initially sponsored by the Institution of Civil Engineers, into the mitigation of potentially destructive bridge deck flutter by the use of movable aerofoils, much in the same way that modern aircraft are controlled and stabilised by such aerofoils.

Both flat plate and time domain analyses are presented, and the benefits offered by the movable aerofoils are quantified, using data based largely on the Humber Bridge deck parameters.

The paper concludes with a proposal for a practical implementation of active aerofoil controls on the bridge deck along with a discussion on the way ahead.

Keywords: box girder, flutter, aerofoils, aeroelastic, instability, long span.

1. Introduction

Active aerofoil controls have had a remarkable impact on the new generation of transport aircraft. The technology enables them to carry more passengers over greater distances, to operate on shorter runways, to use less fuel and to make them ever safer and easier to fly than could be achieved without active controls. This paper suggests that comparable benefits may become available for the coming generation of exceedingly long span suspension bridges. Specifically, active controls may alleviate the destructive effects of flutter, coupled torsional and flexural oscillatory instability, which is one of the major determining factors affecting the achievable suspended spans.

It is considered that the potential savings in the weight of the bridge deck and its supporting structures promised by active stabilisation is consistent with the theme of this Symposium, which relates ecology and aesthetic concepts to engineering structures in the urban environment.

2. Background

It was this potential read-across from the world of aerospace that led the late David Piésold (of Knight Piésold & Partners) to suggest the use of ‘active’ aerofoil control of the bridge deck as a means of controlling flutter. An approach was made to GEC Marconi Avionics Rochester, with their experience in active stabilisation of aircraft, and supported by a grant from the Institution of Civil Engineers (ICE), a multi-disciplinary team was established in 1993 to investigate the topic.

This team included senior representatives from Imperial College Aerodynamics and Structural Engineering departments, GEC Marconi Avionics Rochester, Knight Piésold & Partners, along with various members of the Civil Engineering profession. This initial research was presented to the ICE in December of that year.

Work is continuing on potential future applications for the concept, particularly in the trade-off between active and passive aerodynamic stabilisation.

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