FULL SCALE
DYNAMICS LTD
REAL WORLD CONDITIONS
REAL WORLD SOLUTIONS

Title	Gatwick Airport Pier 6 Link Bridge
Client	Arup
Location	Gatwick, Surrey, UK

Background

The Gatwick Airport Pier 6 Link Bridge (Figure 1), completed in 2005, was constructed to connect a new pier to an existing terminal building at the airport. The bridge traverses a major taxiway and there is sufficient clearance for a Boeing 747-400 aircraft to pass underneath.

Figure 1: Exterior view of bridge.

To prevent excessive vibration caused by large numbers of pedestrians crossing the bridge (Figure 2) simultaneously, tuned liquid dampers (TLDs) were designed to add damping to the critical vibration modes. The purpose of this project was to establish the natural frequencies of the bridge to enable these dampers to be properly tuned. It was also necessary to evaluate potential nonlinear effects from cladding/glazing elements.

Figure 2: Interior view of bridge. Copyright Pete Barr-Watson (licensed under Creative Commons Attribution ShareAlike 2.0 License).

Ambient Vibration Testing

Ambient vibration testing was carried out to provide a quick measurement of vibration modes of the structure. 15 accelerometers were installed; 5 each at ¼ span, midspan and ¾ span. Acceleration response data were acquired for a period of 15 minutes due to natural excitation (wind, ground motion, etc.). Ambient modal parameter estimation was carried out to estimate the lowest 5 modes of vibration.

Forced Vibration Testing

Forced vibration testing was carried out to determine vibration modes at levels of excitation similar to that produced by large numbers of people on the bridge. Two APS dynamic electrodynamic shakers with a total of 1.2 tonnes of moving mass were used to excite the structure (Figure 3) and carry out stepped sine testing under two different levels of excitation.

Figure 3: Equipment setup for FVT.

Multi-input multi-output modal parameter estimation was carried out to estimate the modes shown below. Note that the modes on the left correspond with a high level of vibration and the modes on the right correspond with a low level of vibration. Both natural frequencies and damping values were dependent on the level of vibration.

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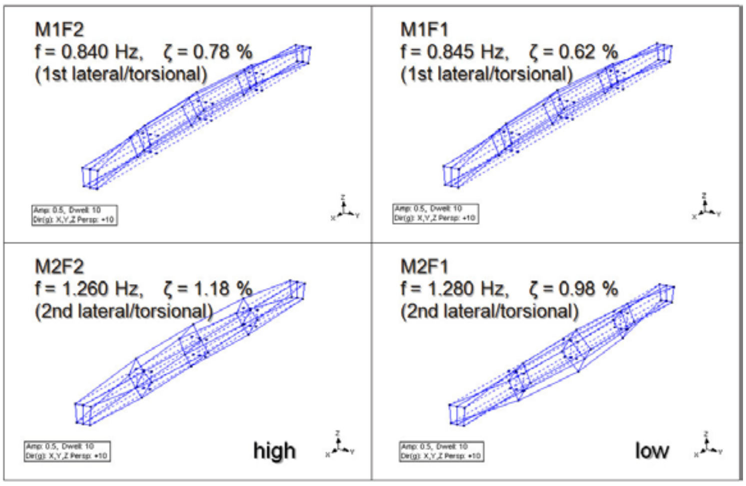

Figure 4: Estimated modal properties from FRF-based shaker modal testing yielding reliable estimates for modes having frequencies below 1 Hz.

Free vibration decay measurements were also made. The bridge was excited in resonance using the shakers, which were then suddenly shut down allowing the bridge to vibration freely. Cycle-by-cycle curve fitting of the acceleration response following shaker shutdown enabled the amplitude dependence of the frequencies and damping values to be established, as shown in Figure 5.

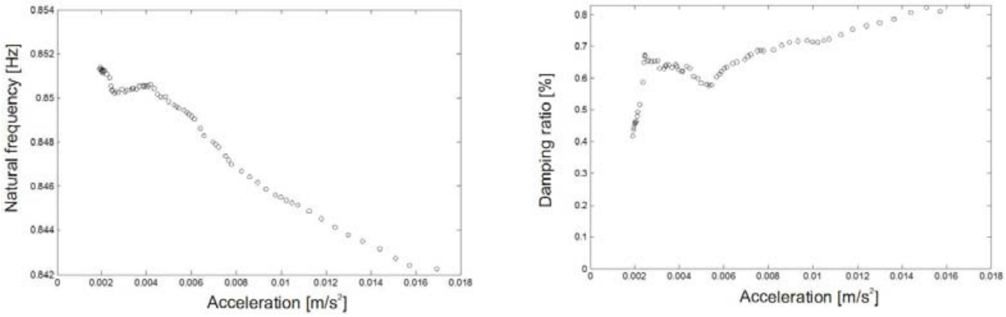

Figure 5: Frequency and damping versus amplitude.

Successful completion of these measurements enabled the engineers to tune the TLDs to the critical vibration mode for pedestrian excitation. The measurements also revealed that the cladding and glazing elements on the bridge had a major effect on the structural dynamic properties, despite being designed as purely non-structural elements.