Railway Viaduct 92

- Riveted plate girder rail viaduct
- Eigenvalue and moving load analyses
- Simulation and field measurement validation

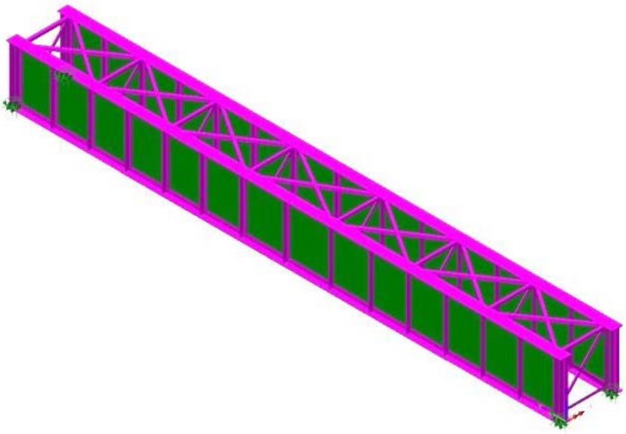
The Railway Viaduct 92 was constructed in 1930 over the Oroua River in the North Island of New Zealand. Mehrdad Bisadi, a PhD researcher at the University of Auckland, is investigating the accuracy and reliability of the impact factors used to design and assess New Zealand rail bridges. He has conducted a field monitoring exercise to measure the displacements and accelerations of a rail viaduct superstructure. The objective has been to fine-tune a LUSAS Bridge model prior to carrying out numerical modelling of the dynamic response of the viaduct for different train dynamic characteristics.

Bridge Structure

Railway Viaduct 92 comprises ten simply supported spans hosting single ballast-less track. Each span is 18 m (59’-10”) long, comprising two I-shape riveted plate girders, cross frames, horizontal bracings, and timber sleepers. The girders consist of steel plates and angle section profiles which form the web and flanges of the girders. The cross frames connect the girders together and provide a lateral rigidity for the viaduct superstructure. The horizontal bracings are on the upper flange of girders to stabilise the bridge in lateral directions. A timber walkway on the one side of the bridge provides access to the track level.

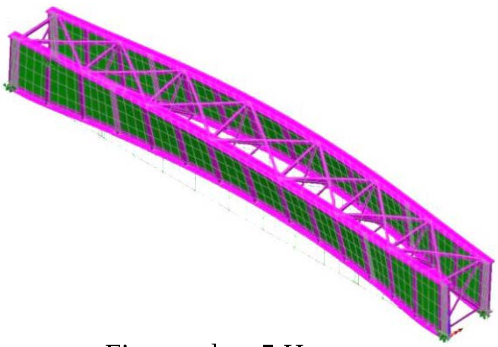
Modelling and Analysis

Mehrdad used LUSAS Bridge software to simulate the viaduct superstructure for dynamic analysis. Shell elements modelled web girders and 3D beam elements represented flange girders, stiffeners, cross frames, and horizontal bracing members. The track was represented as an additional non-structural mass applied to the flange girders. Eigenvalue and moving load analyses were carried out to study the viaduct dynamic performance.

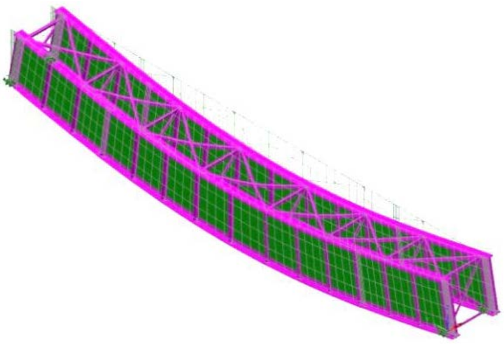


Analysis Results

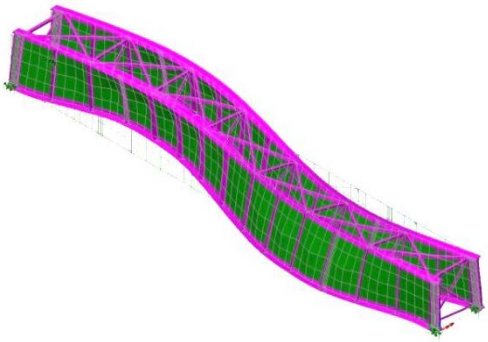
The eigenvalue analysis derived three global mode shapes including one vertical and two lateral modes. The corresponding fundamental frequencies are 12 Hz (vertical mode) and 6 Hz and 14 Hz (lateral modes). The simulated modes closely match the actual viaduct modal parameters extracted from the measured acceleration data.



First mode – 5 Hz

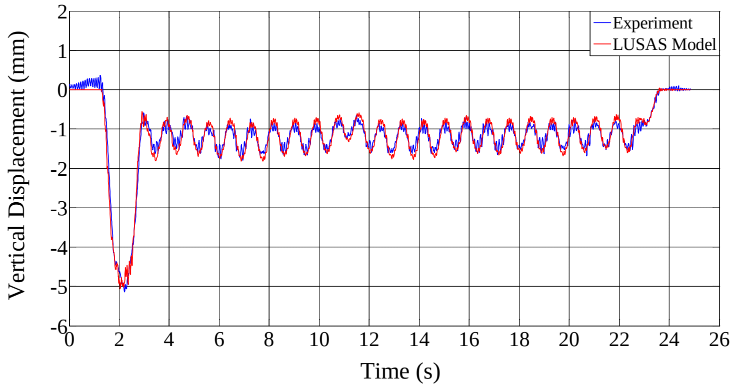


Second mode – 12 Hz



Third mode – 14 Hz

A weigh-in-motion system measured the train characteristics during field monitoring. The measured data was then used to define the train configurations in the LUSAS software. The advanced IMDPlus analysis computed the viaduct dynamic responses during train crossings. A comparison between the measured and simulated results shows that the LUSAS model accurately predicts observed displacements. This can be observed below.



Mid-span vertical displacement

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