The Use of Kinematic GPS to Monitor the Deflections and Frequencies of a 174m Long Viaduct under Traffic Loading

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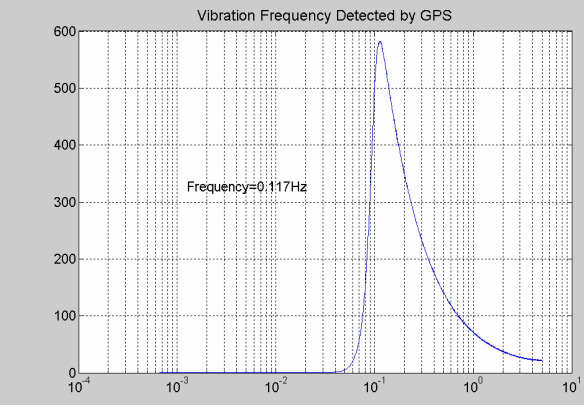
Presentation:

- Some past work
- Field Tests
- Results
- Deflections
- Frequencies
- Conclusions

Previous Work

The Humber Bridge: Spectral Analysis

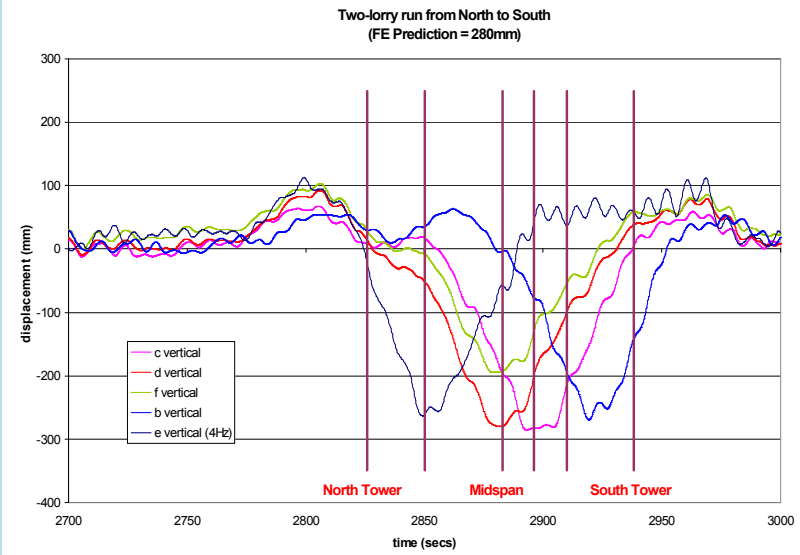


The first vertical vibration frequency predicted by a FE model created by Brunel University is 0.116 Hz

The Tsing Ma Bridge in Hong Kong with same span has 0.117 Hz first vertical vibration frequency

GPS is a viable tool for precisely detecting vibration frequencies

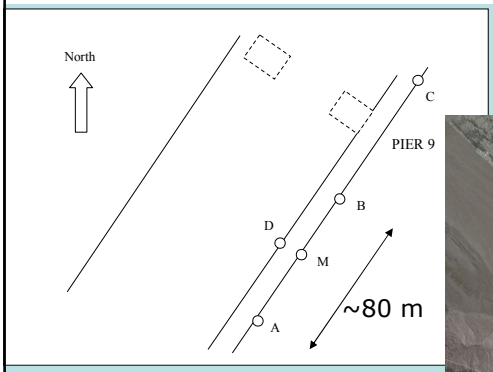
Vertical Displacements



Field Tests:

- Two day feasibility trial
- Concrete Motorway viaduct, 173.7m long
- GPS, dual freq 10 and 20 Hz

Viaduct Layout



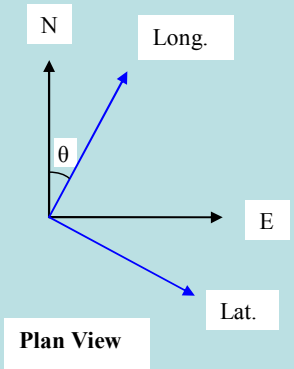
Antenna Locations

Antenna Locations

Reference Station

Granary Station

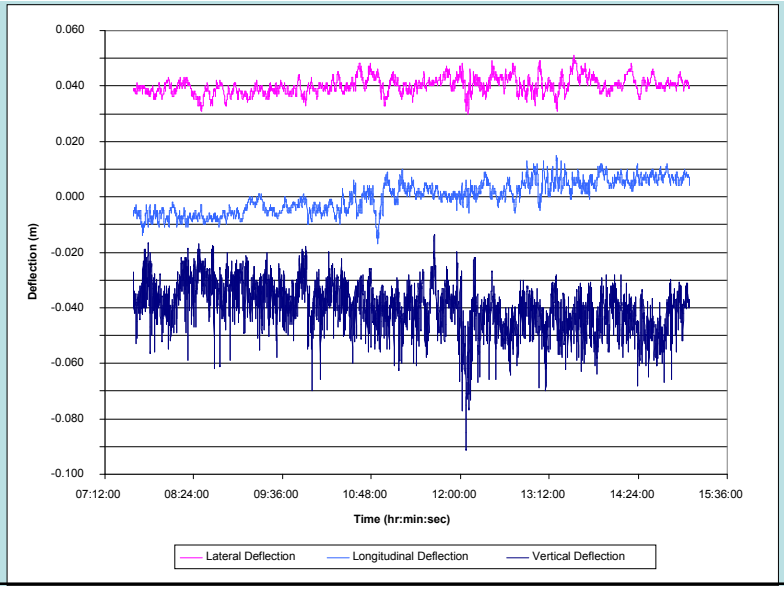
Bridge Coordinates



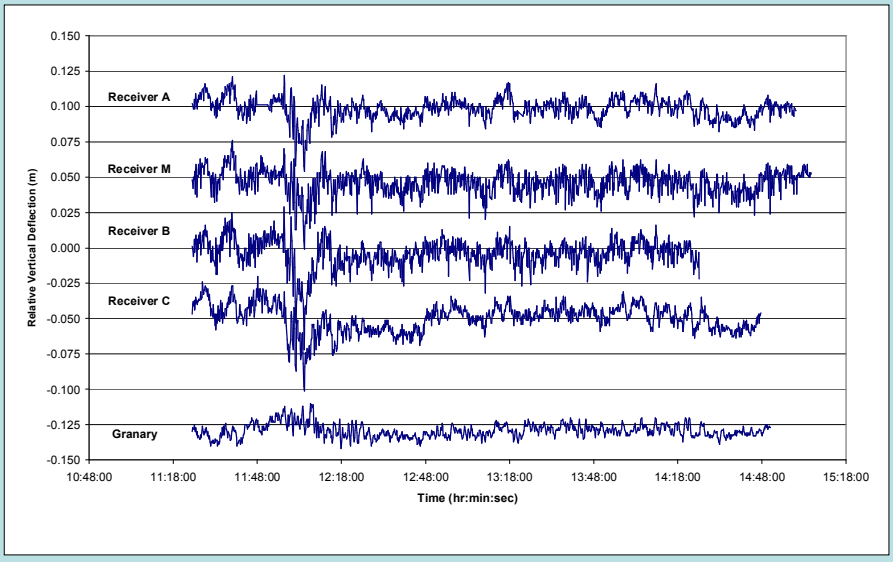
$$\begin{pmatrix} Lat. \\ Long. \\ Vert. \end{pmatrix} = \begin{pmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} E \\ N \\ H \end{pmatrix}$$

θ = Azimuth of Viaduct = 35°08’54”

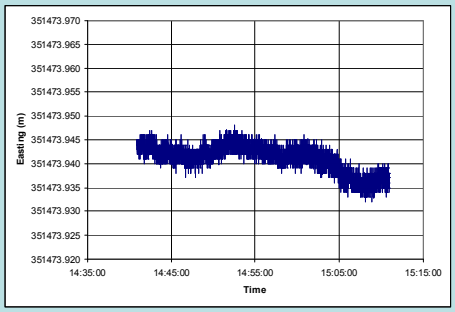
Midspan Movement



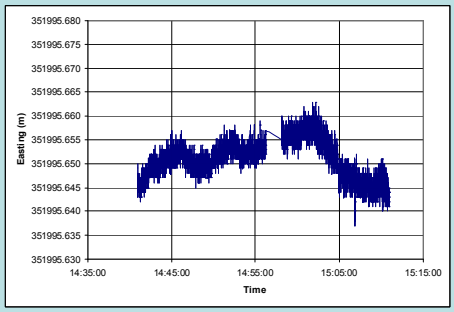
Vertical Displacements



Eastings

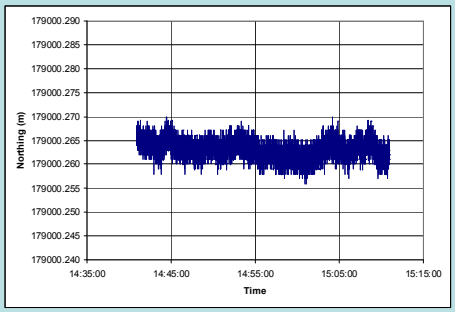


Granary

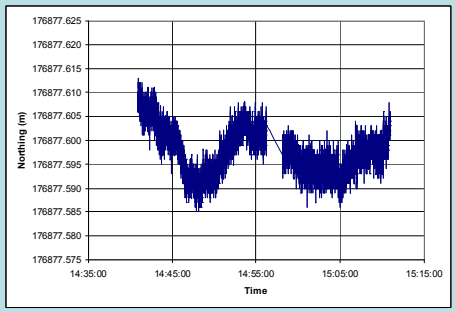


Bridge Mid Point

Northings

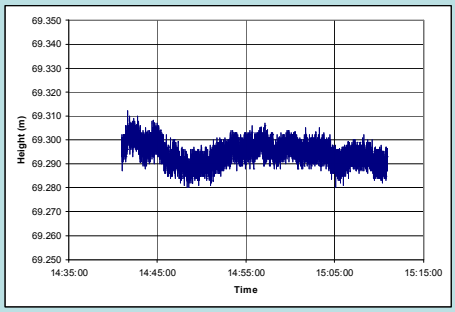


Granary

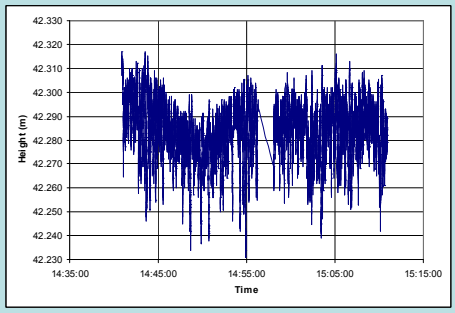


Bridge Mid Point

Height

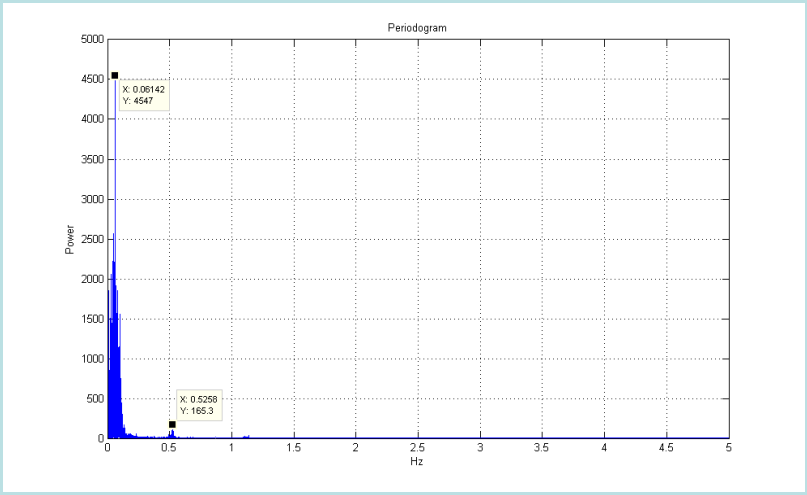


Granary

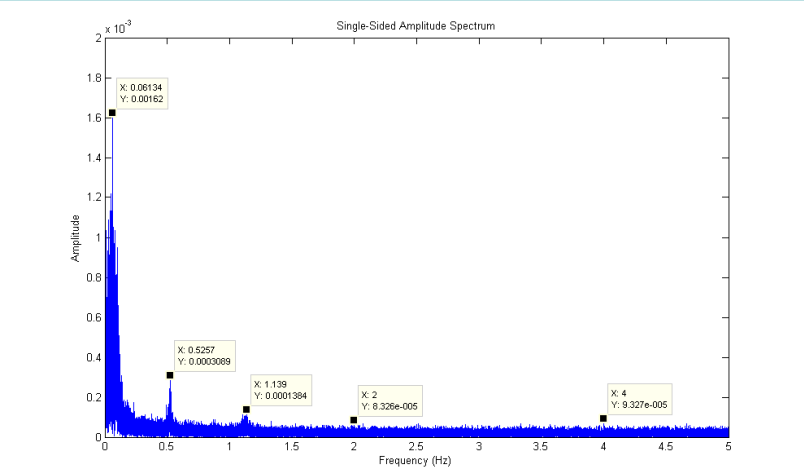


Bridge Mid Point

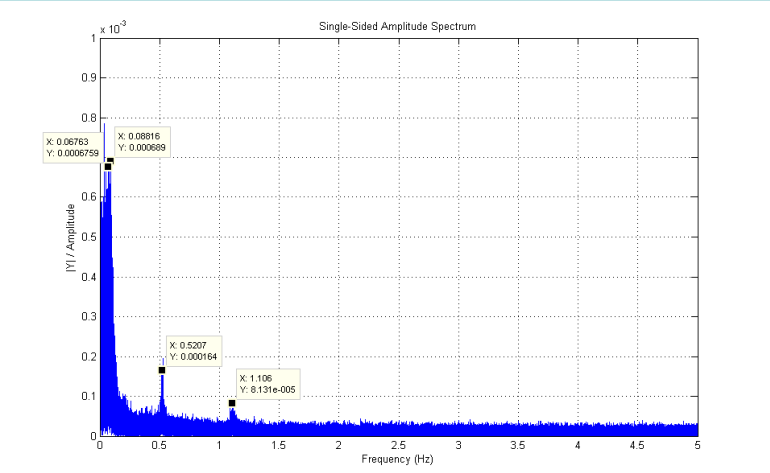
Vertical FFT



Vert Amplitude Spectrum, day1



Vert Amplitude Spectrum, day2



Conclusions:

- GPS is a viable measurement tool in the viaduct environment
- Adequate number of satellites required for positioning were visible
- Both sites were affected to a limited degree by multipath
- Three main frequencies were clearly detected by the GPS in the vertical component
- Mean movements of ±10mm in the lateral, longitudinal and vertical direction were evident, which could be due to diurnal effects
- Peak deflections in the vertical can lie anywhere up to the order of 50mm

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