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Bridge-related research at the University of Bristol



Outline of presentation

- BLADE
- Performance based engineering
- Site monitoring
- Dynamics of long-span bridges
- Other bridge-related research at Bristol
- Future direction of research



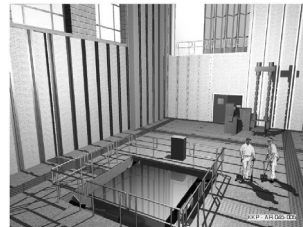
Bristol Laboratories for Advanced Dynamics Engineering (BLADE)

- Due for completion Spring 2004
- £15m grant from Joint Infrastructure Fund
- Integration across Engineering Faculty



BLADE Facilities (1)

- Earthquake and Large Structures Laboratory
 - Earthquake shaking table
 - Strong floor
 - 5m and 15m high strong walls



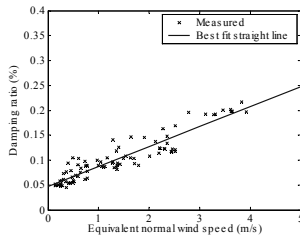
BLADE Facilities (2)

- Dynamics Laboratory
- Advanced Control and Testing Laboratory
- Environmental Laboratory
 - Soil mechanics, Composites, High temperature metals
- Heavy Test and Concrete Laboratory
- Light Structures Laboratory
 - Fatigue, Aircraft structures
- Modelling and Simulation Laboratory
- Workshops and support areas

BLADE Goals

- Develop a viable performance-based engineering framework
- Develop dynamic sub-structuring and other enabling technologies
- Build new knowledge and understanding of systems, non-linear dynamics, materials, control, and risk
- Apply the above to real problems and disseminate

Damping ratios of cable vibrations in relation to wind velocity

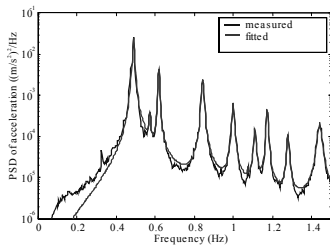


- Theoretical aerodynamic damping matches measured data
- Structural damping determined (intercept)
- No significant effect of corrosion protection wax

Addition of secondary cables

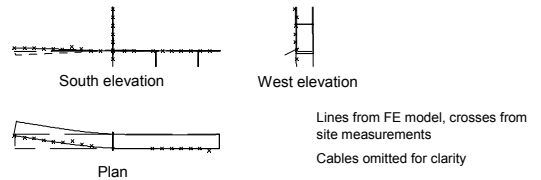


System identification from ambient vibration measurements



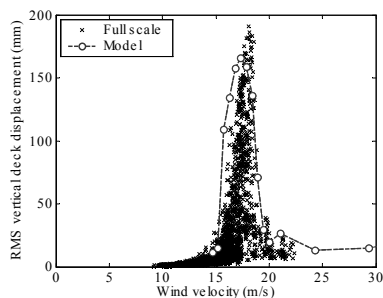
- New method allows for multiple vibration modes, loading spectrum and signal processing distortion
- Modal parameters identified, including damping
- Statistical analysis of accuracy

Comparison of FE and measured mode shapes - first mode of SSC half bridge



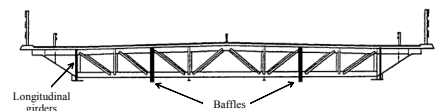
- Measured modes used to assess methods of Finite Element modelling (static and dynamic)
- Possible extension to model updating and Structural Health Monitoring

Second Severn Crossing vortex-induced vibrations - full-scale and final model measurements

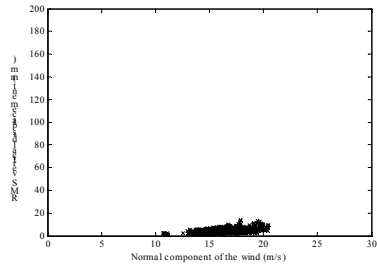


- Model corrected for full-scale damping, wind turbulence and vibration mode

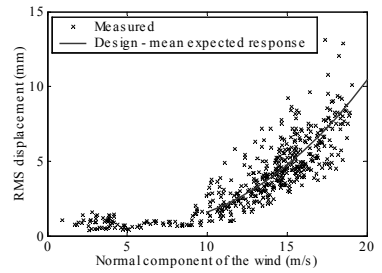
SSC deck cross-section showing baffles added to inhibit vortex-induced vibrations



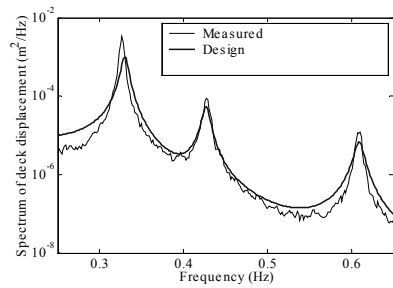
Effect of baffles on vortex-induced response of Second Severn Crossing



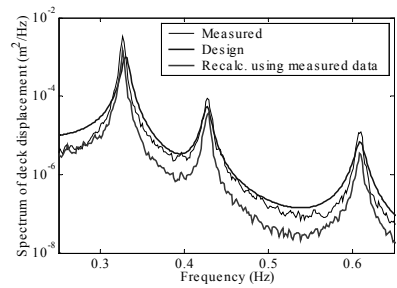
Second Severn Crossing RMS deck buffeting response near midspan – vertical bending



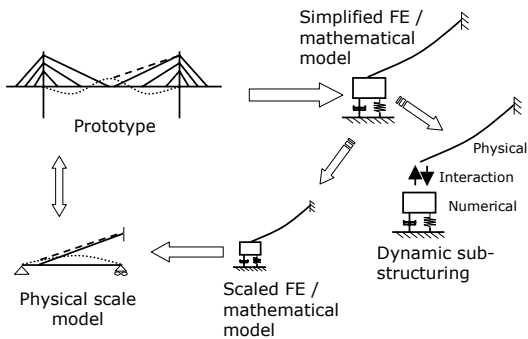
Spectra of deck vertical displacement



Spectra of deck vertical displacement



Cable-deck interaction - modelling



Other bridge-related research at Bristol

- Vulnerability analysis, systems and risk
- Bridge strengthening with Fibre Reinforced Polymers
- Punching shear failure of concrete slabs
- Active load control of bridges
- Fatigue of structural materials
- Local non-intrusive corrosion detection
- Multi-support earthquake excitation of long-span bridges
- Pedestrian-induced vibrations

Future research directions

- Performance-based engineering
- Integrating behaviour of system components
 - Technical / societal
 - Loading / structural performance (e.g. aerodynamics / non-linear dynamics)
 - Different structural components (e.g. cable-deck, soil-structure, concrete-FRP)
- Dynamic sub-structuring
- Structural Health Monitoring