Practical Steps To Extend the Lives of Bridges

Engineers Ireland,

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Adaptive and Semi-Active Vibration Control of Railway Bridge Dynamics

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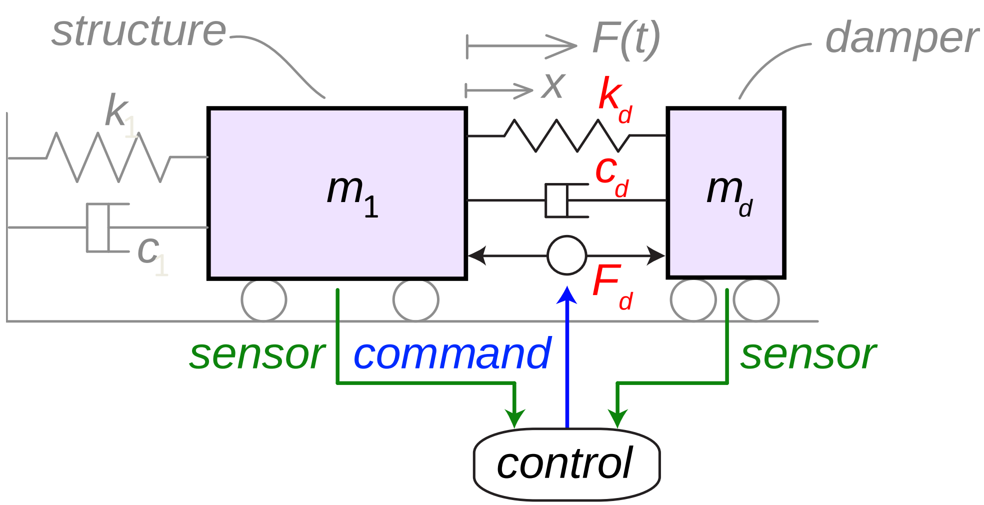
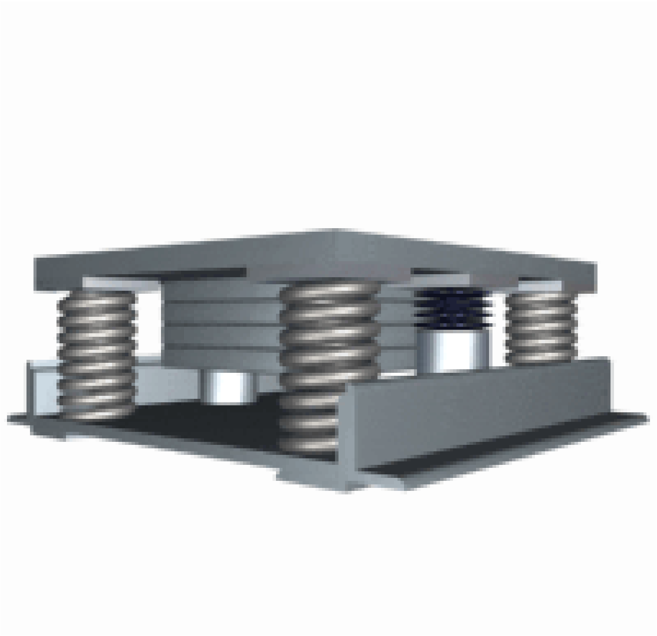
Aim and scope

- Attenuate dynamic effects to allow for:
  - Higher train speeds
  - Higher train loads
  - Extended bridge service life
- Scope of the secondment
  - Develop and implement vibration control, for simulations
  - Develop a prototype damper
  - Demonstrate the damper on a case study bridge

Tuned mass damper (TMD)

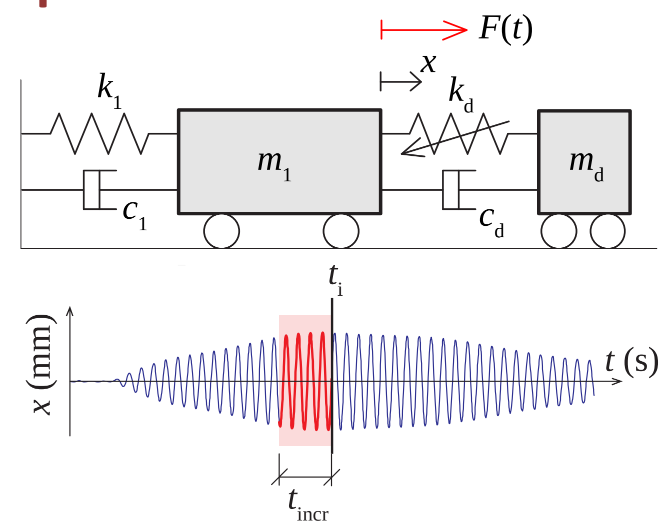
- Use a “small” suspended mass to disrupt vibrations from the main structure
- Improved performance using vibration control

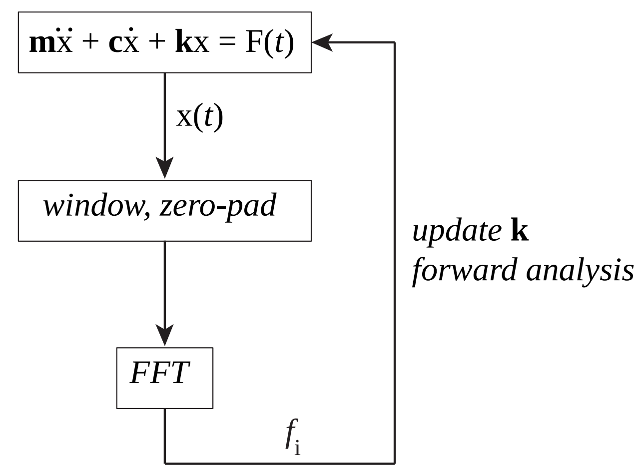




Vibration control, TMD applications

- Account for changes in frequency, change k_d
- Real-time feedback, e.g. during train passages
- Requires a data acquisition system to control the damper
- Fail-safe: act as passive damper if the control system fails



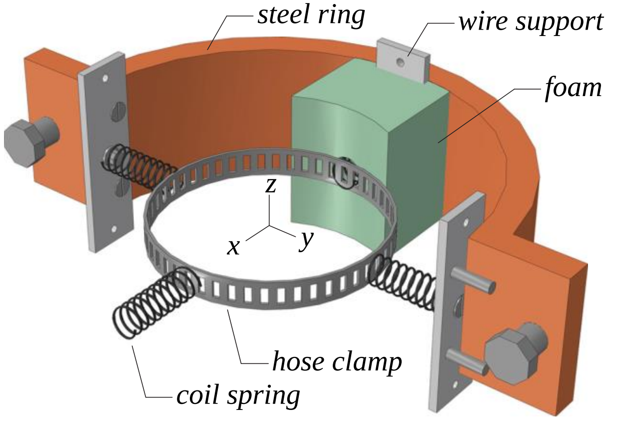


Case study bridge

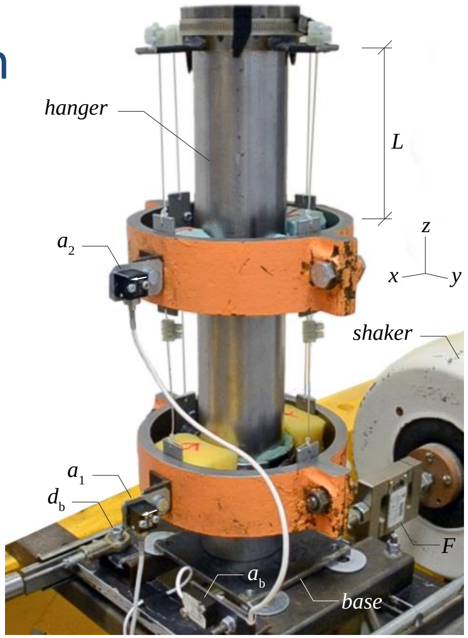
- Tied arch steel railway bridge, North of Sweden
- Important for freight transports
- Resonance in the hangers, reduced fatigue service life
- Change in frequency during train passage (increased axial force)
- Different frequencies in the longitudinal and transverse direction

Damper design (multi-passive TMD)

- Tailor made for the case study bridge
- Accounts for changes in frequency during train passage and free vibration
- Transverse and longitudinal vibration



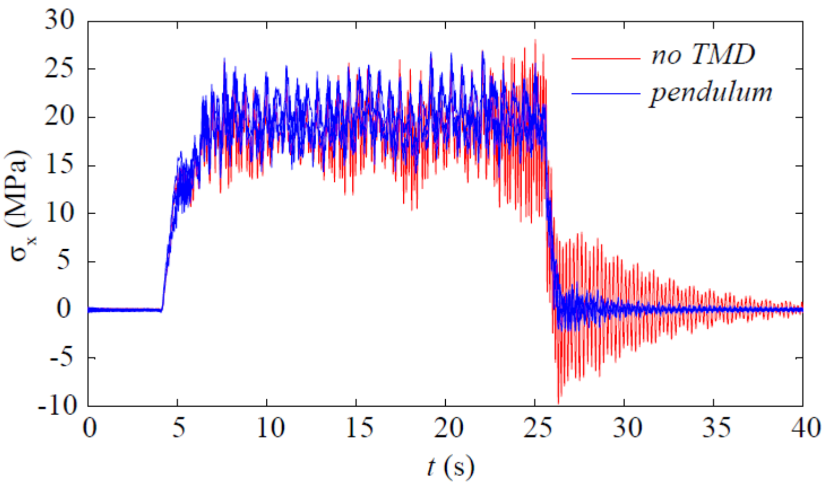
Design

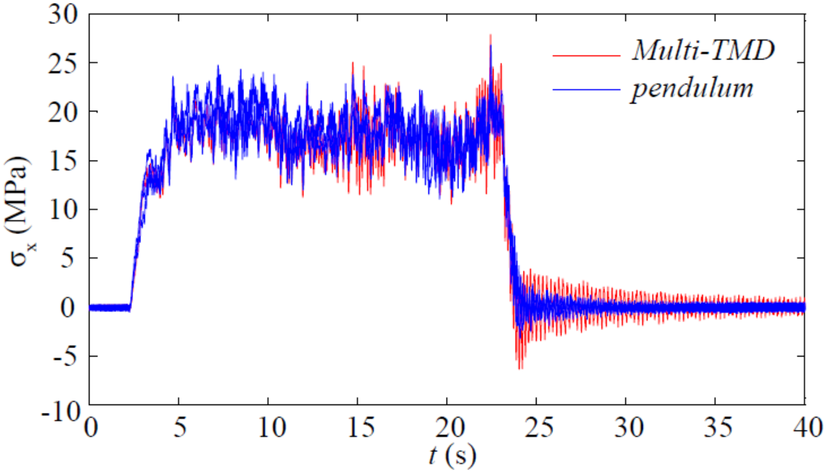


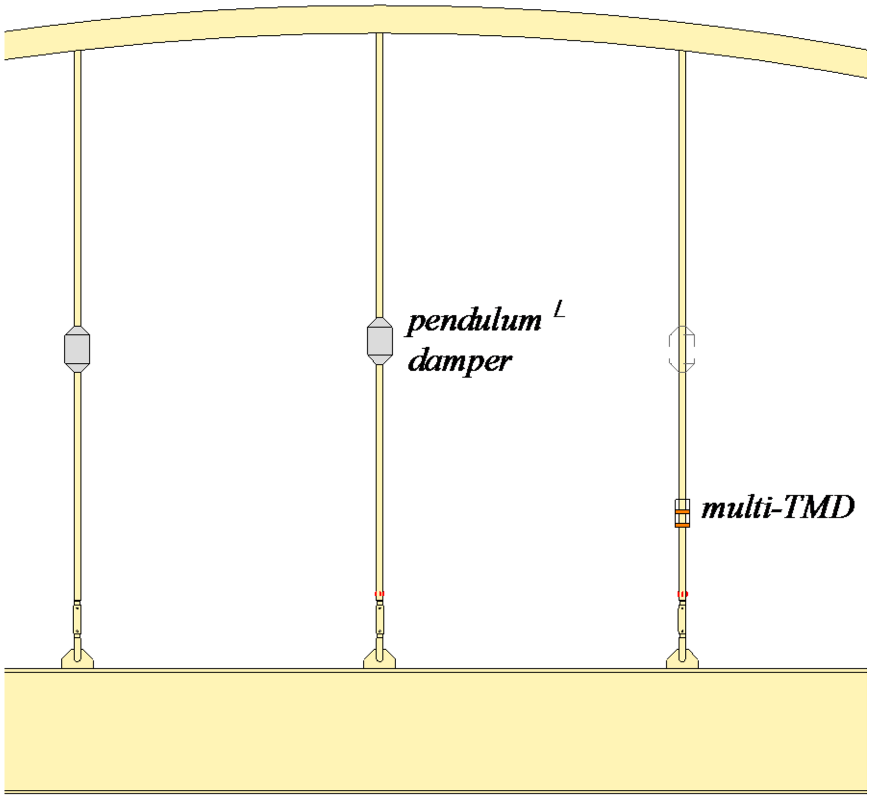
Lab-test at Trinity College Dublin

Mounted on the bridge

Results


no TMD
pendulum
σx (MPa)
t (s)


Multi-TMD
pendulum
σx (MPa)
t (s)


pendulum damper
multi-TMD

Conclusions

- Tuned mass damper systems
  - Good performance for structures prone to resonance
  - Significant improvement using vibration control, for cases of variable frequency excitation
  - Difficult to achieve robust control systems in practice
  - Maintenance and service life of the control system?
- Case study bridge
  - Good performance of the prototype damper
  - Significant reduction of the stress range, results in longer service life
  - Existing pendulum dampers still in service (since 2006), performance verified during field measurements in 2012

Thank You

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Project Website

www.longlifebridges.com

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