FABRE – Consorzio di ricerca per la valutazione di ponti viadotti e altre strutture
Ponti, viadotti e gallerie esistenti: ricerca, innovazione e applicazioni
2- 4 Febbraio 2022, Lucca

Metriche per la vulnerabilità dei ponti in muratura soggetti a scalzamento

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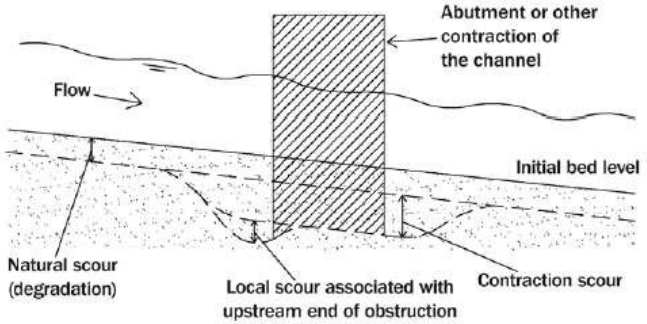
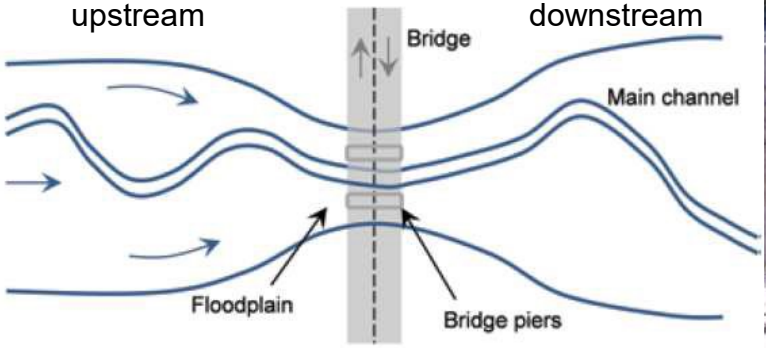
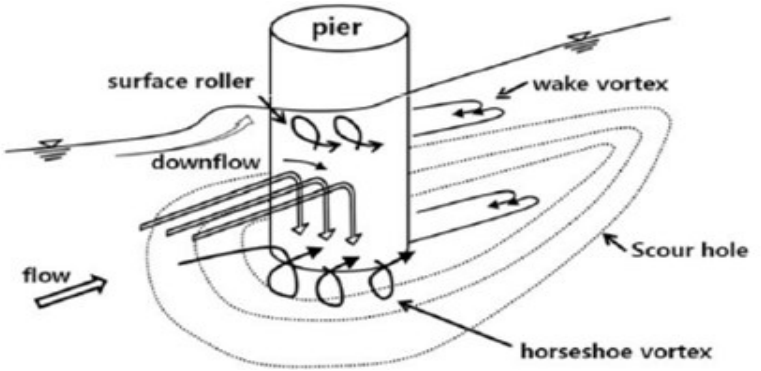
Natural scour: the result of river processes causing erosion of the channel boundary. Can include long-term bed degradation, lateral migration through bank erosion, bend scour

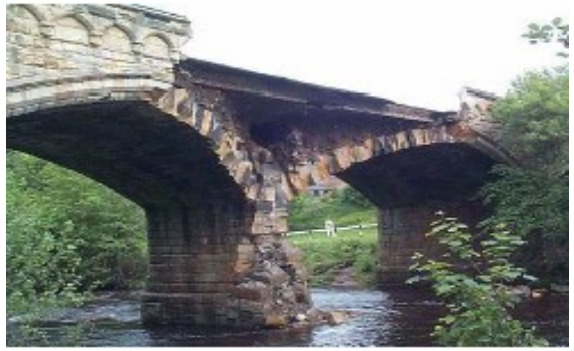


Contraction scour: the result of water accelerating as it flows through an opening (bridge) that is narrower than the channel itself



Local scour: caused by the down-flow generated at the upstream face of the pier, with formation of horseshoe vortices at the base.





High vulnerability of masonry arch bridges

Trigno river bridge, Molise Region, Italy (collapsed during the flood event of **2003**)

Source:
Zampieri, P., Zanini, M. A., Faleschini, F., Hofer, L., & Pellegrino, C. (2017). Failure analysis of masonry arch bridges subject to local pier scour. Engineering Failure Analysis, 79, 371-384.

Ballynameen Bridge (Faughn River), Northern Ireland. Damaged by floods in August **2017**, has undergone £800,000 repair works.

Source:
Solan, B., NOWROOZPOUR, A., Clopper, P., Watters, C., & Ettema, R. (2019, September). Scour-induced failure of masonry arch bridges: Causes and countermeasures. In E-proceedings of the 38th IAHR World Congress.

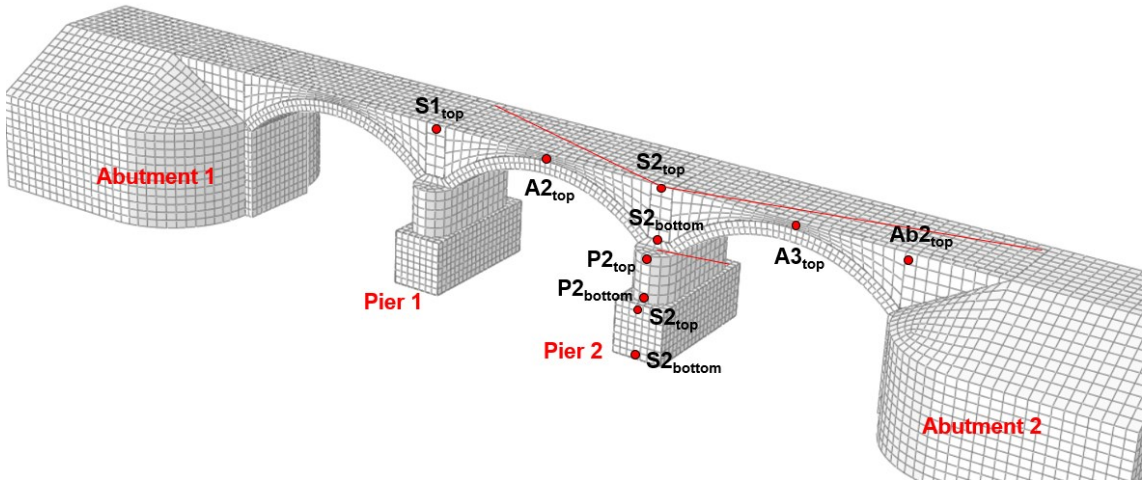
Rubbianello Bridge, Marche Region, Italy. Collapses occurred after flood events of **2013** and **2015**. Photo: bridge in 2015.

Source:
Scozzese, F., Ragni, L., Tubaldi, E., & Gara, F. (2019). Modal properties variation and collapse assessment of masonry arch bridges under scour action. Engineering Structures, 199, 109665.

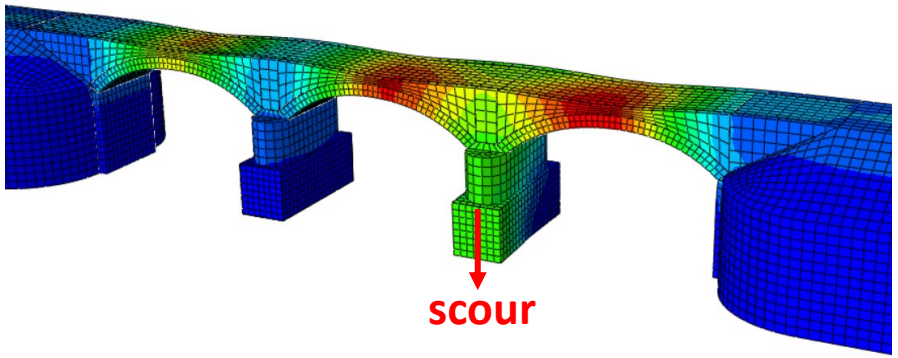
Study aims

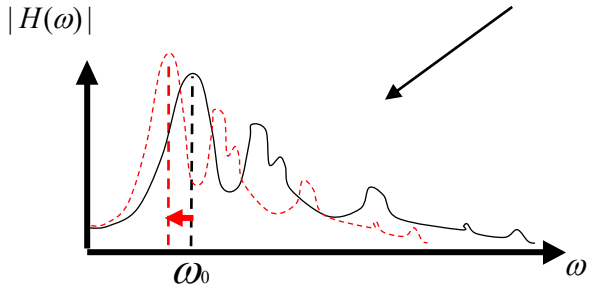
- Understand how masonry arch bridges respond to scour progression (find response predictors)
- Characterize the main damage mechanisms and identify relevant limit states
- Provide insights on effective monitoring strategies

Kinematic parameters

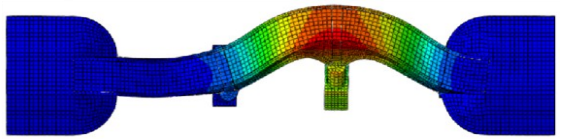


Modal parameters





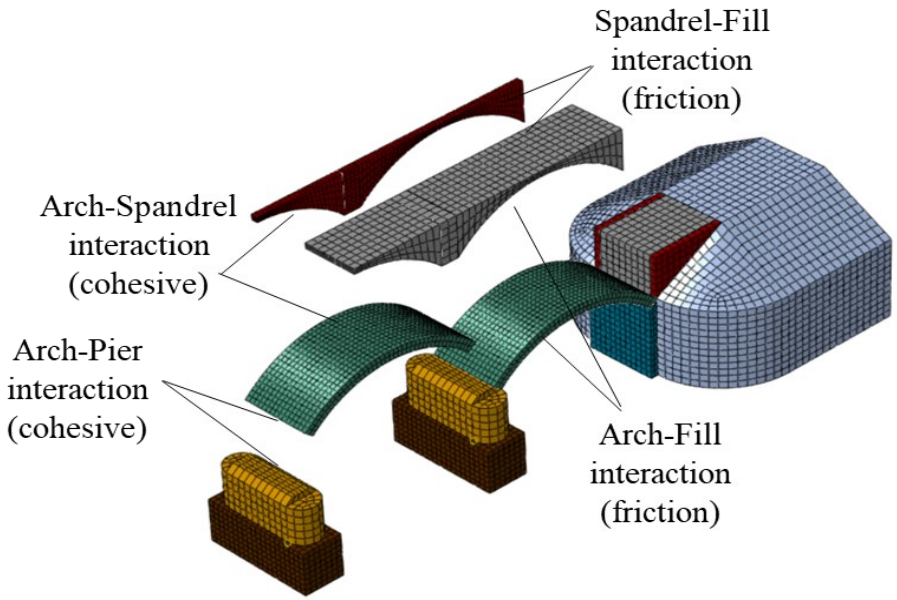
Frequency variation

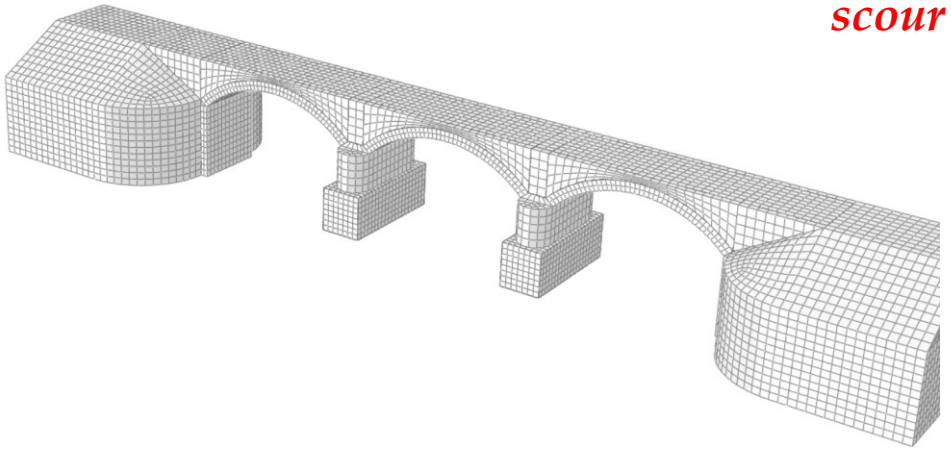


Mode-shape variation

Abaqus finite element model

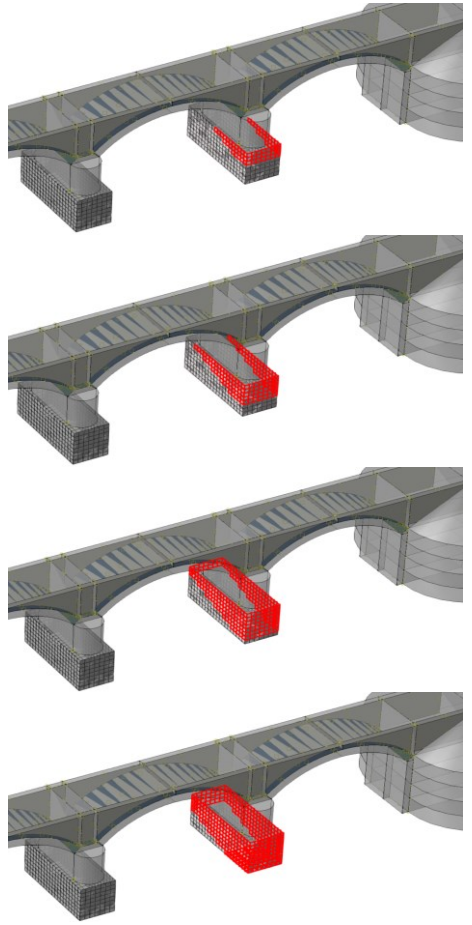
- 3D solid elements; different NL constitutive laws and damage criteria; large displacements analysis
- Interface elements to model the separation between critical parts
- Winkler modelling approach (Gazetas 1991) for soil-foundation interaction





scour

Scour simulation:
soil elements deactivation



Main Conclusions

- The performed study aims to better understand how masonry arch bridges respond to scour progression.
- The study on the bridge response predictors and damage mechanisms is an undergoing activity.
- The changes in frequency observed with scour evolution are negligible for scour depths lower than the foundation height.
- High sensitivity of transverse mode shape since the early stages of the scour progression, i.e., for scour depths lower than the foundation height.
- Potential suitability of mode shape-oriented scour monitoring strategy.

Further details can be found here

Scozzese, F., Ragni, L., Tubaldi, E., & Gara, F. (2019). Modal properties variation and collapse assessment of masonry arch bridges under scour action. Engineering Structures, 199, 109665.

Tubaldi, E., Macorini, L., & Izzuddin, B. A. (2018). Three-dimensional mesoscale modelling of multi-span masonry arch bridges subjected to scour. Engineering Structures, 165, 486-500.

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