Proceedings of the 8th International Conference on Civil Structural and Transportation Engineering (ICCSTE'23)
Canada – June 04-06, 2023
DOI: 10.11159/iccste23.003

Multi-Level Modelling Strategies for Accurate Assessment of Masonry Arch Bridges

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Abstract - This keynote lecture presents multi-level FE modelling strategies developed within the Computational Structural Mechanics group at Imperial College London for nonlinear simulation of masonry bridges. Most masonry bridges and viaducts were built more than a century ago and are still in use representing key components of roadway and railway infrastructure systems in different countries around the world. Material deterioration and increased traffic loading have led to the progressive development of damage and cracking in the brick/blockwork potentially leading to substandard performance. Accurate assessment is required to evaluate structural safety and guide the implementation of effective strengthening measures. It should be based on a realistic representation of the complex interaction among the different components including arch barrel, spandrel walls, backfill and piers in multi-span bridges. The developed 3D and 2D mesoscale and macroscale models for masonry bridges are based on different scales of representation to model material nonlinearity in masonry. Backfill materials are modelled by elasto-plastic continuum descriptions taking into account the inherent cohesive and frictional characteristics, while the physical interfaces between the different masonry parts and the backfill are represented by nonlinear interfaces allowing for separation and sliding. Detailed mesoscale models enable separate descriptions for masonry units and mortar joints providing a high-fidelity representation of the material response and the incorporation of existing damage and cracking. More efficient macroscale models guarantee a reduced computational cost. They still allow for the typical 3D response of masonry bridges but require detailed calibration of the model material parameters. Numerical examples comprising comparisons against the results from physical experiments on full-scale specimens and monitoring data on realistic bridges are presented for a critical appraisal of the developed multi-level modelling strategies for masonry arch bridges.