Limit analysis for masonry arches: influence of pier texture, arch shallowness and joint friction

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Abstract. Among the most characteristic structures in historical constructions for crossing large spans are the masonry vaulted structures. By utilizing their ability to withstand compressive forces and giving a particular curve to compensate for their lack of tensile strength, such distances can be overcome. In the case of ancient masonry, a pier's ability to bear such stresses and safely convey them to the support is directly related to its structural health, as well as a number of other factors [1]. Additionally, historic masonry usually has dry or weak mortar at the joints, concentrating the weaknesses at these spots. In this case, Heyman's infinite friction hypothesis may not be accurate for the assessment of existing structures as it is not able to capture the sliding mechanism [3]. Therefore, a rigid block model with no tension and frictional joints may be suitable to account for the discontinuous nature of the masonry and, with very few input parameters, provide reliable safety assessment in terms of collapse mechanism and multiplier [2], able to seize both rotational and sliding modes. Using an in-house code [4,5] that utilizes limit analysis as a rigid block approach to modelling masonry with frictional joints, a study on the crucial parameters impacting the safety level of piers under the thrust of arches is performed. The pier texture, joint friction angle, and arch shallowness, namely shallow, semi-circular, and pointed arches, were investigated under two load scenarios: horizontal and concentrated vertical live load. The main findings of this work show that all studied parameters have a significant influence on the structure response. Higher friction values, sharper arches and piers that follow the rule of art result into higher collapse multipliers.

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