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FE MODELS FOR THE EVALUATION OF HYDRODYNAMIC PRESSURE ON CONCRETE GRAVITY DAMS DURING EARTHQUAKES

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Abstract: Earthquakes are a significant factor in the design and safety evaluation of dams and, in this context, an accurate prediction of forces acting on the structure is needed. The hydrodynamic action plays a key role in this regard and its accurate evaluation is a major issue. Most of the earthquake analyses of gravity dams in the past have ignored the interaction between dam and reservoir. The equivalent body of hydrodynamic forces, the "added mass" model, derived from the well-known Westergaard theory, is nowadays the most widespread approach still adopted in modern design codes. Nevertheless, taking into account Fluid Structure Interaction (FSI) is sometimes more appropriate, though more complicated.
In this work, hydrodynamic pressures on a large Italian gravity dam have been calculated using different modelling approaches: rigid barrier, deformable dam with added masses and FSI. Frequency domain analyses have been carried out both on plane strain models and on more refined 3D models, by applying a horizontal acceleration to the dam base. The comparison among frequency response curves obtained from 2D and 3D models highlights noticeable differences concerning resonance frequencies and peak response values, even with the same modelling approach.
This study demonstrates that simplified 2D added-mass models may be over-conservative compared to 3D FSI simulations.
Concluding, it can be argued that full 3D coupled analyses should be preferred to simplified 2D ones to estimate the hydrodynamic pressure acting on the upstream face of the dam during earthquakes.

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