Frequency Response Analysis of Soil-Structure Interaction for Concrete Gravity Dams

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Introduction: The structural safety assessment of concrete gravity dams during earthquakes requires the evaluation of different interacting subsystems involving the water reservoir and the terrain half-space. In this study the effects and possibilities of different modeling techniques are investigated.

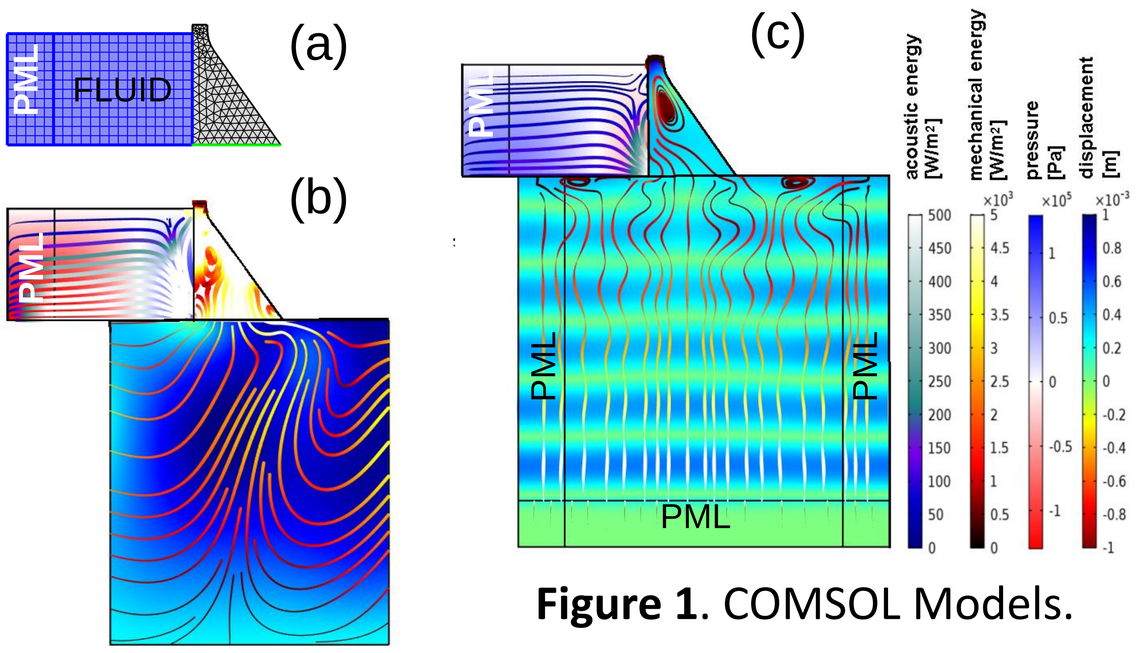

Figure 1. COMSOL Models.

Computational Methods: The solid mechanics and acoustics interfaces are used, in the frequency domain. Three models are compared, a rigid terrain (a), a massless terrain (b) and an infinite terrain model (c). In all cases, the same prescribed acceleration at the dam base is provided. In the first two models, the acceleration is prescribed at the boundaries, while, for the third model, the application of a cinematic condition at the interface between dam and soil must be avoided because it stops the outgoing waves. The problem is overcome through the global equation functionality, by applying a distributed force load at the PML interface, enforcing the prescribed acceleration at the dam base.

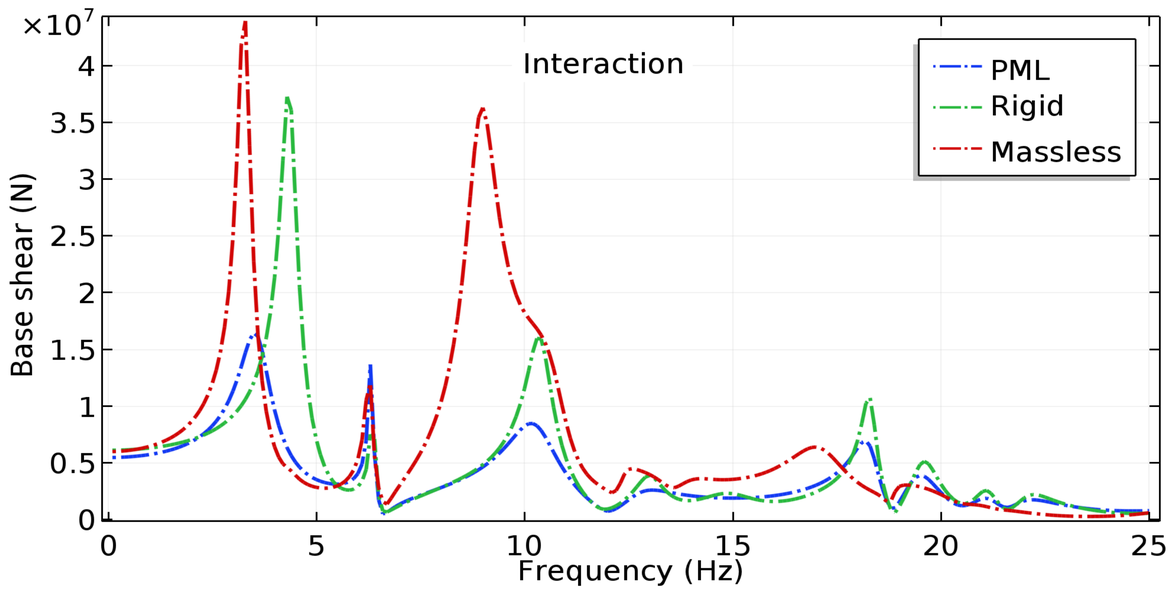

Figure 2. Frequency response for the three models.

Results: A noticeable reduction of the response is visible in the infinite terrain model, displaying the “radiation damping” phenomenon, that increases the apparent damping of the system (figure 2).

Parametric study: The same problem is then solved for different concrete and terrain material properties, to investigate the system response bearing the different values, via *LiveLink*™ for MATLAB®.

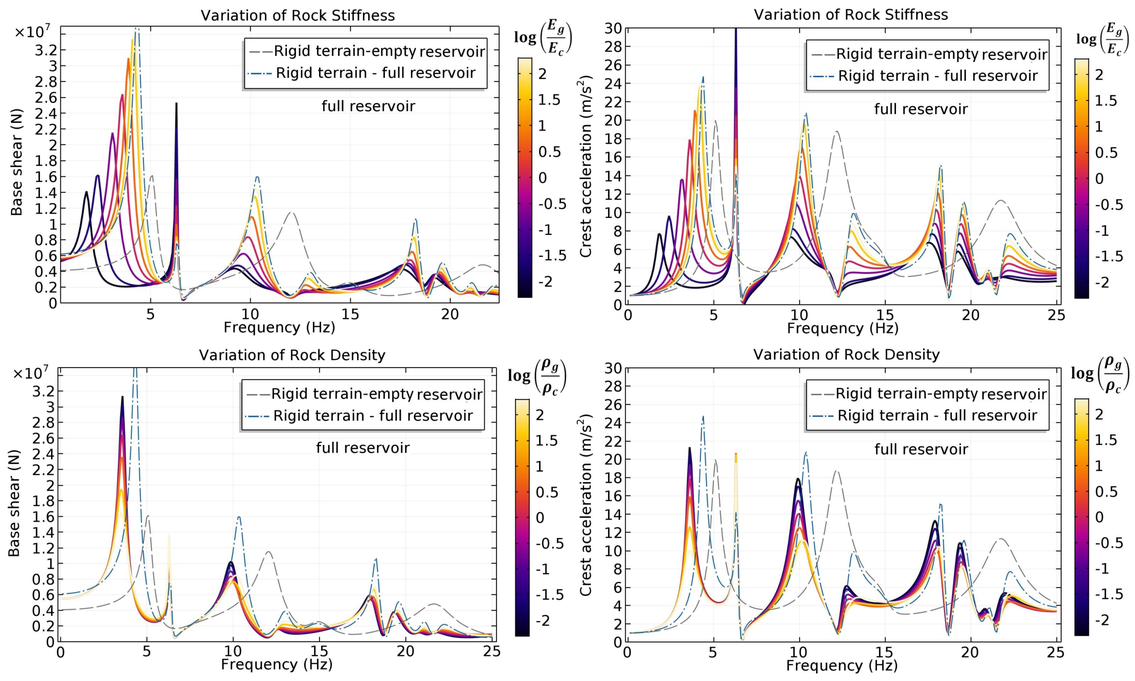

Figure 3. Parametric variation of system response with density and stiffness of soil and concrete.

Conclusions: COMSOL Multiphysics® has proven to be a valuable tool for investigating non standard structural mechanics and interaction problems, in this case the equivalent damping provided by the terrain radiation is estimated.

References:

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