SEISMIC TOMOGRAPHY TESTS APPLIED TO A GRAVITY DAM

P. Capizzi¹, R. Martorana¹, C. Pirrera², A. D’Alessandro³, F. Bucalo¹

¹ Dipartimento di Scienze della Terra e del Mare (DiSTeM) Università degli Studi di Palermo, Italy
² Self-employed geologist
³ Istituto Nazionale di Geofisica e Vulcanologia, Centro Nazionale Terremoti, Roma, Italy

The control of the safety assessment of a dam is largely dependent on knowledge of the mechanical parameters of the actual construction, as well as its geological substratum (Karastathis et al., 2002). The application of geophysical methods can be used in existing dams to evaluate the materials (strength properties) and to verify if they match design expectations, as well as to contribute to the safety control (Bond et al., 2000; Kepler et al., 2000; Loperte et al.,...
In particular seismics methods can considerably contribute to the examination indicating the less consolidated material and the degradation of mechanical parameters (Karastathis et al., 2002).

For the characterization of the concrete conservation three seismic tomographies (TS4, TS10 and TS14) and a vertical seismic profile (DH) on the dam body were performed (Fig. 1).

All seismic surveys were performed using the digital seismograph X610-S (M.A.E.). Three 2D seismic topographies were carried out in the body of the dam, energizing on the upstream and receiving signals on the downstream face. The receiving points were spaced of 2.5 m, while the source points were positioned with spacing of 1 m. A total of 704, 888 and 744 raypaths were used for TS4, TS10 and TS14 respectively. The energizations were made using a sparker source. In particular it was used the IPG800 pulse generator that provides an energy up to 1000J to 800V to the BIS-SH-DS probe, by means of an electrical impulse. The different depths of immersion of the source is linked to the different level of filling of the sediment in the lake.

Traveltime data were inverted using the commercial software package GeoTomCG, based on the tomography program 3DTOM (Jackson and Tweeton, 1996). It performs inversions with the simultaneous iterative reconstruction technique (SIRT, Peterson et al., 1985). SIRT calculations modify an initial velocity model by repeated cycles in three steps: forward computation of model travel times, calculation of residuals and application of velocity corrections to the set of voxels contained in the model. The cycle recurs through a specified number of iterations. For a more accurate estimation of the P-wave velocity, a curved ray inversion was performed with a revised form of ray bending, derived from the method given by Um and Thurber (1987).

The three tomographic models (Fig. 2) show similar velocity distributions, with P-wave velocity ranging between 3000 m/s and 4500 m/s. Variations of the velocity values can be justified by different degree of water saturation. Really P-wave velocity values increases in the presence of water filling the porous of the concrete (Karastathis et al., 2002). High velocity values can then be associated to infiltration areas, which seem to be present in the lower part of the dam body. In addiction, all velocity models show slightly lower values in the highest part of the dam body still remaining within the typical range of a good quality concrete.

Finally, at the TS10 section of the dam body a vertical seismic profile (DH) was acquired. The vertical seismic profile showed P-wave velocity ranging between 3800 m/s 4750 m/s and
S-wave velocity ranging between 1100 m/s and 2520 m/s (Fig. 3). Also in this case lower values are present in the upper part of the dam body, as well as show the three seismic tomographies. Even Poisson ratios show typical values of the concrete in good condition, varying between 0.29 and 0.41 (at the upper part of the dam body), which are representative values for concrete.
Fig. 3 – Vertical seismic profile of P-wave velocity at TS10 section.

Acknowledgements. We would like to thank the “Carruba e Margiotta Ingegneri Associati” group and Geolab srl for funding the research and for assistance during the data acquisition.

References


