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Design, conception and realisation of high energetic mechanical impacts on a civil engineering structure to evaluate sensing techniques in ISTIMES project framework

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One of the objectives of ISTIMES project is to evaluate the potentialities offered by the integration of different electromagnetic techniques able to perform non-invasive diagnostics for surveillance and monitoring of transport infrastructures. Experiments in controlled conditions are so necessary to analyse the characteristics and potentialities of diverse EM sensing techniques for the infrastructure monitoring. The full-scale rockfall test station of Montagnole (French Alps) owned by IFSTTAR has been so used to test a long cement concrete beam laid on two supports like a structure.

This testing station located on top of a 80m high cliff is able to drop blocks weighing up to 20 tons, at heights from 5 to 70m. It enables targeting any point on a half-circle measuring 12 meters in radius. Hence, the wide experimental area at the bottom of the cliff which can be impacted by a block allows to test some parts of building structures against impact at scale 1. Observation platforms at ground level and on top of an embankment enable one to monitor the experiments.

In order to facilitate measurement testing and analysis, a simplified structure was designed and built. A reinforced concrete beam of 16 m long, 0.5 m width and 1 m high has been realised. It leans on two pillars screwed on two foundation structures realized at ground level. Experiments addressed the progressive damage, at different stages, of the concrete beam submitted to falling blocks impacting the soil close to the structure (indirect impact) and in a second phase directly onto the beam. So, the different sensing techniques studied in ISTIMES were evaluated during and between these high energetic mechanical impacts. Steel blocks of 2.5 and 10 tons were used and two falling actions scenarios were unrolled:

• The first falling action aimed at studying and diagnosing structural damage induced by an indirect impact on ground of the ball close to the structure. The approach leant on a progressive energy release thanks to blocks dropping from various heights.
• The second falling action aimed at studying and diagnosing structural damage induced by a direct impact of the block onto the reinforced concrete beam. In this second configuration, due to the high risk of rapidly breaking the concrete beam only the 2.5 Ton steel block was used and also tested with a progressive energy release approach (two small heights 1m and 5 m).

These experiments allowed to test the following EM technologies:
• Distributed Optical Fiber sensors,
• Electrical Resistivity Tomography,
• Electrical Capacity Tomography,
• Hyperspectral spectroscopy,
• Ground Penetrating Radar,
• Infrared Thermography,
• Optical Displacement Monitoring,
• Ground based Synthesis Aperture Radar.

During experiments rapid digital video camera and geophones at ground level were also used to have complementary information on the structural damage process.

Finally, these experiments were used to validate the implementation in real site of different sensing techniques in controlled condition and evaluating the synergetic effect of above mentioned EM technologies.

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