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Ambient vibration measures on strategic buildings in Matera in the framework of the CLARA-Smart Cities project

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Ambient vibration techniques can be profitably used for non-invasive diagnosis of the structural integrity of buildings. Standard Spectral Ratio (SSR) or Horizontal to Vertical Spectral Ratio (HVSR) techniques are good indicators of the dynamic structural behavior of buildings and of their interaction with the subsoil foundation. Thiswas one of the operational objective of the project “Cloud plAtform and smart underground imaging for natural Risk Assessment” (PROGETTO Smart Cities - CLARA).
In October 2015 a survey has been performed on 6 of 10 buildings that were identified to be tested in the city of Matera. Tri-axial tromographsTROMINO® have been used, with a sampling frequency of 128 Hz and a 12 minutes time window of ambient noise recordings. Data have been analyzed with HVSR and SSR by the Grilla software.
Free field surveys have highlighted a clear high amplitude frequency peak at a 1.5 Hz in all the testing sites, showing a significant impedance contrast between calcarenites and shallow sand and clay.
The buildings tested were:
- “LiceoPascoli” High School. The structural modes are at 2.7 Hz for the transverse component and 4.2 Hz for the longitudinal one.
- “Loperfido” High School. Mode frequencies were identified at 3.4 Hz, 4.3 Hz, 5.7 Hz, showing an asymmetrical behavior and a probable rocking mode at 3.4 Hz.
- Firefighters head office, under construction. Mode frequencies were very clear at 4.5 Hz on the N-S direction and 6 Hz on the E-W direction.
- City Hall. The structure is more complex than the other buildings analyzed. Many structural modes have been identified: 1.8 Hz and 2 Hz (coupled modes), 2.8 Hz and 4 Hz.
- Province building.It has a peculiar plant, cake slice shaped. This was the only site were the free field survey showed a higher frequency peak, at 5.2 Hz. The structural frequencies identified were at 3.7 Hz (longitudinal) and 4.7 Hz (transverse).
- Architecture building – University of Basilicata. Only one structural mode was identified, at 6 Hz, since the building has only two floors and the center of the building is empty.
Using these techniques the building structural characterization can be very fast (two or three buildings per day), cost effective and informative, since it is possible to detect mode frequencies and double resonance effects.
Moreover, two force-balance accelerometers and low cost accelerometers were installed at the top and bottom of the City Hall building to verify if MEMS accelerometers could be suitable for building monitoring, the CLARA Smart City project aims to the comparison of co-located accelerometers. We analyzed the behavior of the building with these different type of sensors during small earthquakes occurred during the monitoring period.