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The damping ratio and the resonance frequency represent relevant health indicators in structural health monitoring, and they are key parameters in the design of buildings. The combination of two modal parameters (i.e., damping, frequency) is reported to vary in time due to changes in environmental conditions and with damage to the structure and dynamic loading. Amplitude dependence of the damping and frequency parameters has also been reported for strong loading, such as strong winds. However, none of these reasons can explain the much higher fluctuations of the damping values compared to the resonance frequency in the amplitude range of natural ambient vibrations. The objective here is to investigate if any amplitude dependence in this lower range of loading can explain the observed differences in the scattering of these two modal parameters. To do so, the first approach consists of a study of vertical clamp-free beams made out of different materials. Secondly, the observations and interpretations obtained are scaled up to buildings under continuous monitoring. Finally, we consider the fluctuation–dissipation theorem to explain these uncommon results.

Site Effects in the Val D'agri Basin, Southern Italy

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The Val d'Agri area (VA), which is one of the areas with the highest seismic hazard in Italy, hosts the largest on-shore gas-/oilfield in Europe. Since 2002, the operator installed a local seismic network to monitor the seismicity of the area and to study the potential influence of industrial activities on it. Recently, the Italian Government decided to assign the monitoring duties to an independent external consultant *(SPM)* and published experimental guidelines *(ILG)*, which describe the recommendations to follow for the geophysical monitoring of hydrocarbon extraction, waste-water injection and gas storage. Exclusively in the event of incompressible fluid injection, the *ILG* propose the application of an alert system, which entails specific measurements, in case that seismic parameters exceed specific thresholds levels. The reference parameters that have to be monitored inside an area called Inner Domain *(DI)* - a 3D-volume 5 km around the operation area are PGV, PGA and magnitude.

VA basin is a quaternary tectonic basin located in the Lucanian Apennines, filled by Plio-Pleistocene deposits overlapping Mesozoic-Paleogene Lagonegro unit and Miocene flysch succession. The Lucanian Apennine is characterized by a thin-skinned thrust system tectonically superimposed on a deformed carbonate substratum (Apulia platform). All these seismic parameters are sensitive to the complex geological setting of the area, hence, using a fixed-threshold activation system can be a misleading approach. During this *ILG* test-period, one of the purposes of the *SPM* is to adjust for the specific site the threshold values imposed by the guidelines. Therefore, this study aims at: the evaluation of the network quality by analyzing the noise level at each seismic station; estimating the contribution of the local geological structure on the site response at each station by applying spectral-ratios techniques, on earthquakes and microtremor recorded by the VA network.

Rotation in Civil Engineering Structures: Analysis of the City-Hall (Grenoble) Building Using 3C and 6C Sensors

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Civil engineering structures are often modeled as single-degree-of-freedom systems, taking into account only horizontal translation forces. However, their response to seismic loading produces rotational forces that can in some cases generate considerable stresses and resultant damage. These rotational forces are essentially related to (1) rotational deformation about both horizontal axes (rocking), resulting from ground-structure interactions, considering the structure as a rigid body; (2) rotation about the vertical axis (torsion), essentially activated when the centre of mass (i.e. where the seismic inertial forces apply) is offset from the centre of rigidity (i.e. where the elastic forces apply). The simplified model including the rotations of the ground-structure interaction is based on modal decomposition, i.e. each component of the motion is assumed to be independent of the others. Thus, in structures, only translational sensors are usually installed and the rotational components are evaluated via the spatial derivatives of the horizontal and vertical components. However, there are combinations of translations and rotations and rotations can only be evaluated by measuring all 6 components of motion (3 translations and 3 rotations). In this presentation, a simple analysis is made to explain the rotations observed in the City Hall building in Grenoble (France), a 12-story reinforced concrete building. This building has been continuously monitored for 10 years, with 3-component accelerometers located at the bottom and top. Modal decomposition is performed using ambient vibrations. A set of earthquake records is then used to evaluate rotations using derived functions and compared with the records of a 6C rotation sensor temporarily installed at the top of the building. The comparison between the direct rotation measurement and the spatially derived rotation is performed.

Does Nonlinear Soil Behavior Affect Kappa Estimates?

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The high-frequency attenuation parameter kappa was introduced by Anderson and Hough (1984) to describe seismic high-frequency attenuation from ground motion records. Current research and applications of kappa focus on the linear elastic regime and understanding the relationship between kappa and other attenuation descriptors such as material damping ratio. Because soil nonlinear behavior is often triggered at soft sites subjected to strong ground shaking, the investigation of the applicability of kappa in the nonlinear regime is important. To fill the identified gap, we use the Japanese Kiban-Kyoshin network (KiK-net) database that is rich with high quality records at various site conditions to evaluate the effects of soil nonlinear behavior on kappa estimates (including individual kappa values, kappa_r and the site-specific component kappa, kappa_0). Using PGA (peak ground acceleration) and shear-strain index as proxies to capture the in-situ stress-strain relationship, linear and nonlinear ground motions are identified at selected sites of interest. The acceleration spectrum approach is used to estimate individual kappa values. Based on the identified linear and nonlinear data sets, this work studies that (1) the site-specific dependency of kappa_r on soil nonlinear behavior (e.g., comparisons between kappa_r and shear-strain index) and (2) the relationship between soil nonlinear response and the estimated site-specific component, kappa_0.

Variations in Site Response Across Urban High Impedance Contrast Basins

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Seismic hazard research shows that there is an amplification of seismic waves where soft sediments overlay bedrock, which has implications on human and structural safety in major cities across the globe. This amplification can be attributed to the impedance contrast between the sediments and bedrock, where high impedance contrasts lead to significant amplifications. Additionally, one-dimensional vertical wave propagation through the soil layer and/or three-dimensional wave propagation effects across a sedimentary basin influence the magnitude of amplification at a given site. When the propagation behavior is one-dimensional and well-behaved, namely vertically propagating waves through horizontally-layered media (e.g. SH1D assumptions), the site response may be well predicted by the velocity profile of the underlying column of media (sediment and bedrock). However, when three-dimensional wave propagation effects are in-play, regional information around basin shape and velocity heterogeneities should be incorporated into site response analyses. Through comparison of the near surface amplification in two high-impedance contrast sedimentary basins: Boston, Massachusetts, USA and Mexico City, Mexico, we identify 1D and 3D contributions to amplification and provide insight into potential prediction methods of site amplification in similar high-impedance contrast environments.

We utilize the Horizontal to Vertical Spectral Ratio (HVSR), dividing the horizontal component Fourier spectra by the vertical component Fourier spectra, on inter-event ambient noise data and/or earthquake records at each station to obtain the fundamental site period. These data are combined with prior studies in both areas, such as Yilar et al. (2017) and Pontrelli and Baise (2019) in Boston and Mexico City, respectively, to relate spatial patterns of fundamental site period and amplification ratios with characteristics of each sedimentary basin, with the goal of discriminating between 1D and 3D basin effects.