

EVALUATION OF THE LOCAL SITE EFFECTS OF THE UNESCO WORLD HERITAGE SITE OLD CITY OF DUBROVNIK (CROATIA)

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1. Introduction and aim of the study

The most seismically active region in Adriatic part of Croatia is the SE coastal region that have numerous cultural heritage sites. Therefore, it is important to estimate seismic risk for cultural heritage sites and to develop procedures for seismic risk assessment. These are the goals of the research project Seismic Risk Assessment of Cultural Heritage Buildings in Croatia (SeisRICHerCRO, <https://seisrichercro.wordpress.com/>) funded by the Croatian Science Foundation.

Local site effects, a known problem in earthquake engineering, play significant role in earthquake damage distribution. The old town of Dubrovnik is particularly vulnerable in terms of local site effects because the old city is built on three geomorphological and geological entities: southern bedrock ridge, central filled and flattened part (former sea embayment), and northern bedrock ridge. Apart from the last devastating historical earthquake in Dubrovnik area in 1667 of M~7), instrumentally recorded strong earthquake on 15 April 1979 M6.8 with mainshock at the epicentral distance of 105 km from Dubrovnik caused strong damage effects in the wider Dubrovnik area (intensity of VII °MSK) with incalculable damage to cultural and historical objects the old town Dubrovnik (Fig.1).

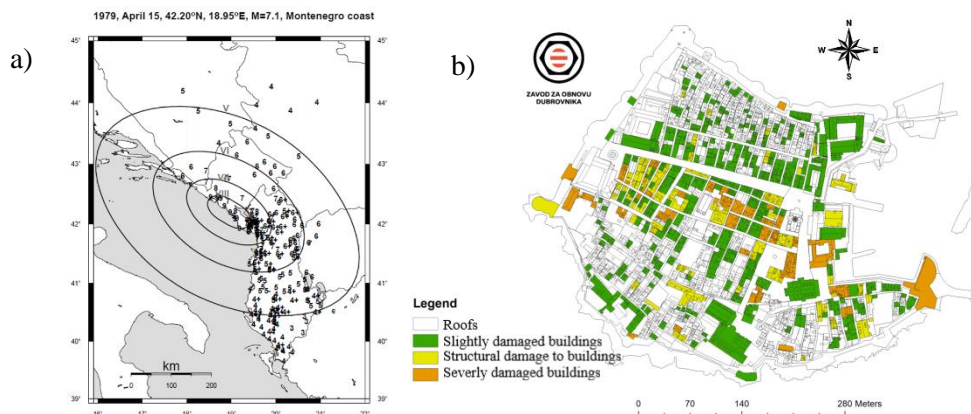


Figure 1. a) 15 April 1979 M6.8 earthquake damage [1] b) damage to the Old City of Dubrovnik [2]

The main aim of this study is mapping of local site effects variations in the old city of Dubrovnik using old investigation data as a starting point from 1980's, after 1979 Reconstruction of Dubrovnik. Data quality and spatial uncertainty brought by older equipment used in 1980's compared to using novel and sophisticated geophysical research methods followed by new geological investigations will significantly improve planning and reconstruction of Dubrovnik following new microzonation maps.

2. Main results and conclusions

Non-invasive microtremor Horizontal-to-Vertical-Spectral Ratio (HVSR) [3] and geophysical Multichannel Analysis of Surface Waves (MASW) [4] have been adopted as common seismic site characterization methods (especially in heritage sites instead of expensive and invasive drilling) for the purpose of this study (Fig.2) with examples of analysed HVSR and MASW results.

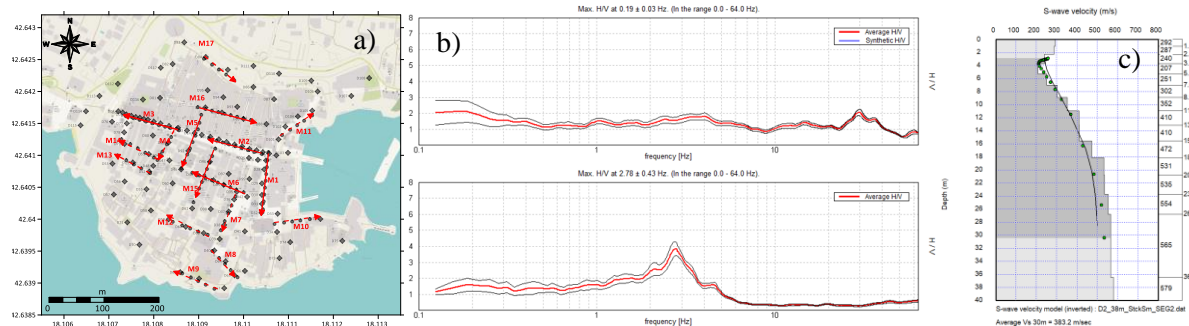


Figure 2. a) Map of microtremor measurements (grey markers) and MASW profiles (red lines), b) example of HVSR frequency curves (D27, D83), c) example of 1D MASW Vs profile (profile M2)

Based on individual results and using interpolation methods, mapping of the local site effects in the Old City of Dubrovnik in terms of site resonance frequencies, H/V amplitudes, Vs30 and carbonate bedrock depths can be derived following revision of the Eurocode 8 [5]. Definition of the seismicity and variations of the local site conditions are one of the inevitable phases of the complex process of repair and strengthening of existing structures in the old town Dubrovnik together with design seismic parameters and the seismic risk level of building inventory as a basis to define the necessary preventive measures against expected strong earthquakes in the future.

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