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Urban Reflection Seismics: A High-resolution Shear-wave Survey in the Trondheim harbour area, Norway

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A shallow reflection shear-wave seismic survey was carried out in mid summer 2008 in the harbour area of Trondheim, Norway, that suffers from prominent landslide events in the last decades. The harbour has been built on man-made land fillings at the coast of the Trondheim Fjord in several expansions implicated in some submarine landslides, which are reported since about 100 years. Whereas high-resolution marine seismic methods mapped the fjord area in detail in the range of decimeters, the seismic investigation below the infilled and paved harbour area was a difficult challenge.

Therefore, SH-polarized shear-wave reflection seismics was applied experimentally, and the field configuration was especially adapted for the application on paved surfaces with underlying soft soil of estimated more than 150 m thickness. A land streamer system of 120 channels (geophone interval of 1 m) was used in combination with LIAG's newly developed shear-wave vibrator buggy of 30 kN peak force. This mini truck is designed for full environment-friendly urban use and enables fast and sensitive operation within a seismic survey area. The sweep parameters were configured to 25-100 Hz range, 10 s duration, using 14 s recording time sampled by 1 ms interval. Shear wave frequencies above the used frequency range, which can also be generated by the seismic source, were avoided consciously to prevent disturbing air wave reflections during operation. For an advantageous solution for the seismic imaging of the subsoil down to the bedrock a grid of 4.2 profile-km was gathered.

The data recorded experimentally in the initial seismic survey stage achieved finally a highly resolved image of the structure of the sediment body with ca. 1 m vertical resolution, clear detection of the bedrock, and probably deeper structures. The profiles were processed up to FD time migration, and indicate that slip planes, turbidity masses and other features relevant for geohazards are present within the top of the bedrock. Due to the clear and continuous reflection events, also the shear-wave velocity could be calculated at least down to the bedrock to indicate the dynamic stiffness parameters of the sediment layers.