Site-effect study

There is in the area in the central part of Izmir expected to be significant site effects potential during an earthquake which produces large ground motions, as mentioned in the paragraph concerning the ground motion simulations there have been conducted in this project. This expected site effect potential is due to that the north-south extension in western Anatolia produces large graben structures, like the origin of Izmir Bay. This basin, which underlies most of the metropolitan area of Izmir, contains accumulated sedimentary deposits. Furthermore, the large river delta of the Gediz river, on the northern part of the Izmir Bay, has brought fluvial deposits to the area, as well as smaller rivers has done on the southern part of the city. Finally the large expansion of the city due to fast development of the metropolitan area has engendered several artificially filled coastal areas.

In the part of this projects which concerns site effects there is focused on the potential of amplification of the seismic waves due to the sediment layers that overlays the bedrock of the area. The ground motion simulations which have been conducted in this project are all found for bedrock level, and therefore the potential site effects are not taken into account in the estimations of ground motions.

During this project there has been conducted fieldwork in a part of Izmir, located near the seaside on the northern side of the Izmir Bay. The aim of this fieldwork was to collect and process data in order to get a better idea of the site effect potential due to sediment layers during a large earthquake in this region. In order to do this we have chosen to use two different approaches, that in the end will give us information on which frequency content of the seismic wave there are woundable for amplification, and secondly we aim to estimate how much the simulated seismic waves during an earthquake will amplify due to the sediment layers.

The applied techniques are both previously verified. The first is known as the H/V technique and have been applied in several studies, (Atakan et al., 2004; Giardini et al., 2003; Jimenez et al., 2003; Nakamura, 1989). In this method the ration of the horizontal and vertical components of a three component seismic station is found in order to determine the fundamental frequency of the site. The second approach uses array measurements of the ambient noise from two stations with varying inter-station distances to derive the dispersion curves from the surface waves and afterward to obtain a shallow structure velocity profile, (Bensen et al., 2007; Mooney and Bolt, 1966; Rodriguez and Havskov, 2007).

Field area

The fieldwork was conducted during a stay in Izmir, Turkey in October 2007. There were done field measurements in two sites on the northern side of the Izmir Bay, see figure 1a. One site located in Mavişehir and the other site located west of Mavişehir in Cigli. The two sites are described shortly in the following.

The area of Mavişehir is a populated area, where there are mainly constructions of -20 stores high apartment building which are placed very close to each other. There was collected data along three different lines in the area, located relatively close to the sea side (from approximately 100-500 meters inland), see figure 1b. As it is evident form the panorama picture in figure 1c, the land in Mavişehir is very flat, and the building are built just above sea level (approximately 1 m).

Figure 1: Pictures showing the area where the fieldwork concerning site effects were conducted. Upper left, a), shows an overview satellite picture of Izmir, from Google Earth, where the field area in Mavişehir is marked by a yellow box. Picture b) in a more detailed picture of Mavişehir, also from Google Earth, where the three lines on which we conducted array measurements are marked and numbered from 1 to 3. The lover picture, c), is a panorama picture of Izmir taken from the castle of Kadifekale viewing towards west. The low land of Mavişehir is shown in the red box, photo from Louise W. Bjerrum.

The area in Mavişehir is land that previously was covered by the sea and only 20 years ago the shore line was placed approximately 500 meters to the north. Before the constructions in

this area were built, it is assumed that the area was re-worked and filled with construction materials of 3-4 meters. The whole area is very flat and the ground was observed to be very soft.

During the data compilations several people living in the area showed knowledge about the bad ground conditions in the area, and this information even came from children in the age of 7-10 years. A man, approximately 30 years old, told us that when he was a child, the area behind line 3, see figure 1b, was often flooded and that the picked up sea shells in this area when he was a child. Further more we were told, that the tall houses, around which we collected data, is approximately 10 years old, and they already have cracks inside since the traffic in the area makes the building move. Closest to the sea side there are some rows of lower buildings, these a visible tilted and the traffic from outside is easily felt in these houses. Also we were told that the water level in the area is very high, something which was evident after a large rainstorm in the area just before the field work, where the water from the rain was yet not sunken into the ground after four days of dry weather, see figure 2.

Figure 2: Picture of the ground in Mavişehir four days after the last rainstorm, the wather has yet not sunken into the ground due to the very high water level in the area. The picture is taken towards south, and the Izmir Bay is approximately 100 meters away, in front of the park complex in the background.

In Mavişehir there was collected data on three sites, see figure 1b, with the arrays striking in different directions. Line 1 was oriented north-south, line 2 striking east-west and finally line 3 oriented southeast-northwest.

In addition to these measurements a site west of Mavişehir, named Cigli, was chosen, see figure 3a. In this area there are not built any constructions yet, and the preparation for

constructions, filling the ground with materials, have not started. Of this reason the sediments from when the land was drained from water and deposits from the river delta is visible on the surface, see figure 3b and c. The measurements done on this site is meant as a reference for the measurements done in Mavişehir. The area large flat area on the river deposits are furthermore planned to be the location of the new International airport of Izmir, in case Izmir is chosen to host *Expo 2015*, and it is of this reason extra interesting to estimate the site effects in this area.

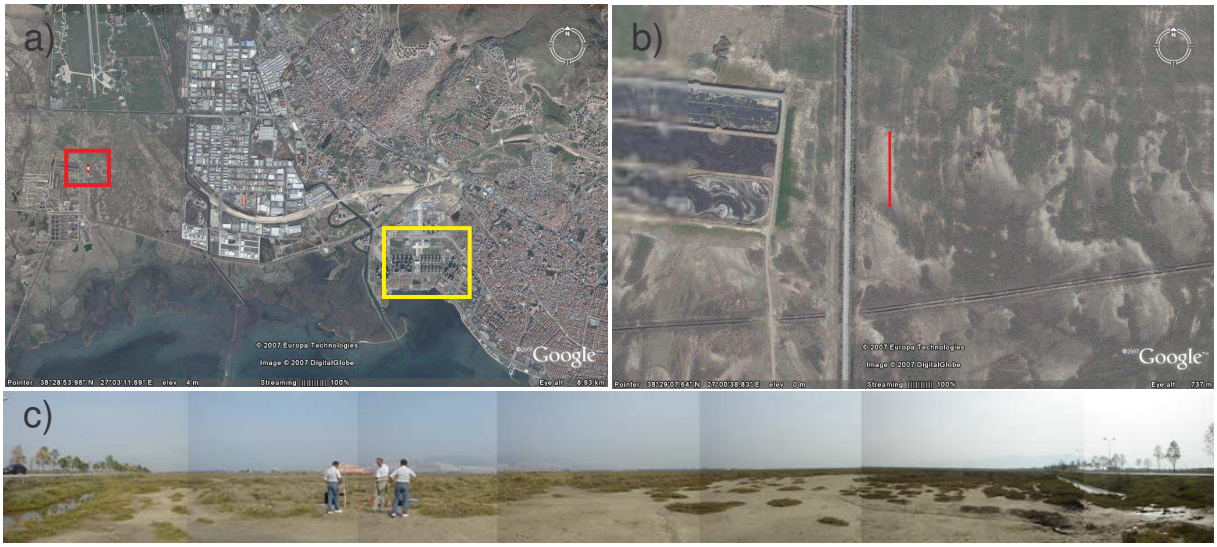

Figure 3: To the left, a), satellite picture from Google Earth, where both the populated area of Mavişehir (in the east) and the field area in Cigli, away from the constructions and on the bare sediments, which is marked by a red box. To the right, b), are shown a more detailed picture of the field area of Cigli, and the fine grained sediment layers are visible on the surface, also from Google Earth. The red line represents the line along which the array measurements were recorded. In the lower picture, c), is shown a panorama picture from the site, where it is evident that the area is very flat and uncovered.

On the Cigli site the instruments was therefore placed directly on the sedimentary layer, and the ground was quite water saturated due to the heavy rain only four days prior to the fieldwork on this site. The flat land has previously been sea bed, but has been dried in order to make room for future constructions.

Data compilation

For each site there was made both recordings for H/V analysis and array noise measurements. The methods are shortly described in the following.

H/V analyses are an estimate of the spectral ratio between the horizontal channels to the vertical channel. The date required for such an analysis is therefore a recording on a three component seismometer. In order to get sufficient data there is needed records of noise free data for 15-20 minutes form one site.

In the array noise analysis the ambient noise is used to produce dispersion curves and from these estimate the shallow shear wave velocity structure of the area. The data used for such an analysis are gathered from two vertical 4.5 HZ geophones, which are connected a digitizer, and the recordings therefore results in recordings on two traces. There are gathered several sets of data with a length of 7-10 minutes, and for each recording the inter-station distance is changes. In this fieldwork it was chosen to collect data in an array with 11 points (from 0-100 meters distance, with a spacing of 10 meters). This method is not as woundable to noise as the H/V method.

Processing of the data

The data obtained in the field has yet not been fully processed. It has been realized that the data gathering at the first site in Mavişehir (striking north-south) was not successful; there seem to have been a problem with the connections. The data for the H/V analysis has been roughly processed in the field in order to check that the data quality is acceptable, but no further analysis has been done on this work.

The processing of the ambient noise data for the array measurements, is still going on. During this process the aim is to write a detail description of this work. Until now there have been obtained correlations curves for the data at all the inter-station distances for the data gathered at two sites in Mavişehir and the site in Cigli, an example of this from Cigli is shown in figure 4.

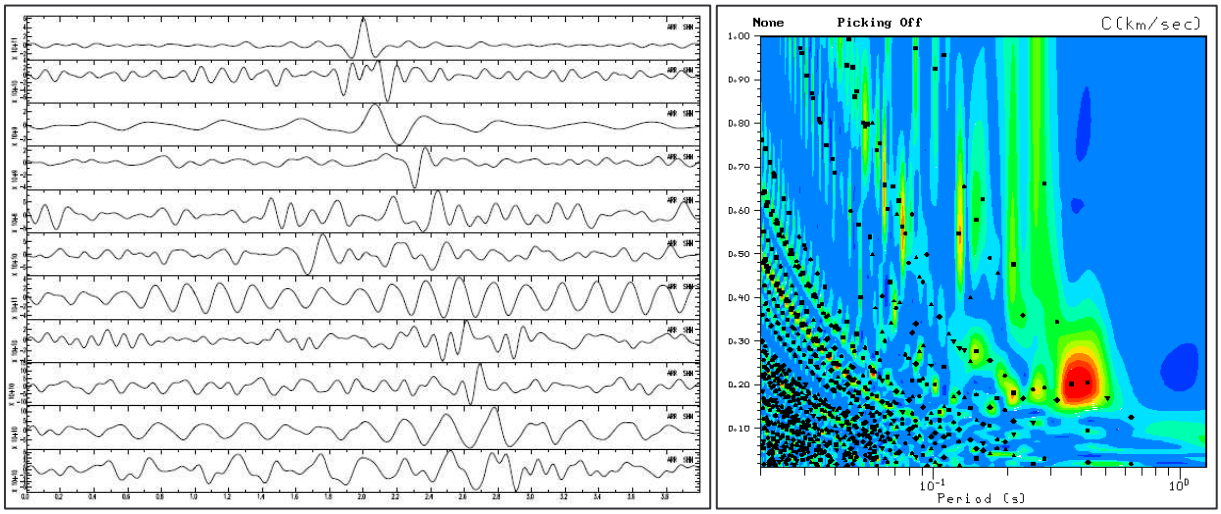

Figure 4: Left is shown correlation curves for the records obtained in Cigli. Top line corresponds to 0 meters inter-section distance, and then the distance increases with 10 meters from signal to signal. To the right is shown the plot from which the dispersion curves for the phase velocity is going to be picked, also for Cigli.

Further more the dispersion curves of the phase velocity are ready to be picked in the plot shown to the right in figure 4. This work will continue during the next couple of months.

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