O3-1	MODELLING OF SH WAVE PROPAGATION IN SEDIMENTARY BASINS

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We modelled SH wave propagation in a sedimentary basin using finite difference method. Sedimentary basins are of great importance as places having substantial concentration of population in the earth. Due to the soft material filling the basin, they seriously affect the propagation characteristics of the waves passing through during earthquakes or explosions. These effects are the displacement amplifications, resonance, and attenuation of high frequencies, focusing of seismic waves and surface wave generation. Especially in the western part of Anatolia, there are such sedimentary basins with dense populations. These basins were generally formed by horst/graben systems.

There is an important earthquake activity in the western Anatolia because of active tectonic regime. The region has experienced a N-S extension since the late middle Miocene. This results in an E-W trending horst/graben system. The earthquake activity mentioned above is related with the fault zones created horst/graben structure in the region. This means that the cities situated in such basins in the region are seriously at risk of earthquake. Thus, studying of the seismic wave propagation in sedimentary basins is vital for earthquake engineering and microzonation studies in the western Anatolia.

In both seismology and seismic, modeling of the wave propagation is widely used. Calculating the response of the earth to a signal, that is, seismogram is the main purpose of seismic modeling. There are different methods to obtain seismograms. The discrete coordinate method is one of them. When there is no an analytical solution to the problem, numerical solution of the elastodynamic equation can produce a solution. The discrete coordinate methods can be divided into three main groups as the following:

a) Finite differences,
b) Finite elements,
c) Spectral methods.

The advantages of these methods are that earth models with arbitrary variations of velocity, density and elastic parameters can be included easily; and that one can display the wave field (snapshots) during solution (Ergintav and Canitez, 1992). For these reasons, we employed finite difference method to simulate SH wave propagation in sedimentary basins.

The wave equation for the horizontal shear displacement in two-dimensional medium is given by

$$\partial / \partial t(\partial w / \partial t) = (1/\rho)(\partial / \partial x(\mu \partial w / \partial x) + \partial / \partial z(\mu \partial w / \partial z)) \qquad (1)$$

where w is horizontal shear displacements; r (x, z) and m (x, z) are density and rigidity respectively; x and z are coordinates; and t is time. Due to the similarity, observed by Sato (1954) , between the equation (1) and the acoustic wave equation in a heterogeneous medium, one can use the same computer program developed for acoustic wave modelling to model SH wave propagation by some minor modifications in the parameters (Kelly, 1983).

As mentioned previously, the advantage of the finite difference modelling of SH wave propagation is that arbitrary shear modulus and density fields can be handled easily. We used a second order accuracy in both time and space for the finite difference approximation of the derivatives.

We achieved a zero normal stress component at the top of the model for free surface condition. We applied Reynolds' (1978) absorbing boundary conditions to suppress the edge reflections.

By using different basin models, we examined the effects of velocity contrast between the basin and underlying basement rock, the depth of the basin, the dipping walls of the basis on the amplitude amplification, resonance, and surface wave generation. We observed that sedimentary basins caused the seismic energy to be trapped in the basin; and that this led to increase duration, resonance and surface wave (Love wave) generation.

References

Sato, Y., 1954, Study on surface waves X: Equivalency of SH waves and sound waves in a liquid: Bull. Earthquake Research Inst. (Tokyo), v. 32, p. 7-16.

Reynolds, A. C., 1978, Boundary conditions for the numerical solution of wave propagation problems: Geophysics, v. 43, p.1099-1111.

Kelly, K. R., 1983, Numerical study of Love wave propagation: Geophysics, vol. 48, p. 833-853.

Ergintav, S. and Canitez, N., 1992, Jeofizikte Modelleme, Ed: Nezihi Canitez, Literatur Yayincilik, Istanbul.