Site Characterization of the Sedimentary Cover at the Himalayan Foothills using Active and Passive Seismic sources for estimation of Earthquake Hazard

A.K. Mahajan and Nitesh Rai

Wadia Institute of Himalayan Geology, 33, General Mahadeo Singh Road, DEHRA DUN. India, akmahajan@rediffmail.com

The characterization of the sediments, down to bedrock, is very important from the seismological point of view in order to study the possible earthquake effects (site effects). Shear wave velocity and the thickness of the subsoil above bed rock are the key parameters in estimating the seismic hazard of any site. Several non–invasive geophysical methods are increasingly applied for geotechnical investigations as they can identify material properties and material boundaries as well as variation in space and time of relatively large volume of soil. However, the depth of penetration using different methods always remains a matter of concern for sediments having thickness more than 100 m in frontal part of the Himalaya and Gangetic plains. The thickness of the soft sediments above bedrock in frontal part of the Himalaya varies from few meters to more than 100 m, whereas in Gangetic plain (Ganga basin) the thickness goes beyond 400-500 m. In order to deal with this problem we have used active and passive seismic sources with different field configuration to target bedrock level. Different soil investigation methods have been applied around the Himalayan foothills and Ganga foreland basin, focusing on three sites with different soil characteristics in northwest Himalaya (Fig.1). Active and passive array experiments were carried out using: Multichannel Analysis of Surface Waves (active MASW), Passive Remote MASW and F-k technique. A dispersion curve was estimated for every site covering a wider frequency band rather than if only one method would have been used. Combining the information provided from active and passive experiment using MASW has provided the information down to 150 m in Doon valley and 300 m down to Ganga basin thus reaching the bedrock level in Doon valley (Fig.2). However the use of F-k method in the same sites provided depth penetration more than 500 m thus, reaching the bedrock level in Ganga basin as well (Mahajan et al., 2011). Combining the information provided by all the methods and after applying neighbourhood algorithm, the best suitable shear (S) wave velocity profiles were estimated for each area (Fig.3). In this way, soil sediments were characterized by the resonance frequency, the soil thickness and the mean S-wave velocity. The study has demonstrated that the use of different methods give coherent and more robust results than when only one method is applied which are required for estimations of site specific seismic hazard.

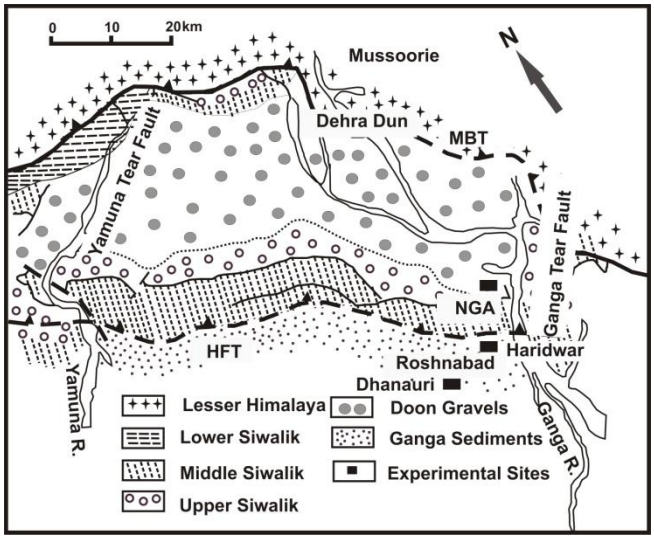

Figure 1: Location map of experimental sites in northwest Himalaya for that span from the Doon valley the site characterisation using active and passive seismic methods

Reference

Mahajan, A.K., Galiana-Merino, J.J., Lindholm C., Mundepi A.K., Rai, N. and Chuahan, N., 2011. Characterization of the sedimentary cover at the Himalayan foothills using active and passive seismic technqieus..Journal of Applied Geophysics, 73, 196-206.

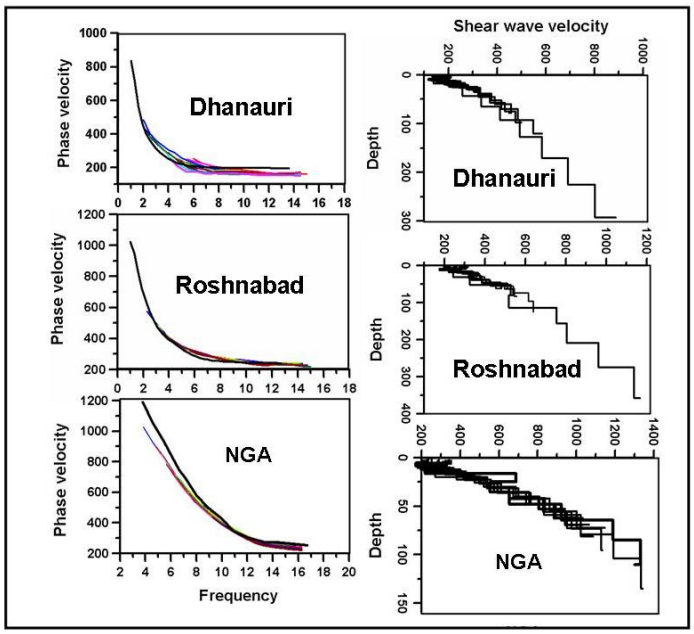

Figure 2: Dispersion curves and associated Vs profiles using different 12 offset positions in active MASW and circular array in MASW passive experiment.

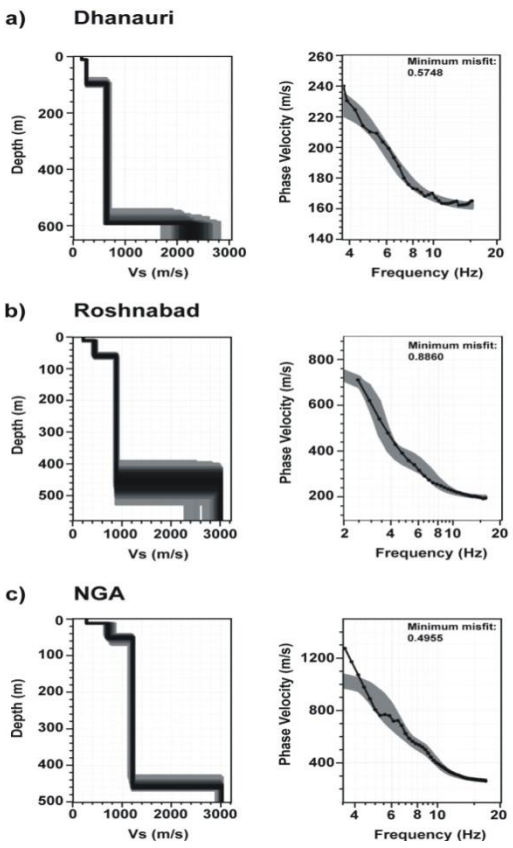

Figure 3: Vs profile and associated dispersion curves estimated for the three sites Dhanauri (a) Roshnabad (b) and NGA(c) (Modified after Mahajan et al., 2011).