Shear Wave Velocity Investigation for Ten Representative Sites of National Capital Territory, New Delhi, India

A.K. Mahajan, Wadia Institute of Himalayan Geology, India
A.K. Shukla, Earthquake Risk Evaluation Center, India
Ajit Pandey, Earthquake Risk Evaluation Center, India
Mukesh Chauhan, Wadia Institute of Himalayan Geology, India
Neetu Chauhan, Wadia Institute of Himalayan Geology, India
Nitesh Rai, Wadia Institute of Himalayan Geology, India

ABSTRACT

In this paper, shear wave velocity (Vs) investigations are carried out using Multichannel analysis of surface waves (MASW) method at ten representative sites in the NCT region, New Delhi. The analysis shows that the Vs obtained from the sites located on Alwar quartzites of Delhi Super Group ranges from 770 m/s to 2800 m/s, whereas on other sites located on lake/river sediments (Nazafgarh, Balsava and Akshar Dham) have Vs less than 180 m/s. The sites located on thick sediments shows Vs of the order of 180 m/s to 250 m/s. According to the soil classification, the sites covered can be classified under three categories: Class ‘B’ (Vs > 760 m/s; JNU site and Asola site), class ‘D’ (Vs > 180 m/sec-360; Bhavana, Suhalpur, Ghazipur and Kirbi cantt. sites), whereas the sites located near lake/river sediments are classified as class ‘E’ (with very soft soil) and will be prone to liquefaction potential during strong earthquake shaking.

Keywords: Delhi NCT Region, Liquefaction, MASW Technique, Shear Wave Velocity, Site Amplification, Soil Classification

1. INTRODUCTION

Rapidly growing population exceeding 16 million in National Capital Territory (NCT), New Delhi is subjected to significant seismic risk. Delhi, the capital city and its surroundings have experienced several earthquakes in the historical past (Kafi Khan, 1874; Iyengar, 2000). During the recent times the most significant earthquake was August 1960 (M 6.0) having its epicenter...
with in NCT, New Delhi (Srivastava & Somayajulu, 1966). The city also experiences ground vibrations due to Himalayan earthquake. The 1905 Kangra and 1991 Uttarkashi earthquakes cause damage of intensity VI, V respectively in NCT region. So the seismic status of Delhi, in terms of historical seismicity and intensity experienced in recent times indicates the influence of soft soil deposits. Further, Bhuj earthquake of 2001 and Kashmir earthquake of 2005 has well demonstrated that the unconsolidated materials of young sedimentary basins can have a profound effect on the spatial distribution of earthquake ground motion amplification, resulting in variation in the severity of damage to buildings, transportation corridors and other lifeline infrastructures. This had also been experienced during the earthquakes of Mexico City in 1985, San Francisco in 1989, Los Angles in 1995 (Kramer, 1996; Ansal, 2004). Most of the NCT region is also on either river/lake deposits or thick sedimentary deposits except ridge area (comprises quartzite bed rocks). The shear wave of near surface material has long been considered as a key parameter in thick sedimentary deposits (Borcherdt, 1994) and characterized as a best indicator of stiffness (Bullen, 1963; Aki & Richard, 1980). Most of the building codes are based primarily on average shear wave velocity in the upper 30 m soil profile (Kramer, 1996; Street et al., 2001; Gosar et al., 2008). The shear wave velocities have been computed for ten representative sites in NCT Delhi region to validate 1st level of microzonation map which discretizes the NCT into nine units based on quaternary-Holocene litho-fill content and other geotechnical data collected from different contributing institutions (Figure 1, Joshi et al., 2006; Shukla et al., 2007). So, the derived Vs profiles will be helpful to some extent for future planning of extensive shear wave velocity investigations.

Based on the extent of shaking experienced from Himalayan earthquake and from local earthquake within the city (Delhi earthquake of 1960, intensity XI; Srivastava & Somayajulu, 1966), it can be said that, this city is located in highly seismic hazard zone. The increasing urbanization and poorly planned development during the last two decades have further rendered the city more vulnerable to seismic risk. The objective of the study is to produce a scenario of shear wave velocity of the upper 20-30 meters soil column, which has been derived using a non-invasive method, called Multichannel Analysis of Surface Waves (MASW) and validate the first level microzonation map prepared by Earthquake Risk Evaluation center, New Delhi (Joshi et al., 2006).

2. GEOTECTONIC SET UP

National Capital Territory (NCT) of Delhi is located on a ramp of Proterozoic structural complex bounded by two regional faults viz. the Great Boundary Fault (GBF) and the Mahendragarh-Dehradun Fault (MDF) (Naqvi & Roger, 1986). It is surrounded in the north and east by Indo-Gangetic plains, in the south by the Aravali ranges and in the west by the great Indian Thar desert (Joshi et al., 2006). The Aravali range has been exposed and extends in NE direction, dividing the city asymmetrically into two parts. The older alluvium mainly covers the west-northwest part whereas the northeastern part is covered partly by older alluvium and partly by newer alluvium all along the Yamuna River (Joshi et al., 2006). The southwestern, southern and northwestern Delhi has natural depressions in the surface topography which are called Nazafgarh basin, Chattarpur Basin and Balsawa lake basin (Srivastava & Jalote, 1977). The exposed Aravali mountain ranges comprise mainly quartzites of the Alwar series. The Alwar quartzites are the basement rock exposed in the area and belong to the Precambrian age. They are composed mainly of quartzites with interbeds of mica sheets and are intruded locally by pegmatites and quartz (Krishnan, 1982). The rock of Delhi quartzites are highly jointed mainly with three set of joint directions. The effects of weathering are more pronounced along joint plains and pegmatites. The older alluvium deposits
Polymer Consumption, Environmental Concerns, Possible Disposal Options, and Recycling for Water Treatment
www.igi-global.com/chapter/polymer-consumption-environmental-concerns-possible-disposal-options-and-recycling-for-water-treatment/176519?camid=4v1a

Development of a New Blast Vibration Prediction Model Incorporating Burden Variations in Surface Blasting
www.igi-global.com/chapter/development-new-blast-vibration-prediction/65186?camid=4v1a