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Scenario of Secondary Hazard due to Liquefaction over National Capital Territory, Delhi, India - A case study

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Delhi the Capital of India is bounded by the Indo-Gangetic alluvium plains in the north and east, by Thar Desert in the west and by Aravalli hill ranges in the south. The terrain of Delhi is flat in general except for a low NNE-SSW trending ridge which is considereded an extension of Aravalli hills of Rajasthan. The National Capital Territory (NCT) of Delhi occupies an area of 1483 km^2 spreading between Lat $28^0 24' 01''$ & $28^0 53' 00''$ N and Long $76^0 50' 24''$ & $77^0 20' 37''$ E lies in Seismic Zone IV [IS 1893 (Part 1): 2002]. Delhi and its environs not only affected due to local earthquake in past [1720 Delhi earthquakes (M 6.7), 1803 Mathura earthquake (M6.8), 1956 Bulandshahar earthquake (M 6.7), and 1960 Faridabad earthquake (M 6.0)] but also affected by the Himalayan sources [October 20, 1991 Uttarakashi earthquake (M6.6), March 29, 1999 Chamoli earthquake (M6.5). October 8, 2005, Kashmir earthquake (M7.6), April 24, 2015 Nepal earthquake (M7.9) etc] The geotectonic complexity is further aggravated by long history of evolution of Delhi as a mega polis and its further growth with new emerging centers of suburban agglomeration under the new concept of National Capital Region (NCR). The complex interplay of seismotectonices, lithological assemblage in terms of soft sediment accentuation, and co-existence of structures of medieval period as well as the most modern skyscrapers and well-laid modern residential buildings set unique conditions, which need closer evaluation for Seismic Hazard. In this study we addressed properly the safety of fast growing urban capital city of population about 20 million which becomes seismically vulnerable along with its built environments with respect to the location of earthquake source and sites. Using huge data generated through geotechnical and geophysical investigations over an area of 1483km^2 under the seismic microzonation project of NCT Delhi, with appropriate field on instrument parameterizations.

Our analysis showed that the vertical variation of gravity value (g) and depth wise stress reduction factor are inter related with liquefaction potential, of the area estimated on the factor of safety (FS) are made estimated for about 449 sites using Cyclic Stress Ratio (CSR), Cyclic Reduction Ratio (CRR) and Modified Magnitude Scale factors (MSF), which showed its significant variation from 0.88 to 4.4. We infer that zonation of high liquefaction hazard corresponds to low FS (<1.0) and follows inversely related to each other. We documented the area into several zones in which high liquefaction hazard zone falls into region the eastern part of Delhi along Trans-Yamuna area. Liquefaction hazard also reported some other localized area over the NCT Delhi due to shallow ground water condition for post monsoon. Favorable depth of Liquefaction is observed up to the depth of 10.0m below ground level. These observations can be used for evolving earthquake risk mitigation plan for the NCT Delhi.

Key words: Factor of Safety, CRR, CSR, MSF, Liquefaction Hazard, NCT Delhi