Chapter 7
Seismic Behavior and Dynamic Site Response of Municipal Solid Waste Landfill in India

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ABSTRACT

Seismic behavior of landfills need for a better understanding of the dynamic properties of municipal solid waste (MSW) and site response of MSW landfill during seismic events. This chapter presents unit weight, shear wave velocity, strain-dependent normalized shear modulus reduction, and material damping ratio relationships for Mavallipura landfill based on field testing, laboratory measurements, and validated using semi-empirical methods. In addition, one-dimensional seismic response analysis by an equivalent linear method for Mavallipura landfill, Bangalore is done using software like SHAKE2000 and DEEPSOIL. Results indicated that the MSW landfill has less shear stiffness and more amplification due to the loose filling and damping, which need to be accounted for by seismically safe MSW landfill design in India. Also, results of seismic response analyses performed by the authors and other researchers are examined to assess the impact of stiffness and height of the landfill refuse fill on the overall response.

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INTRODUCTION

Disposal of municipal solid waste in engineered landfills is one of the most widely accepted waste management practices in the India and worldwide. During its design life, landfilled MSW undergoes several complex mechanisms controlled by physical, chemical, thermal, and biological processes and their interrelated behaviors. A thorough understanding of mechanisms of landfilled MSW interactions is critical in designing a stable, effective and well-operational landfill in seismic active regions in Japan. However, to date, the recent practices associated with mathematical modeling as well as long-term monitoring of landfill performance are mostly empirical and limited to site-specific conditions only. Moreover, they fail to substantially quantify the changes in the geotechnical properties of MSW that result from coupled processes, especially the highly uncertain biological processes that result in MSW degradation in landfills. Furthermore, the spatially and temporally varied waste composition, heterogeneous and anisotropic nature of field MSW together with leachate and landfill gas production due to biodegradation results in a typical differential MSW settlement and, therefore, can adversely impact the long-term performance of landfills (Reddy et al., 2017).

MSW landfills, are an integral part of waste management and disastrous consequences happen if seismic vulnerability of these landfills is ignored. Therefore, seismic response analysis of MSW landfills is receiving considerable attention these days. The Federal Resource Conservation and Recovery Act (RCRA, 1993) of the United States Environment Protection Agency (USEPA) was the first regulatory legislations that have addressed the importance of seismic loading on MSW landfills. RCRA stated that new MSW landfills or lateral expansions of the landfill located in the seismic zone must be designed to resist the maximum horizontal acceleration. The dynamic force is generated due to earthquakes and produces relative movements within the MSW landfill mass, cover and bottom liner system, foundation and their interfaces. This relative movement in landfill results in cover cracking, geomembrane tears and damage to the appurtenant systems for leachate and gas collection. Such damages were noticed in US landfills during the 1994 Northridge earthquake and was documented by Augello et al., (1995).

However, the seismic response of MSW landfill is very important, especially in seismically active zones (Krinitzsky et al., 1997). Due to seismic event, dynamic loading induces relative movements take place within the waste mass and the foundation, which results increased tensions in the landfill liner material may lead to tearing due to excessive stretching and also cracks developed at the top of the landfill thereby disrupts the function of leachate and gas collection system, ultimately leading to failures of these landfills.
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