Estimation of Settlements for Design of Facilities to be Constructed over MSW Landfills

Broad Area

Design and Development

Motivation/Need for the Study

Excessive land costs have prompted development of built facilities, such as residential and industrial buildings, roads, water supply and sewage pipelines, over inactive MSW (municipal solid waste) landfills and marginal lands in many urban areas across the World (e.g., Figures 1 and 2). Prominent among these sites where facilities have already been developed are the Leeder landfill, Vancouver (Canada), Colma landfill (USA), Rossman landfill (USA), Dhapa landfill (India). Eivemark (2002) describes typical engineering issues faced during the development of an industrial park over the decommissioned Leeder landfill. With the passage of time, municipal solid waste in a landfill decomposes and consolidates. Depending on the types of wastes present (e.g., construction and demolition waste, semi-decomposable and decomposable solid waste, etc.), the settlement can take place for many years. Because of heterogeneity of MSW, estimation of settlements for such material is difficult. Environmental Protection Agency of Ireland estimate a settlement as large as 10 to 25% of the depth of the landfill for facilities constructed over decommissioned landfills (EPA, 1999). For structural integrity of developments over MSW landfill, settlement is probably the most important concern (Sowers, 1973; Eivemark, 2002). Differential settlement leads to development of cracks rendering many facilities unserviceable within a few years (see, e.g., Figures 3 and 4). Unfortunately, no simple guideline is available for estimating differential and total settlements for construction of facilities over MSW. Therefore, this proposal would attempt to plug this knowledge gap.

Figure 1. Facilities developed ca. 2011 over an inactive MSW landfill at Dhapa, Kolkata, India

Objective and Scope of Work

- Correlations will be developed for compressibility of landfill materials using shear wave velocity, composition and maturity as parameters.

- A rational yet simple procedure will be proposed for estimating settlements using these correlations.

- Validation of the proposed procedure will be carried out with the help of field measurements.

Figure 2. Facility under development at Dhapa, Kolkata, India

Figure 3. Structural distress due to differential settlement in facilities constructed over Dhapa Landfill

Figure 4: Differential settlement and distress in facilities constructed over inactive MSW landfills (source: http://www.scsengineers.com)

Methodology

MSW landfills are highly heterogeneous material (Zekkos, 2005; Dixon and Langer, 2006; Hristovski et al., 2007). According to Hristovski et al. (2007), the MSW landfills in Macedonia are composed of metal (6.10%), glass (7.19%), plastics (7%), paper (24.47%), organic waste (23.99%), garden waste (8.70%), and other wastes (23.36%). In a broader sense, the MSW landfill materials can be divided into three categories, i.e., (i) non-decomposable waste, (ii) semi-decomposable waste, and (iii) decomposable waste. Based on the type of waste material present, the settlement can take place for many years. The amount of preloading applied to the MSW materials also plays a major role on the settlement characteristics of the landfills. Therefore, it can be stated that there are three major contributing factors, i.e., (i) composition, (ii) age, and (iii) compaction, which should be taken into consideration for finding out the differential settlement of foundations over landfills. Considering all these three major factors, in this present proposal, a series of field tests have been planned for assessing their influence. A few inactive MSW landfill sites will be selected for screw-plate testing to obtain the load-settlement curves from different depths and locations. Shear wave velocity of MSW, proposed as a measure of compressibility and settlement, will be

obtained from non-intrusive testing, e.g., MASW. In the field, the CSW (continuous surface wave) instrument will be used to obtain the Shear wave velocity profiles at the selected locations. Based on the data obtained from the field tests, the correlations will be developed for compressibility of landfill materials using shear wave velocity, composition and maturity as parameters. Validation of the proposed correlations will be carried out by using field test data obtained within model bioreactor landfills with a varied material composition after subjecting them to accelerated artificial ageing.

Outcomes/Deliverables:

- A simple and practical tool for estimating settlements of the facilities constructed over inactive MSW landfills to aid the geotechnical and structural design of infrastructural facilities in marginal lands underlain by MSW dumps. Such a tool based on rational engineering principles is currently available often leading to inadequate performance of facilities constructed on MSW dumps.

- Data obtained in this research and results of data analysis could aid further research on constitutive modelling of MSW – the current state of knowledge regarding which is far from complete.

Team Composition

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