# Evaluation Procedures for Estimating Lateral Spreading Displacement in Soil

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**Abstract**

It is important to recognize that lateral spreading does not require very loose soils to occur. It can produce potentially damaging deformations in medium dense soils, particularly when ground motion durations are long. The goal of this study was to use recent improvements in understanding of the lateral spreading and their effects on nonlinear site response to guide the development of improved predictive relationships for permanent displacement associated with lateral spreading. Lateral spreading is a complicated phenomenon and the mechanics by which it occurs are also complicated. A number of recent studies have helped illuminate the physical processes that control the development of lateral spreading deformations. Other studies have focused on practical, empirical procedures for estimation of lateral spreading displacements. This procedures was intended to produce a predictive relationship that is consistent with the known mechanics of liquefaction, lateral spreading, and nonlinear site response, and also with actual field observations of lateral spreading.

**Keywords: Displacement, Lateral Spreading, Liquefaction, Procedures**

## 1. INTRODUCTION

Because the damage caused by lateral spreading is closely related to the permanent deformations it produces, procedures for evaluating lateral spreading hazards have focused on estimating permanent displacements. It should be recognized that lateral spreading is an effect of liquefaction, i.e., that its occurrence is conditional upon the initiation of liquefaction. If liquefaction is not triggered, permanent shear strains will be small (though not zero) and, therefore, permanent deformations will be small [1].

A number of different approaches to the lateral spreading displacement problem have been proposed, ranging from purely empirical statistical correlations to numerical approaches based on nonlinear site response analyses with advanced constitutive models. These approaches adhere to basic principles of soil mechanics to different degrees and are consistent with field observations of lateral spreading behavior to different degrees[1].

Bartlett and Youd (1992) developed the first widely used empirical procedure for estimating lateral spreading displacement [2]. A subsequent extension of that procedure (Youd et al., 2002) has become a de facto standard in geotechnical engineering practice. However, the Youd et al. (2002) procedure, like its predecessor and imitators, is based purely on regression upon a database of observed lateral spread case histories. Youd et al. went to considerable lengths to investigate many different forms of the predictor variables before settling on those that were used in the final model. The variables used in the model reflect slope geometry, material properties, and level of earthquake loading, all of which are known to influence lateral spreading. However, the primary variable used to describe material properties – $T_{15}$ – introduces some potential limitations to the applicability of the Youd et al. model. The $T_{15}$ parameter implies behavioral characteristics that are inconsistent with the known behavior of liquefiable soils. $T_{15}$ is defined as the cumulative thickness of all sub layers with corrected SPT resistances of less than 15. This definition implicitly assumes that liquefiable soils with SPT resistances of greater than 15 provide no contribution to lateral spreading displacement, and that all liquefiable soils with SPT resistances less than 15 contribute equally to lateral spreading displacement. These implications clearly conflict with the known behavior of liquefiable soils. Furthermore, the T15 parameter makes no distinction between the contribution of a shallow soil layer (with a given $(N_1)_{60} < 15$) and a deeper layer of the same soil. These limitations can combine to produce potentially inaccurate estimates of lateral spreading displacement, particularly for thick deposits of potentially liquefiable soil [3].