



INDOT Research

TECHNICAL *Summary*

Technology Transfer and Project Implementation Information

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Mechanical Behavior of Non-Textbook Soils (Literature Review)

Introduction

Traditionally, soil mechanics has focused on the behavior of two distinct types of geomaterials: clean sands and pure clays. Under the application of external loads, these two types of geomaterials represent and are conveniently associated with two extreme types of soil responses: drained and undrained behavior. The drained behavior of clean sands and the undrained behavior of pure clays have been covered extensively in most soil mechanics textbooks. In order to provide some insight into the mechanical response of additional materials, a literature review on the mechanical behavior of “non-textbook” soils (i.e. soils other than clean sands and pure clays) was carried out. The non-textbook soils investigated in this study were silty sands, clayey sands, silty clays, sandy clays, sandy silts, and cemented soils. The review focused on the following aspects of their mechanical behavior: (1)

response to static loading; (2) response to cyclic loading; (3) compressibility, consolidation and creep behavior; (4) hydraulic conductivity; and (5) additional studies. Static response studies focused on both strength and stiffness properties of non-textbook soils. Investigations on the cyclic response emphasized the liquefaction resistance and, whenever available, the evolution of excess pore-pressure during cyclic loading. Whenever possible, an attempt was made to compile experimental protocols and theoretical frameworks used in the studies cited in the literature review. The literature review indicates that many aspects of the mechanical behavior of non-textbook soils have been studied in a somewhat superficial manner. A summary of the major observations regarding the mechanical behavior of non-textbook soils is presented. Topics meriting future research are identified.

Findings

The literature review indicates that many aspects of the mechanical behavior of non-textbook soils have been studied in a somewhat superficial manner. Topics meriting future research are identified and a summary of the major observations and conclusions regarding the mechanical behavior of non-textbook soils is presented below:

- (1). The selection of the best parameter to capture the influence of density state on the behavior of a wide range of geomaterials is an issue that still has not been resolved and should be further investigated. This has been shown to be particularly true for silty sands, clayey sands, and sandy silts.
- (2). The development of a suitable parameter that incorporates and properly quantifies the role played by soil structure into mechanistic analyses of geomaterials seems to be an open issue as well, particularly for materials such as cemented soils, silty sands, and clayey sands.
- (3). Constitutive modeling of cemented/structured geomaterials is a topic that shows great potential for future research. The literature review carried out on this topic suggests that the majority of the models currently available are unable to capture and integrate into the same framework all the relevant aspects of the behavior of these materials. This limitation is particularly

- evident with respect to foundation design in/on/with cemented soils.
- (4). The effect of sulphates on the degradation and expansive behavior of cemented geomaterials, particularly those artificially-cemented with Portland cement, has been pointed out in a few studies. Such a problem may have serious implications in pavement management systems constituted by a significant percentage of stabilized bases and stabilized/improved subgrade soils;

the mechanisms that control this phenomenon have been unsatisfactorily studied to this date.

Most aspects of the mechanical behavior of sandy silts, sandy clays, and silty clays have been studied in an extraordinarily limited manner and also show potential as prospective research areas. Silty soils and glacial tills are additional examples of non-textbook geomaterials commonly encountered in Indiana that also present great potential for future studies of mechanical behavior.

Implementation

Based on the findings above, additional research on the mechanical behavior of non-textbook soils, particularly regarding sandy silts, sandy

clays, silty clays, and cemented soils should be promoted.

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