Research Project

05-5GT

Capsule

Technology Transfer Program

LTRC

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Evaluation of the Base/Subgrade Soil Under Repeated Loading

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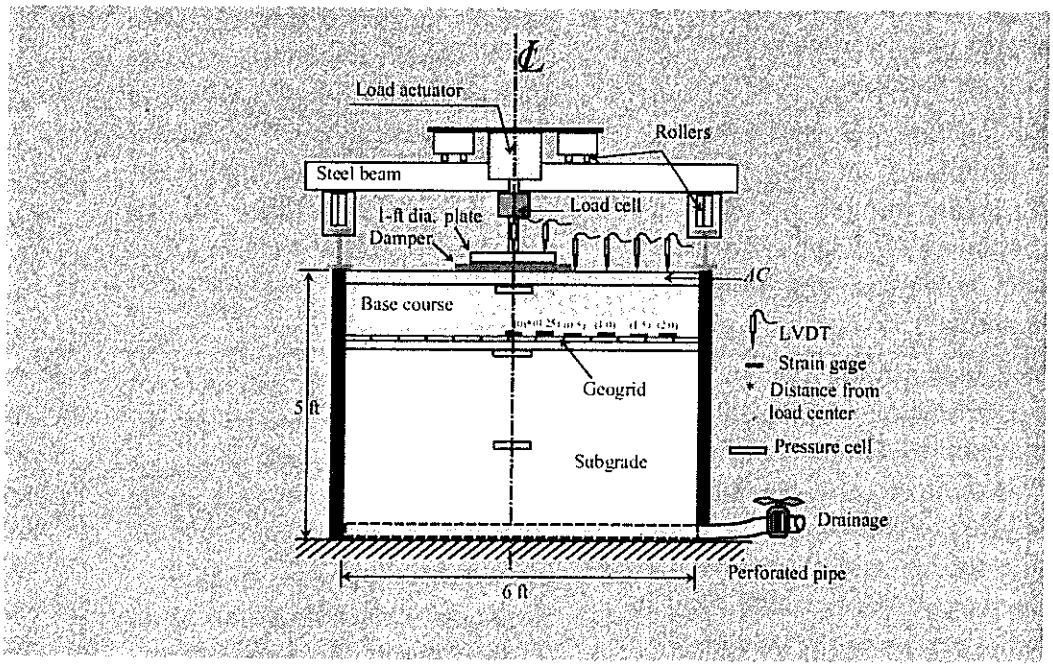
Problem

Effective, advanced, and reliable test facilities are necessary to keep up with the current advances in highway and geotechnical engineering. LTRC's Accelerated Loading Facility (ALF) at the Pavement Research Facility (PRF) is an example of such state-of-the-art equipment. It is used extensively for large-scale simulation of vehicular loads, particularly for pavement testing applications with different materials and pavement conditions.

However, due to the size of ALF, the length of the loading track, and long test duration, only a limited number of sections can be prepared and tested in a year. A reduced-scale portable facility is therefore needed to simulate vehicular loads on pavement sections and to possibly use for other various applications and test purposes.

LTRC conducted an earlier feasibility study that compared potential reduced-scale facilities: the wheel-beam assembly (vehicle simulator), the model mobile load simulator (MMLS3) facility, and the cyclic load actuator. The study recommended the cyclic load actuator facility for future research on paved and unpaved roads with var-



Schematic of the repeated load testing facility

ious test conditions pertaining to the subgrade, subbase, base course, and asphalt concrete.

Because this recommendation was mainly based on earlier research studies and consultation with experienced researchers, the cyclic load actuator needs to be validated, calibrated, and verified to assure the quality of its measurements and the reliability of its results compared to full-scale testing results provided by ALF.

Objective

The objectives of this project are

1) To develop an indoor load facility, including the design and construction of the load actuator test box and frame that can be used for testing paved/unpaved roads and simulating the actual field loads and conditions.

2) Validate the results of the cyclic load actuator, and then calibrate them with the results of the large ALF test sections, thus assuring the repeatability of section properties.

3) Conduct an experimental evaluation of the influences of subgrade strength and the reinforcement type and stiffness, as well as the base reinforcement benefits.

4) Conduct finite element analyses on sections similar to the pavement sections being tested. The finite element method will be used to simulate the conditions of the test pavements, conduct a parametric study of influential factors in the design of reinforced pavements, and attempt to evaluate the equivalent additional base layer thickness due to the presence of the geogrid reinforcement.

Description

After a detailed literature review, the researchers will design and construct the actuator box and reaction frame based on the following considerations: the minimum size requirements reported in the literature, facilitating testing under drained and undrained conditions, ease of placement and compaction of the materials used in the construction of the test section, selecting test box and reaction frame materials based on cost analysis, and enforcing the structural safety of the frame and connections with the box.

The project's experimental testing phase will be divided into two major categories. The first category will be comprised of conventional lab tests such as grain size distributions and material classifications, California Bearing Ratio (CBR), direct shear tests, triaxial tests, and consolidation tests (on fine subgrade soils). The second major category is the large-scale testing using the actuator facility, which will include eight indoor sections and three field test sections.

The repeatability of test sections and the quality control of the placement-compaction processes will be verified by comparing the results of identical sections. For the field test sections, relative responses measured by the actuator facility will be compared to relative responses measured by the LTRC-ALF facility. The findings from the indoor sections will be compared to the findings of studies on similar materials from the literature.

After its test results are validated, the actuator facility will evaluate the benefits of using three types of geogrid reinforcements. Finally, the ABAQUS program will be used to conduct finite element analyses. The results from the finite element analyses will be compared, calibrated, and validated using the results of the indoor tests on selected reinforced/unreinforced pavement sections. The analyses will also be used in a comparative parametric study to evaluate the contributions of different design variables and propose design alternatives.

Implementation Potential

The success of the proposed test facilities will lead to significant savings in pavement testing due to the reduced test duration, maintenance, and personnel. The test duration will be significantly less than that of the ALF, which will allow a larger test result database, thus enhancing knowledge pertaining to the evaluation/prediction of the behavior of similar structures. Moreover, implementation possibilities for future testing will be derived from the results of the comparative study of different pavement improvement methods.