RDT

Brief

Research Investigation 99-029
Research Report 03-001

July, 2003

Determination and Prioritization of Geotechnical Issues for MoDOT

Description:
Every local, state and federal transportation agency must deal with the challenges and consequences of constructing and maintaining infrastructure founded on soil and rock. This media (soil and rock) can be quite variable in its lateral extent and its properties. Often, subsurface conditions may be less than ideal but use of the existing media may be the only practical solution. Thus conditions for founding long term, high-performance infrastructure may pose a challenge and numerous resulting geotechnical problems, from acute landslides/slope failures to chronically deteriorating pavements, are evident in Missouri and nationwide.

During research meetings between Missouri Department of Transportation personnel and Civil Engineering faculty from the Columbia and Rolla campuses of the University of Missouri, it was decided to document the extent, distribution, frequency and importance of geotechnical-related issues in MoDOT's highways and adjacent rights-of-way. Such information has not been available and as a result, maintenance and research efforts are often scheduled on a "problem of the moment" basis rather than through evidence of the nature, extent, and importance of the issue. The goal of this project was to initiate the development of a baseline for the geotechnical portion of MoDOT's infrastructure by identifying, documenting, and prioritizing geotechnical isssues; i.e., those having to do with earth materials, such as slope instability, soil erosion, and pavement sub-grade instabilities.

Procedure:
A written survey was distributed to all District Geologists, Area Engineers, Resident Engineers and several Operations Engineers and Construction Inspectors. Interview and field verification trips were made to each District to document site conditions. All geotechnical related problems were considered; however, emphasis was placed on evaluating the effectiveness of recently implemented designs for bridge approach slabs and pavement edge drains. The geotechnical problems were prioritized and an evaluation of the effectiveness of recently implemented designs was provided along with recommendations for approaches which can be taken to solve the identified problems.

Results:
The principal geotechnical issues identified during the survey are listed in Table 1. Half of all the issues cited involve excess or uncontrolled water. A measure of each problem's importance was developed by combining the frequency of occurrence with the severity. The combined effect is reported as "Impact." The "Impacts" for the geotechnical issues identified in this project are given on a state-wide basis in Figure 1.

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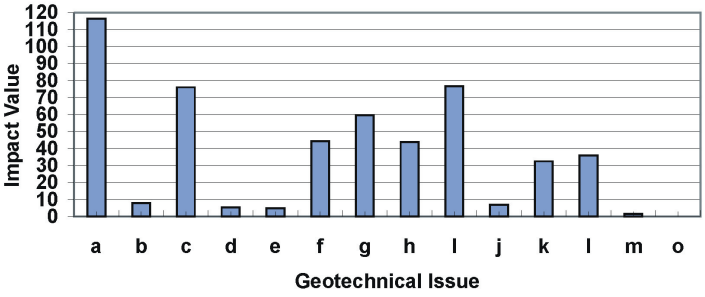
Table 1
Geotechnical Issues Identified During This Survey

Item	Geotechnical Issue
a	Soil Slope instability
b	Rock slope instability
c	Unstable pavement subgrades
d	Bridge foundation problems
e	Earthquake foundation problems
f	Scour under bridges and river banks
g	Bridge approach embankments and slab problems
h	Pavement subsurface drainage(edge drains) problems
i	Erosion on embankments, slopes and/or stream banks
j	Bridge abutments or earth retaining structure problems
k	Settlement Problems
l	Sinkholes/Mines

Figure 1
Statewide Impact for Each Geotechnical Issue Identified in the Survey



The top four geotechnical related challenges facing the Districts include: slope instability (soil); pavement (in terms of stability, sub-base support, and drainage); erosion control (both on new construction and long-term facilities) and bridge approach slabs. Every District reported soil slope instability as a major issue, typically in the top three concerns for the District (Figure 2). Field visits revealed the slopes to be too steep and of marginal

Figure 2
Slope Instability Observed During Survey

strength materials. Erosion issues observed included steep slopes, concentrated drainage or inappropriate materials being place in areas of concentrated drainage (Figure 3). Pavement problems were extensive across the state, i.e., poor quality surface and failure of pavement (Figure 4). The causes include: poor subsurface drainage, inadequate sub-base support, expansive soils and settlement. All Districts cited bridge approach slabs (BAS) as problematic (Figure 5). The redesign (c. 1993) has not alleviated the "bump at the end of the bridge." Causes varied from design of the approach slab to construction/inspection practices. Pavement edge drains (PED) appear to be working satisfactorily when the pavement has enough structural thickness. However, when the installation of the PED was not associated with other pavement improvements, the performance did not improve.

Figure 3
Erosion Observed During Survey

Figure 4
Pavement Problems Observed During Survey

Figure 5
Bridge Approach Slab Observed During Survey

Conclusions:

In general, the most critical or severe problems are those that are impacting the pavement surface (ride quality). Until a situation (slope, BAS, subsurface drainage, scour, erosion, etc.) begins to impact the pavement, there is a general feeling that the issue has a lower priority than those that are impacting the pavement. This perspective is understandable since it is generally the quality of the ride that the motoring public notices first. Other things being equal, if the ride is smooth, little attention (or funding) is given to solving problems that are in an early stage; e.g., poorly draining roadway or small slope failures. In certain instances, the full impact of problems such as roadway differential movements, small slope instabilities, and poor drainage are not realized since maintenance personnel have built-in programs to pave over or otherwise treat the 'symptoms' on a routine basis. However, the root cause of the problem is never corrected in many cases, which leads to long-term maintenance of items that could be corrected at the source with no further maintenance required.

Recommendations:

Three general recommendations, if enacted, will lead to a substantial reduction in geotechnical-related problems, reduced life-cycle costs and improved performance of MoDOT infrastructure.

The general recommendations are:

- Further increase involvement of MoDOT's geotechnical specialists in all phases of operations including the iterative process of the structural designs for bridges, walls and pavements; educating inspectors on the requirements for competent construction of geotechnical features in the transportation system; and collaborating with the maintenance forces to identify recurring problems that can be solved at the source.

- The Research Unit should institute long-term, performance monitoring programs to facilitate evidence-based changes in design, construction and maintenance practices.

- Specific research needs of high priority.
  - A detailed database on the costs of initial construction and maintenance of soil slopes is paramount to the effective reduction of effort and cost for remediation of failures of these slopes. A systematic evaluation of specific slope repair methods should be conducted.
  - Develop a spatial comparison of pavement ratings and maintenance/repair intervals correlated with pavement types, subsurface drainage systems and subsoil types among other parameters and verify with well-instrumented study of edge drains in new and remedial construction.
  - Laboratory and field evaluations to identify the key parameters involved in erosion control and field demonstrations to show what erosion control measures work and under what conditions.
  - A detailed study of bridge approach slabs to isolate key variables and pinpoint the sources leading to poor performance is warranted.

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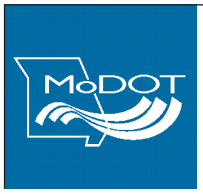

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