

**Project Title**

Compaction Testing of Granular Materials

**University**

South Dakota State University

**Principal Investigator**

Allen L. Jones, PhD, PE, Professor  
Department of Civil and Environmental Engineering  
South Dakota State University  
Brookings, SD 57007  
Phone: (605) 688-6467  
Email: allen.jones@sdstate.edu

**Research Needs**

The South Dakota Department of Transportation (SDDOT) and many other state DOTs have used the Ohio Department of Transportation's (ODOT) Typical Moisture Density Curves for the compaction of granular soil materials. However, the ODOT Materials Manual states "Moisture-Density proctor curves and controls were originally developed to be used on cohesive (clays and silts) soils. Errors or complications arise when trying to extrapolate these principals to granular materials." Therefore, additional information is needed by the SDDOT in assessing compaction of these materials. SDDOT is also using more materials recycled from PCC pavements and asphalt concrete pavements as subbase and base courses. Recycled materials are placed using the test strip method to determine how much effort is needed to achieve acceptable levels of compaction. Test strips work well for large areas but become problematic for small areas.

SDDOT has identified a need to reevaluate how they determine whether granular material has been compacted to the desired density. Most compaction testing has been performed using the nuclear gauge or sand cone methods, and the in-place density standard is determined by either the use of a test strip or a moisture density relation curve (Proctor). Some DOTs have started using newer methods such as the lightweight deflectometer (LWD), dynamic cone penetrometer (DCP), proof rolling and the use of intelligent compaction. The SDDOT wishes to examine how other DOTs determine the in-place density of granular materials. The SDDOT also wishes to determine whether the current Ohio curves are adequate for their needs or should be updated and whether the SDDOT needs to use different test methods to ensure adequate compaction.

**Research Objectives**

- 1) Evaluate the adequacy of using Ohio Curves for granular materials.
- 2) Identify existing and possible alternatives for determining target density of granular bases.
- 3) Determine whether an alternate method of testing compaction of virgin and recycled granular materials should be used.

## **Research Methods**

Through review of existing literature and practices at state and national levels, this research will first review compaction testing of granular materials as it applies to DOT construction. The research team will then obtain and analyze data from the SDDOT to determine if the Ohio Curves are a valid method for compaction testing. Based on this information, the most appropriate method for verifying compaction at SDDOT project sites will be evaluated. Based on the method (or methods) recommended, the research team will prepare the necessary technical documents for the SDDOT implementation including policies, procedures, or specifications needed to adopt new or revised compaction testing methods. Procedures and specifications produced, and costs will be determined for the revised or new compaction testing method.

## **Expected Outcomes**

This research will identify an all-inclusive compaction testing method for the SDDOT to adopt. The method will result in greater labor efficiency and is expected to result in construction cost savings.

## **Relevance to Strategic Goals**

The expected outcomes of this project are directly related to the following goals: State of Good Repair and Economic Competitiveness.

## **Educational Benefits**

This project will provide a valuable learning experience to a graduate student. A master's level graduate student will be hired to work on this project which will provide the material for a master's thesis. Results from the study can be incorporated into courses on advanced geotechnical engineering and pavement design.

## **Work Plan**

The proposed research work is divided into 10 Tasks. Following is a listing of the project tasks.

- Task 1: Meet with the project's technical panel to review the project scope and work plan.
- Task 2: Review and summarize literature pertinent to compaction testing of granular material.
- Task 3: Survey other state DOTs and federal agencies to document their methods, testing frequencies, procedures, equipment, and training requirements for granular compaction testing.
- Task 4: Compile data from past SDDOT granular material density tests and compare it to Ohio Curves to determine whether the curves can be used, new curves are needed or the department shouldn't use the curves and move to using a different method.
- Task 5: Determine the most appropriate compaction testing method for virgin granular materials and granular materials incorporating recycled materials by analyzing the survey and SDDOT density data.
- Task 6: Meet with the technical panel to review work completed on previous tasks and to present recommendations on adequacy of using Ohio Curves and new compaction testing equipment or procedures.

- Task 7: Prepare policies, procedures, or specifications needed to adopt new or revised compaction testing methods.
- Task 8: Estimate the costs, including personnel and equipment, of changing from current compaction methods.
- Task 9: In conformance with Guidelines for Performing Research for the South Dakota Department of Transportation, prepare a final report summarizing the research methodology, findings, conclusions, and recommendations.
- Task 10: Make an executive presentation to the South Dakota Department of Transportation Research Review Board at the conclusion of the project.

### **Project Cost**

Total Project Costs:	\$65,000
MPC Funds Requested:	\$27,071
Matching Funds:	\$37,929
Source of Matching Funds:	South Dakota Department of Transportation

### **TRB Keywords**

Compaction; granular material; Ohio Curves

### **References**

- Nazzal, Munir (2014). "Non-Nuclear Methods for Compaction Control of Unbound Materials", NCHRP Synthesis 456, Research Sponsored by the American Association of State Highway and Transportation Officials in Cooperation with the Federal Highway Administration, Transportation Research Board, Washington, DC.
- Drnevich, Vincent, Aaron C. Evans, Adam Prochaska (2007). "A Study of Effective Soil Compaction Control of Granular Soils", Final Report, FHWA/IN/JTRP-2007/12, Joint Transportation Research Program, Project No. C-36-3600, File No. 6-14-41, SPR-2783, Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration.