



# Design Guide for Subgrades and Subbases

tech transfer summary

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## RESEARCH PROJECT TITLE

Design Guide for Improved Quality of Roadway Subgrades and Subbases

## SPONSORS

Iowa Highway Research Board (TR-525)

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## SUDAS Program

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The mission of the Iowa SUDAS Corporation is to develop and maintain urban design standards and standard specifications for the State of Iowa that will be recognized, adopted, and used by state and local government, contractors, and consulting engineers as the acceptable standards for construction of urban public environments.

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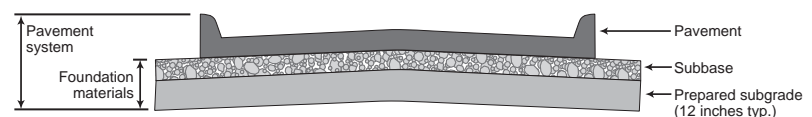
Iowa roadway engineers can help extend pavement life-spans by building stable and properly drained subgrade and subbase layers.

## Objectives

- Help Iowa roadway engineers improve the design, construction, and testing of a pavement system's subgrade and subbase layers, thereby extending pavement life
- Synthesize current and previous research into a practical geotechnical design guide, proposed to be Chapter 6 (Geotechnical) of the SUDAS Design Manual
- Recommend revisions to SUDAS Specifications Section 2010 (Earthwork, Subgrade, and Subbase) to improve construction specifications

## Problem Statement

The performance of a pavement depends on the quality of its subgrade and subbase layers. As the foundation for the pavement's upper layers, the subgrade and subbase help mitigate the detrimental effects of climate and the static and dynamic stresses generated by traffic. The subgrade, the layer of soil on which the subbase or pavement is built, provides support to the remainder of the pavement system and helps the layers above resist deflections caused by traffic loadings. The subbase, the layer of aggregate material immediately below the pavement, provides a drainage system that minimizes both undrained water (preventing freeze-thaw damage) and flowing water (preventing pumping of fines from the foundation). Building a stable and properly drained foundation is therefore vital for constructing an effective and long lasting pavement system.



Cross-section of a pavement system

Additionally, the subgrade and subbase must be spatially uniform according to geotechnical engineering parameters such as shear strength, stiffness, volumetric stability, and permeability. Several environmental variables, such as temperature and moisture, must also be taken into account, since these variables have both short- and long-term effects on the geotechnical characteristics.

However, a gap has emerged between the state-of-the-art understanding of subgrade/subbase geotechnical properties, based on research findings, and the design and construction practices for optimizing geotechnical parameters. Additionally, the typical roadway engineer, who must deal with design and construction issues in a short timeframe, may not be in a position to study each of the geotechnical characteristics and treatment options for subgrades and subbases.

## Overview of the Guide

The *Design Guide for Improved Quality of Roadway Subgrades and Subbases* provides guidance on the following topics:

- Iowa soil characteristics important for pavement foundation design
- Influence of climate, moisture, drainage, and unsuitable or nonuniform soils on pavement performance
- Characteristics of an optimum foundation for long lasting pavements, including key design parameters and measurable field properties
- Construction and testing embankments
- Potential subgrade problems encountered during construction
- Identifying, evaluating, and selecting reliable geotechnical treatments (e.g., moisture/density control, over-excavation and select replacement, soil stabilization, and cost-effective drainage)
- Identifying and selecting cost-effective subbases, based on roadway type, stability and drainage characteristics, construction site conditions, and subgrade type and condition
- Designing, building, and maintaining effective drainage systems
- Evaluating field in-place conditions using new, inexpensive, and effective in-situ testing tools

## Key Recommendations

Three features of the new guidance have been especially emphasized:

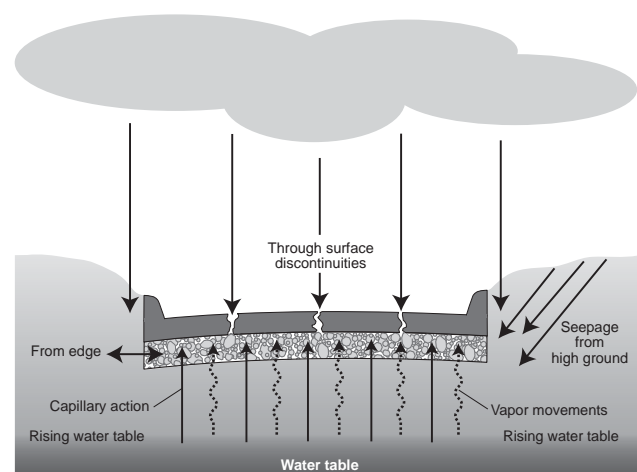
1. Strive for a California Bearing Ratio (CBR) value of 10 or greater. Research has shown that if a subgrade has a CBR value less than 10, the subbase material will deflect under traffic loadings and cause pavement deterioration. To achieve a good CBR value, select materials with a proper moisture content and an appropriate amount of quality compaction, create a proper utility trench backfill, and stabilize the soil as necessary.
2. Construct uniform, permeable subbases with longitudinal subdrains. Iowa is a relatively wet freeze-thaw climate with generally impervious soils. Therefore, providing adequate drainage is crucial to constructing a long lasting pavement.
3. Use dynamic cone penetrometer (DCP) for rapid, accurate field testing. The DCP, standardized by ASTM, is used to determine the CBR of the subgrade and subbase and should also be used on the project's embankments.

## Contents of the Guide

- 6A General Information. Purpose, basic soils information, typical Iowa soils.
- 6B Subsurface Exploration Program. Program requirements, testing, geotechnical report.
- 6C Pavement Systems. Pavement support and problems.
- 6D Embankment Construction. Design, equipment, compaction, soils, testing.
- 6E Subgrade Design and Construction. Design, strength/stiffness, construction, testing.
- 6F Pavement Subbase Design and Construction. Materials (granular/recycled), stability/permeability, construction, testing.
- 6G Subsurface Drainage Systems. Need and types of systems, design, construction, maintenance.
- 6H Foundation Improvement and Stabilization. Stabilization, subdrainage, geosynthetics, encapsulation, moisture conditioning, granular subbases.



*Dynamic cone penetrometer testing*



*Sources of moisture in pavement (based on NHI 13126)*