Soil Cut Slopes

Design Manual
Chapter 200
Geotechnical Design
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This section addresses the typical soil cut slope configurations (backslopes) routinely used by the Iowa DOT during the planning of roadway projects. The applicability of the typical soil cut slope configurations, along with other factors that may influence the stability and performance of slopes, should be considered when establishing final design recommendations. These factors may include the presence or absence of structural foundations, adverse groundwater and seepage conditions, susceptibility to inundation, and/or presence of notably poor soil/rock, etc., any of which may dictate use of flatter slopes.

Routine small cut slopes (less than 10 feet high) are commonly (but not universally) evaluated based on past experience with similar soils and on engineering judgment. Cut slopes that are greater than 10 feet in height, have irregular geometry, have unfavorable groundwater conditions, and/or have varying stratigraphy will warrant a more detailed geotechnical analysis. For design of slopes without more adverse implications than normal, the guidelines provided in this section should be used to select an appropriate maximum slope inclination based on the soil types and other factors present at the specific site.

The Soils Design Section in conjunction with the Design Section is responsible for determining the backslope configurations along the project alignment. The guidelines for soil cut slopes contained in this section are similar to rock cut slope configurations outlined in Section 200F-8.

Quick Tips:

- The Soils Design Section in conjunction with the applicable Design Section is responsible for determining the backslope configurations along the project alignment.
- Applicability of the typical soil cut slope configurations along with other factors that may influence the stability and performance of slopes should be considered when establishing final design recommendations.
- Cut slopes that are greater than 10 feet in height, have irregular geometry, have unfavorable groundwater conditions, and/or have varying stratigraphy will warrant a more detailed geotechnical analysis.

Soils Information

Soil slope design relies on the strength and behavior of the soil that is determined during the subsurface exploration and laboratory testing. This information is presented in the S3 and S4 event submittals. In addition, the groundwater conditions should be fully characterized as part of the design process. The presence of groundwater within or just below a proposed cut will affect the slope angle required to achieve and maintain stability. Groundwater that daylights within a proposed cut slope may require installation of backslope drains or other types of drainage facilities. Groundwater near the toe of slopes may require installation of underdrains.

Soil Slope Configurations

Design Detail 4104 should be used to begin design of all backslopes. A 3H:1V slope should normally be used as the starting point for all soil types. Finalization of backslope design should be done jointly between the Design Section and the Soils Design Section to insure that the optimum section and requirements are used with the project.

For soil excavation greater than 10 feet, a global stability analysis should generally be performed to determine the stability of the slope. A standard 3H:1V slope should still be assumed for these higher backslopes in most soil types, but a detailed slope stability analysis is necessary to verify that a steeper slope meets the required long term factor of safety. The cut slope should have a minimum long term factor of safety of 1.5, and the slope stability analysis should be performed according to Section 200F-1. Special attention and more detailed geotechnical analysis should be given to soil cut slopes within gumbotil or fat clays, and to slopes that expose the loess/till interface.

Special attention should be given to all slopes that involve shale, and especially those with sloping shale surfaces. This includes both foreslopes and backslopes.

Drainage Considerations

The importance of adequate drainage cannot be overstated when designing cut slopes. Surface drainage can be accomplished through the use of drainage ditches and berms located above the top of the cut, around the sides of the cut, and at the base of the cut. Subsurface drainage can also be employed to reduce driving forces and increase soil shear strength by lowering the water table, thereby increasing the factor of safety against a slope failure. Subsurface drainage techniques available include standard backslope drains and/or other less common techniques that are usually tailor fit to a specific site or condition.

Backslope drains are used in areas where groundwater seepage and/or a slide are possible. Where water is perched on a very dense layer or within a sand pocket, a backslope subdrain is installed at a level where the seepage is intercepted by the drain (typically slightly below the surface of any existing very dense or clay confining layer). Maintaining positive drainage is required to adequately remove the accumulated water. Backslope drains are depicted/shown on the design Q sheets and tabulated on Tab 104-9. Backslope drains and their outlets are also shown in full detail on the project cross section.; In fact, what is considered the real design of backslope drains and their outlets is on the cross sections rather than on the Q sheets. For typical backslope subdrain configurations and outlets associated with roadway projects, refer to Standard Road Plans DR-303 and DR-305 respectively.

Cut Slope Stability Improvement

If potential instability of the planned roadway backslopes is determined from the slope stability analysis performed during the stability review and design process (see Section 200F-1), backslope benches are commonly used to improve backslope stability in areas of deep cuts (typically greater than 25 feet high).

The width (typically 15 feet) and location of backslope benches should be finalized in a joint effort between the Design Section and the Soils Design Section. General backslope bench configurations are described in Section 3J-1 with typical configurations outlined in Design Details 4104 and 4107. The Design Section generally puts the backslope benches on the cross sections before the cross sections are available to the Soils Design Section, but those should be reviewed by the Soils Design Section and modified or added to as necessary.

Chronology of Changes to Design Manual Section:

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Updated references to renumbered standards.

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