vicroads GEOPAVE MATERIALS TECHNOLOGY

92 Technical Note

GROUNDWATER IN CUT EXCAVATIONS

INTRODUCTION

This Technical Note provides an outline of some of the most common types of problems related with groundwater in cut batters. The Note also discusses some of the common methods for dealing with groundwater to reduce risk to these parts of the roadway. Finally, this Note provides a basic outline of information that should be investigated when dealing with cut excavations.

GROUNDWATER AND BATTER STABILITY

Groundwater can affect the stability of cut batters in different ways depending on the type of material, depth of excavation, and the quantity of groundwater. The type of material has a significant influence on the type of slope instability, and typical examples of potential problems for cuttings in soil and rock are:

Soil Excavations

Wet batter face – This is caused by porewater pressure in the soil material behind the batter face. The groundwater causes loss of strength for the area through saturation of the material, and can cause collapse of the area. Secondary collapses may occur due to lack of support for the cut batter, or the seepage moving to a new part of the batter in an effort to exit the material.

Base Seepage – also called ‘groundburst’. Base seepage is normally seen as areas of ground heave within the base of the cutting. The heaved areas tend to be wet because the groundwater is exiting the batter into the base of the cutting.

Rock Excavations

Rock batters are heavily influenced by the amount of weathering of the rock, fracture and fissure paths (which may be microscopic), orientation of the fissure path, and are sensitive to heavy rainfall events. In addition, rock batters tend to include highly directional water flow paths which can lead to very rapid inflows to excavations. The directional nature of the rock fractures (and flow paths) makes it difficult to predict flow behaviour from individual boreholes. Where rock batters are considered for cut excavations, specialist advice should be engaged for a more overall interpretation of the existing conditions.

Flows through major fractures in the rock can result in the batter weeping water, or the pore pressure may build up to a critical level without obvious signs of distress Three common problems affecting rock cuts that result from flows through major fractures are:

- Destabilization of batter along joint planes which results in isolated pieces of rock being pushed from the face, and falling into the excavation.
- Destabilisation of the rock batter due to scour caused by water exiting the cutting near the base. This distress mode results in large areas of the batter not being supported and can lead to large sections of the batter becoming unstable and failing.
- Flooding of the excavation may occur due to the water finding a path through the rock to the base of the excavation. This type of instability tends to occur rapidly and with little warning, and results from high rainfall events coupled with highly directional flow paths.

MANAGING GROUNDWATER IN CUT EXCAVATIONS

As noted above, groundwater may destabilise cut batters by pore pressure effects, erosion of the existing slope or base seepage, enhancing the possibility of batter instability. The best solution to avoid groundwater damage in cut excavations includes complete avoidance by raising the gradeline or alteration of route.

Where it is necessary to progress works through areas where groundwater is likely to be a potential problem, an assessment of the capability of dewatering the area for temporary works and/or maintaining it as a dry area by drainage can be made by appropriate tests prior to excavation. The assessment will provide information to make choices as to how the groundwater can be managed for the excavation.

GROUNDWATER INVESTIGATION FOR PROPOSED CUTTINGS

The first step investigating potential groundwater problems normally includes a review of aerial photograph information (for old water courses, areas of imported fill, rock outcrops, etc), a review of local experience, and a search of existing groundwater information (e.g. Department of Sustainability & Environment).

Experienced personnel can make specialised assessments and, in additional to the above information, may use the following to form an assessment of the area:

- Standpipes to monitor change of groundwater level
- Pumping tests to determine flow rate
- Recharge tests which can determine a more accurate flow rate
- Chemical testing to assist with options for water disposal
- Hydrogeologic modelling using computer software to assess large scale changes to the groundwater and environmental changes.

Further information on groundwater investigations and control can be found in the reference listing. References 3 and 5, Cashman & Preene, and Powers &Corwin, are considered authoritative texts.

METHODS FOR MANAGING GROUNDWATER

Groundwater can be managed by providing some form of additional drainage to provide improved stability, or to remove groundwater for the works area. Management of groundwater is considered in two categories; passive and active methods. The passive methods require only routine maintenance. The active systems tend to be used for more difficult sites, or where a problem has been encountered during construction. Active systems tend to require continuous management.

Passive Drainage Methods

The use of passive drainage measures can produce marked stabilisation effects by relieving pore pressures in slopes. Some key factors to consider are the need to reduce recharge to the groundwater system, the alleviation of pore pressures in the slope itself and the need to remove seepage from the base of the batter. Similarly, appropriately designed drainage to relieve pore pressures at the base of the batter will greatly aid long term stability.

Cutoff drains with impermeable lining may be placed parallel to the slope crest to prevent or impede water from entering the cut area. Drains with impermeable lining may also be installed on the batter face to prevent rainwater from entering the cut batter, and direct runoff from the batter face.

Drains can also be placed parallel to the base of the batter to significantly aid slope stabilisation in wet cuttings, by allowing the water in the batter to escape at controlled locations.

In cases where a natural seepage face or the pore pressure gradient behind the face is very steep (often the case in new cuts, where pore pressures have not equalised) and the face is protected by construction (shotcrete or similar material) drainage using weepholes may be necessary to allow the water to escape and achieve pore pressure equilibrium.

Passive drainage may also include boreholes, drilled at shallow inclinations and lined with slotted casing to drain groundwater from the face of the batter. Boreholes require accurate information and monitoring during construction to ensure the system is suitable and durable.

Regular maintenance of passive drainage is necessary to ensure the systems operate as designed. Drains require periodic clearing and inspection to ensure water can flow as planned.

Active Drainage Methods

Active drainage can be very effective in providing stabilisation of cuts for temporary and permanent works, and there are many different methods. Active methods usually alter the path of water around, or under, or deliberately into controlled areas of, the excavation. Active methods can include; bores and de-watering, collection pits and pumping systems.

The improvements resulting from active methods can be spectacular, and may allow oversaturated materials to become suitable for conventional excavation within reasonable timescales.

Active methods are normally a second choice for managing groundwater because the cost over the longer term may be high if there is a need to continually maintain the system (for example where there is a pumping regime). In many cases, the continued reduction of groundwater through the cut batter area can be achieved by good hillside practice which includes batter gradient, drainage systems, construction methods and planting appropriate vegetation to replace that destroyed by works.

REFERENCES

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