Geotextile Applications in Subsidence Fissure Remediation

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ABSTRACT: Groundwater withdrawal exceeding groundwater recharge in the Las Vegas Valley has caused land subsidence which, in turn, has caused new fissures to develop and activated existing fissures. The new and activated fissures may cause significant differential foundation settlements thus, posing potential distress to structures, pavements and other improvements. This paper describes the application of geotextiles to minimize the potential distress due to fissures. Geotextiles are utilized to support foundation materials if fissures continue to develop.

1 INTRODUCTION

Groundwater withdrawal exceeding groundwater recharge in the Las Vegas Valley has caused land subsidence which, in turn, has caused new fissures to develop and activated existing fissures. The new and activated fissures pose potential distress to structures, pavements and other improvements due to potential large differential foundation settlements. The subsidence in the Las Vegas Valley is manifested by a large principal subsidence bowl, punctuated by three secondary bowls. Differential settlements on the order of 2 to 5 feet have been measured in the secondary subsidence bowls (Bell and Price, 1991).

Fissuring generally occurs in stages. The fissures originate as small linear cracks which form when sediments, particularly fine-grained sediments, are pulled apart by horizontal tensional stresses caused by ground subsidence. These cracks may or may not extend to the surface. Surface runoff and infiltration cause erosion within the fissure and the erosional material is transported to lower depths of the fissure by piping or tunneling. The subsurface fissures may have eroded areas, usually called pipes or tunnels, as much as 3 feet in diameter. As the fissure erodes, portions of the fissure roof may collapse and the fissure appears at the ground surface as a string of potholes. As erosion continues, the roof as well as the walls of the fissure may further collapse, leaving portions of the fissure completely open to the surface with other portions of the fissure partly bridged. With further erosion, the entire fissure may become exposed. The exposed fissures may be as much as 10 feet in depth. The actual depth of the fissure may be greater; however, the fissure is often filled with erosional material. Fissures pose the greatest hazard to structures and pavements in the Las Vegas Valley due to the relatively large differential movements and subsequent loss of support that may occur as the fissures develop. Costly damage to structures, pavements and other improvements may occur as a result of fissuring. Therefore, remediation of visible fissures and near surface concealed fissures during the grading process of land development is essential. Geotextiles have been successfully used in the Las Vegas Valley on numerous sites within the last 4 to 5 years as part of fissure remediation.

2 FISSURE REMEDIATION

When encountered either before or during construction, the fissure is overexcavated, a geotextile is placed in the bottom of the excavation, and the excavation is properly backfilled. Typically the overexcavation extends at least to the bottom of the fissures (including deeper tensional cracks), and at least 5 feet outside of the fissure limits in plan view. After observing the excavation bottom for further signs of fissuring, a geotextile is placed in the bottom and up the sides of the excavation. The excavation is then properly backfilled with the compacted native soil to prescribed compaction specifications. Figures showing a typical fissure profile, plan view and cross section are shown in Figures 1, 2 and 3.

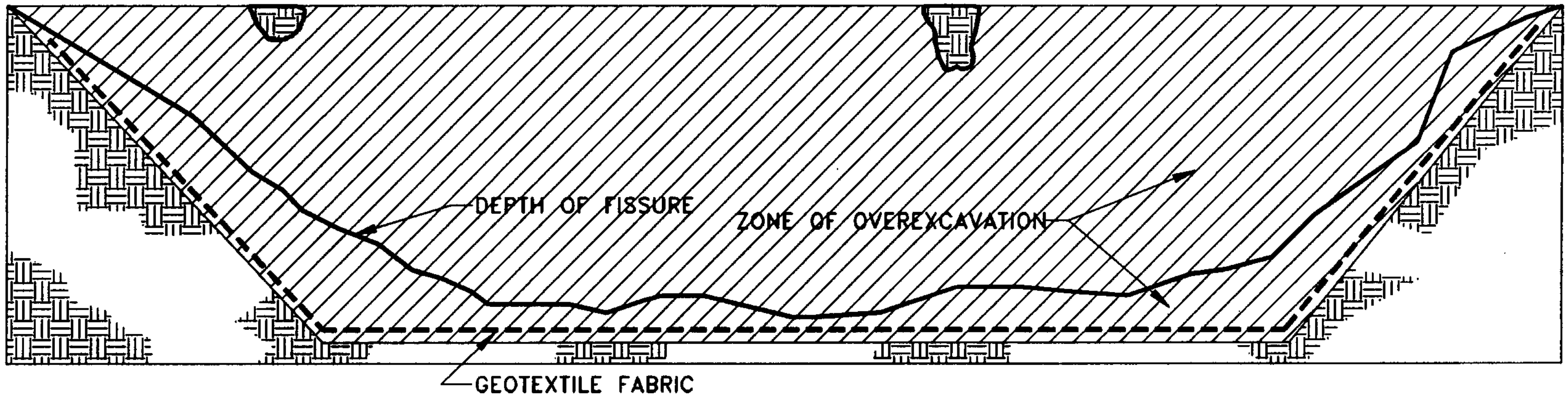

Fig. 1 Typical profile of remediated fissure

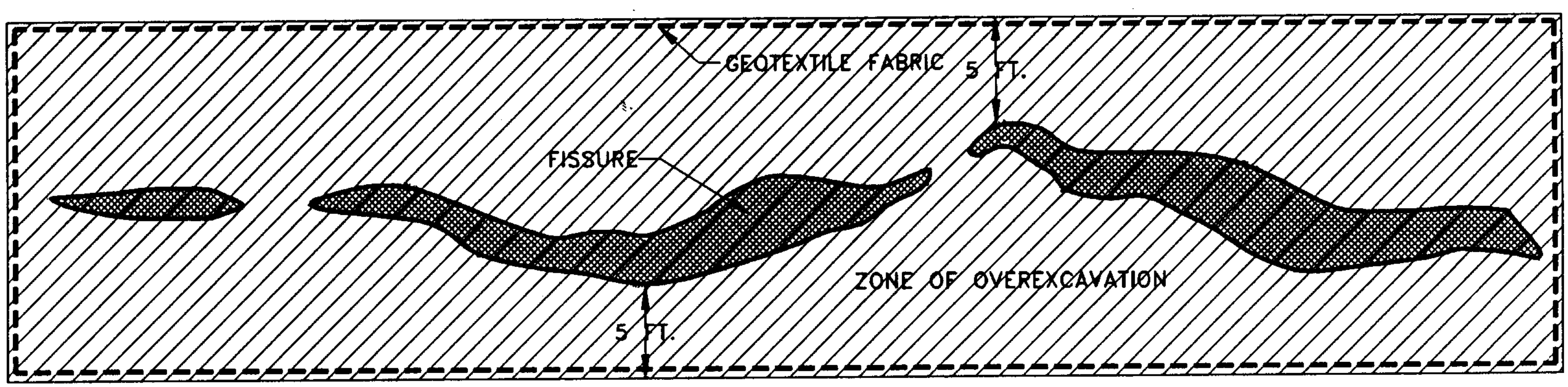

Fig. 2 Typical plan view of remediated fissure

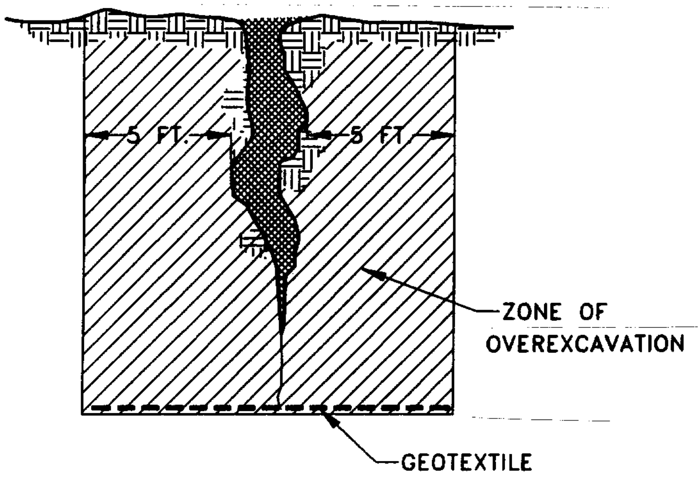

Fig. 3 Typical fissure cross section

2.1 Geotextile Requirements

The geotextile helps to prevent propagation of fissures to the surface should they develop below the geotextile. Geotextile acts as a bridge and prevents soil from falling into the fissure. Important considerations when choosing a suitable geotextile are tensile strength and drainage characteristics.

The geotextile should have sufficient tensile strength to support the weight of the compacted foundation soils above should a fissure develop below the geotextile. Although analytical procedures are not utilized for determining the tensile strength requirements for this application, the strength values in Table 1 have been found suitable for fissure remediation in the Las Vegas Valley.

Table 1 Typical geotextile properties used for fissure remediation.

Property	Geotextile Type	
	Woven	Non-Woven
Grab Tensile (lbs.)	200	200
Grab Elongation (%)	15	50
Mullen Burst (psi)	400	450
Puncture (lbs.)	90	130
Trapezoidal Tear (lbs.)	75	80
Permittivity (Gal/Min/Ft^2)	4	80

Since moisture infiltration causes erosion and transport of soil within the fissure, the geotextile should have a relatively low permittivity (cross-plane permeability) and a relatively high transmissivity (in-plane permeability). The permittivity should be sufficient to prevent ponding of water above the geotextile. The high transmissivity will provide drainage within the plane of the geotextile away from a potential fissure area. This could be accomplished by placing the geotextile slightly sloping away from the fissure area. The thicker non-woven geotextiles are best suited to allow in-plane flow. They are also the most compressible under surcharge loading. It has been found that the decrease in transmissivity reaches a lower limit beyond which the transmissivity will remain constant (Koerner, 1986). This may typically occur with a surcharge pressure of approximately 500 pounds per square foot, or with approximately 4 to 5 feet of compacted soil above the geotextile.

Woven and non-woven geotextiles have been used with specifications as shown in Table 1. Amoco Fabrics and Fibers Company woven geotextile No. 2002 and non-woven geotextile No. 4553 meet the requirements in Table 1 and have been used for fissure remediation in the Las Vegas Valley. There are other companies that provide a wide selection of both woven and non-woven geotextiles with similar specifications.

3 CONCLUSION

Earth fissuring as a result of ground subsidence has been occurring in the Las Vegas Valley, and presents a potential for costly damage to structures, pavements and adjacent improvements. The fissures are remediated prior to site development by overexcavating the fissure, placing a geotextile in the bottom and up the sides of the excavation, and properly backfilling the excavation with native soil. Should a fissure develop below the geotextile, the geotextile will help to prevent the fissure from propagating to the surface, and will provide reinforcement of the soils above the fissure. The geotextile is relatively easy to install, even in situations where the fissures form erratic patterns. Using geotextiles in fissure remediation is a relatively cost effective method of dealing with a potentially destructive soil condition. Geotextile fabrics have been used in the Las Vegas Valley within the last 4 to 5 years as an economical method of fissure remediation. To our knowledge, the installed geotextiles have thus far performed successfully.

REFERENCES

Bell, John W. and Jonathan G. Price (1991) "Subsidence in Las Vegas, Nevada Bureau of Mines and Geology, Final Project Report", Plate No. 2.

Koerner, Robert M. (1986) *Designing with Geosynthetics*, Prentice Hall, Englewood Cliffs, NJ.