

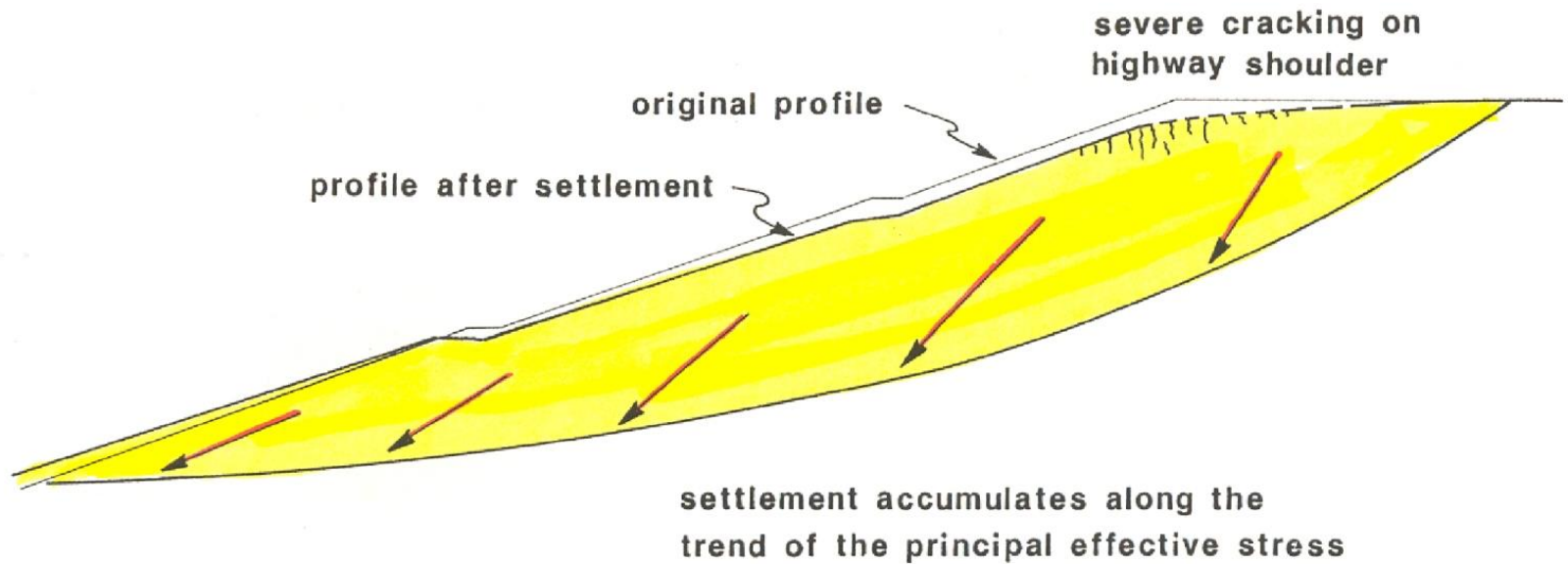
Part 9

GROUND DEFORMATIONS TYPICAL of COMPACTED FILL



SLIVER FILLS

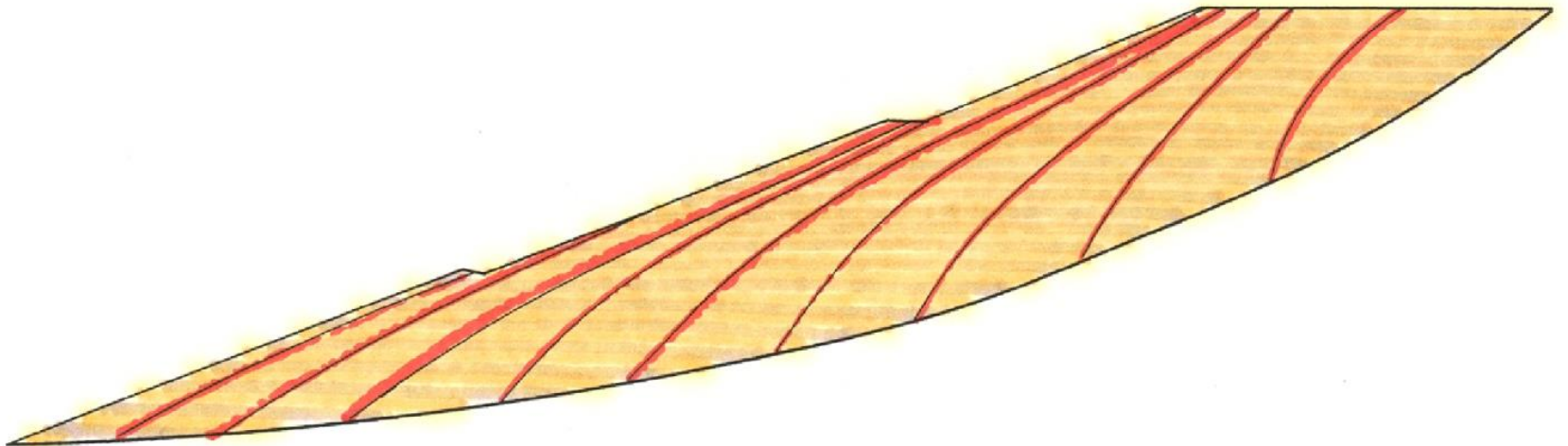
SETTLEMENT VECTORS IN VALLEY-SIDE WEDGE FILL



- **Sliver fills are prone to differential settlement with a significant horizontal component of movement (from Rogers, 1992).**

LAYERED SLIVER FILL

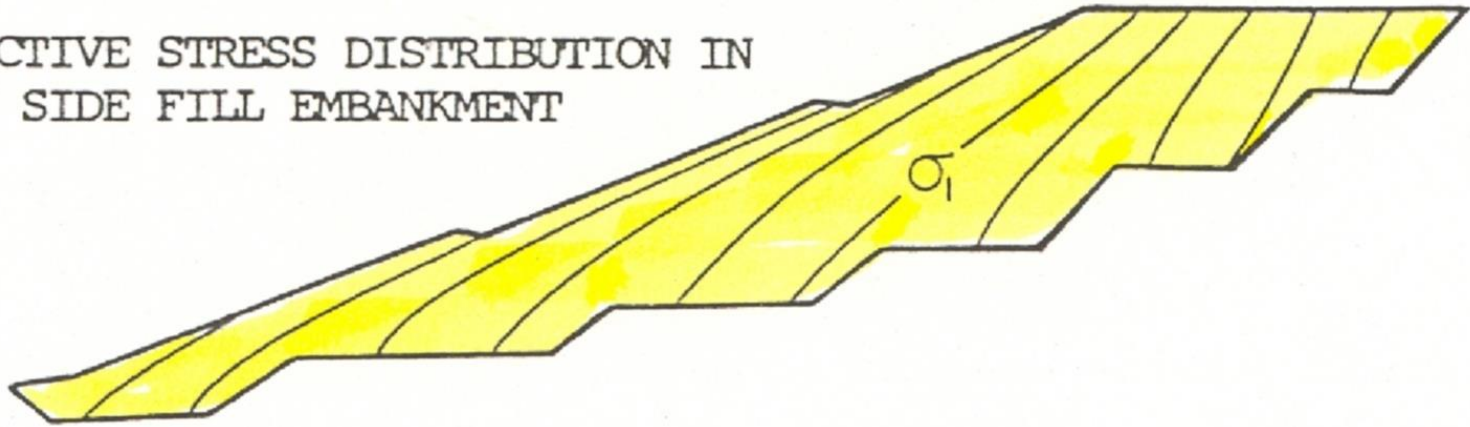
PRINCIPAL EFFECTIVE STRESS DISTRIBUTION
IN A VALLEY-SIDE 'SLIVER FILL'



- Layering of cohesive and noncohesive soils can exacerbate settlement through more severely inclined effective stress trajectories. Settlement follows lines of maximum principal stress (shown in red)

KEYED FILLS

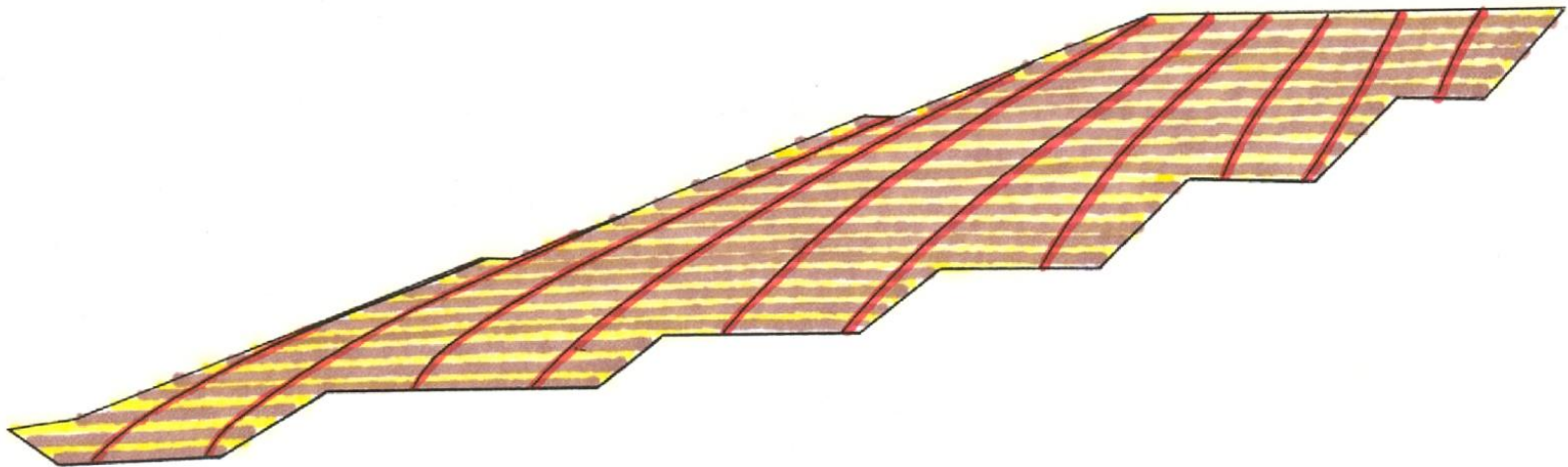
PRINCIPAL EFFECTIVE STRESS DISTRIBUTION IN
A KEYED VALLEY SIDE FILL EMBANKMENT



- **Keyed fills tend to have less severely inclined principal stress trajectories, so differential settlement and horizontal component of settlement are reduced (from Rogers, 1992).**

LAYERED KEYED FILL

PRINCIPAL EFFECTIVE STRESS DISTRIBUTION
IN A KEYED VALLEY-SIDE FILL EMBANKMENT



- Layering of cohesive and noncohesive soils can exacerbate settlement through more severely inclined effective stress trajectories. Settlement follows lines of maximum principal stress (shown in red)

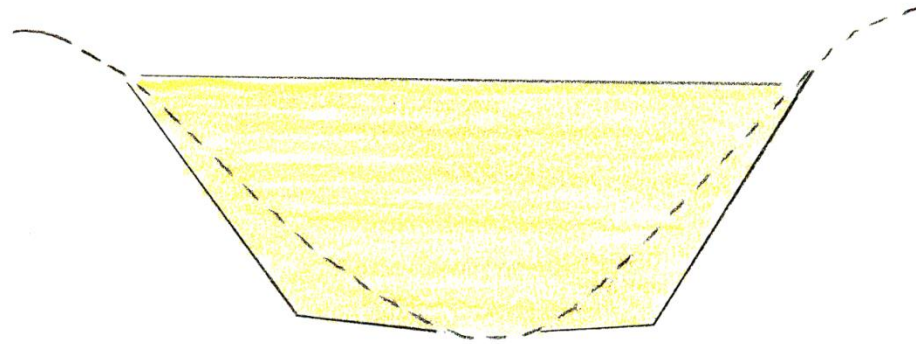
MASS GRADING



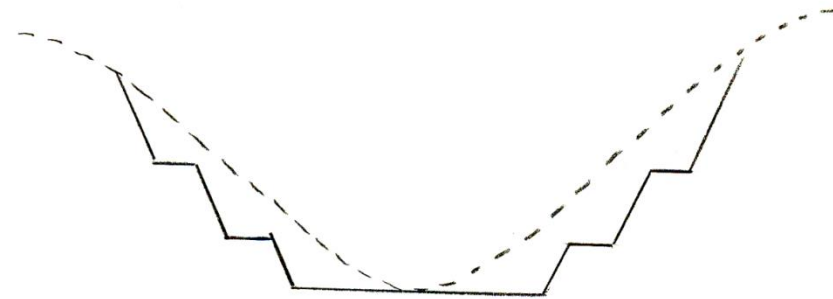
- **Mass grading is a term used to describe earthwork that has been engineered to support structures, water, or highways.**

CANYON CLEANOUTS

OVEREXCAVATION

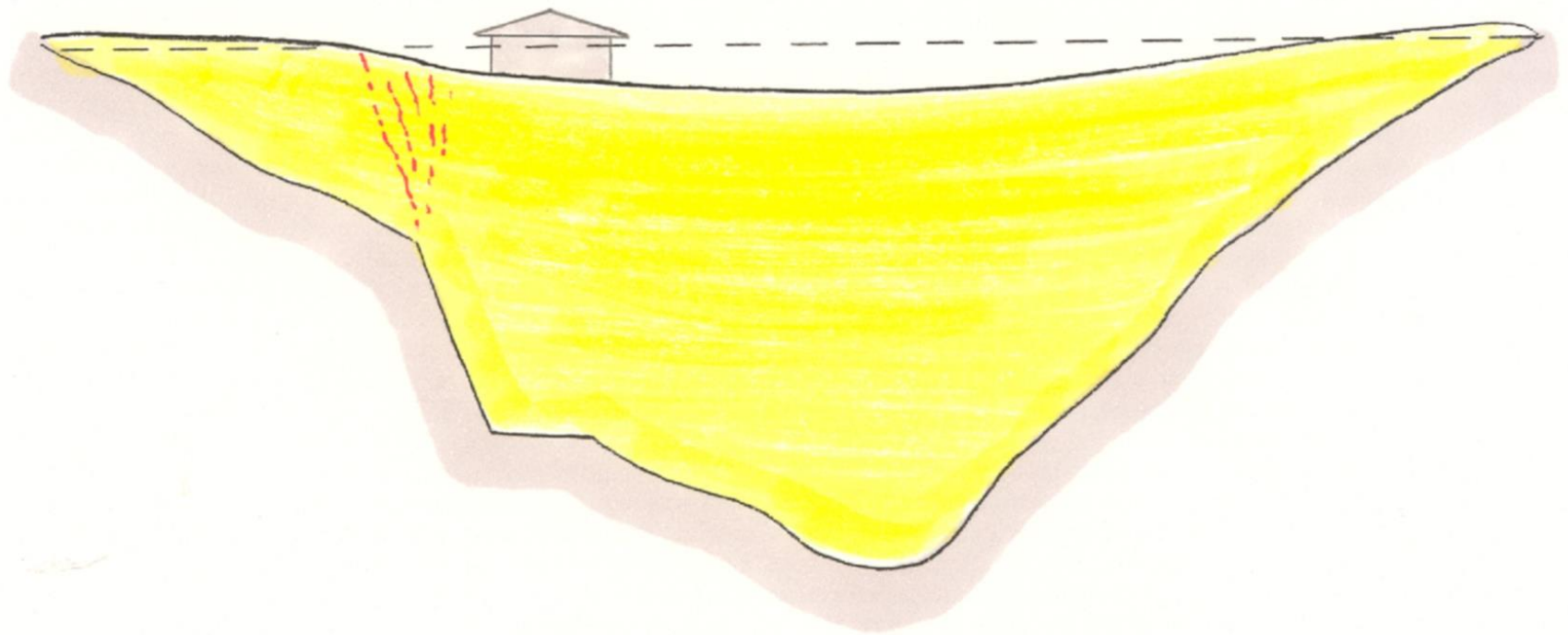


15% differential minimum for residence sites



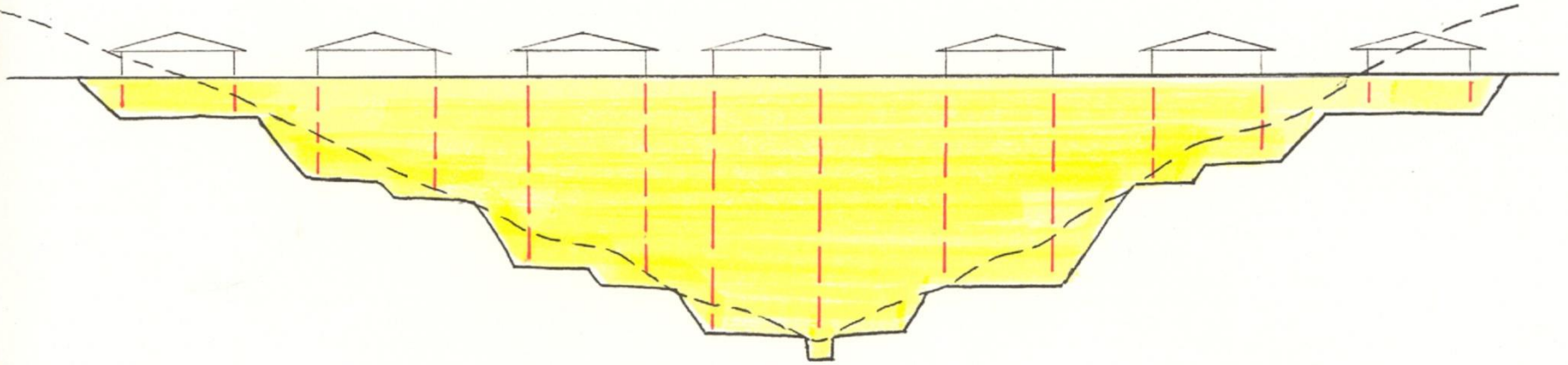
*STEPPED
EXCAVATION*

- Canyon cleanouts or valley fills must be keyed and benched into adjacent slopes
- Fill thicknesses >15% differential and more than 30 feet deep should be avoided beneath structures, if possible



- Unusually high benches in canyon fills can lead to **differential settlement and lot tilt**, as sketched above.
- This is especially problematic in earth dam embankments because tensile zones are created, which are subject to leakage and possible piping.

Benching beneath lots



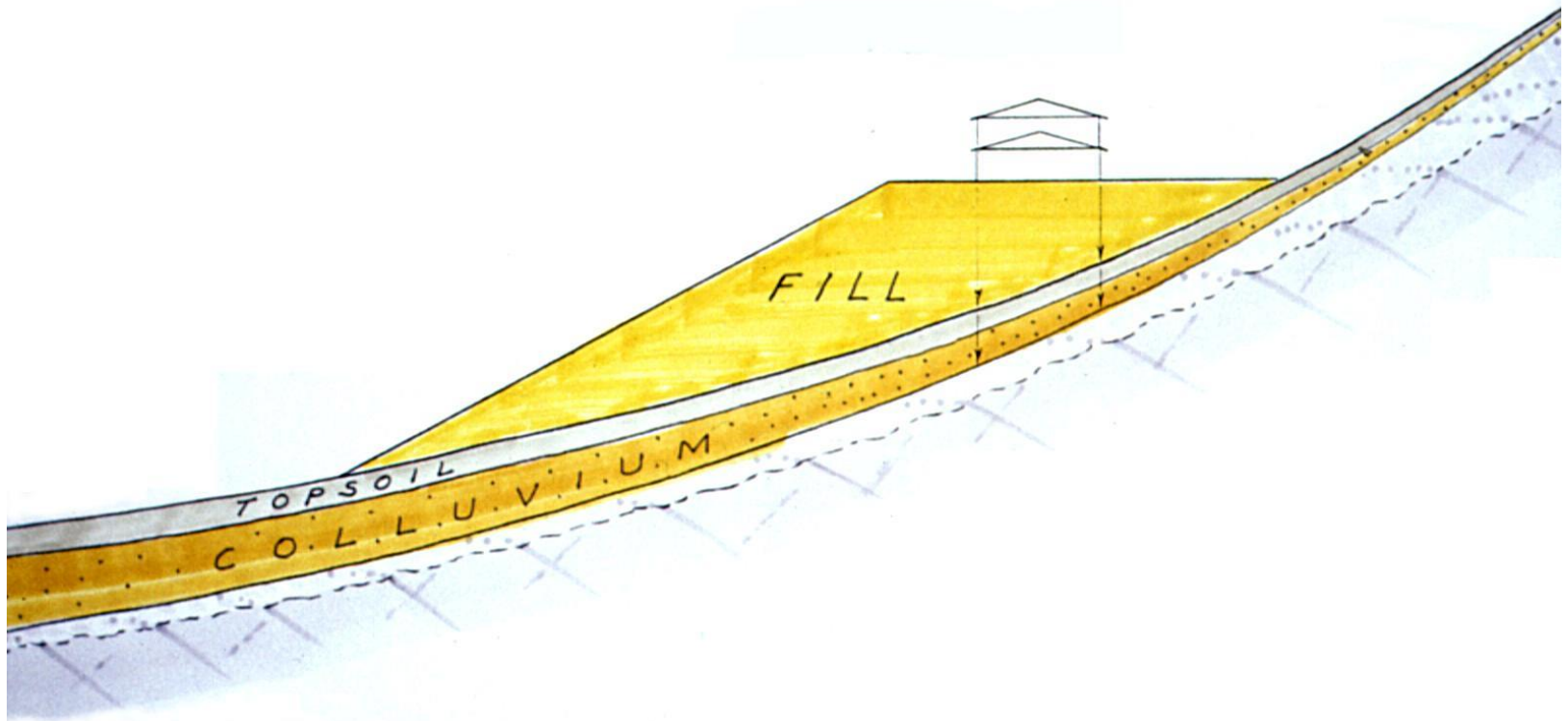
- **Overexcavation benches** should be graded to avoid excessive differential fill thickness beneath the footprint of proposed structures to lessen lot tilt.

CUT-FILL TRANSITIONS



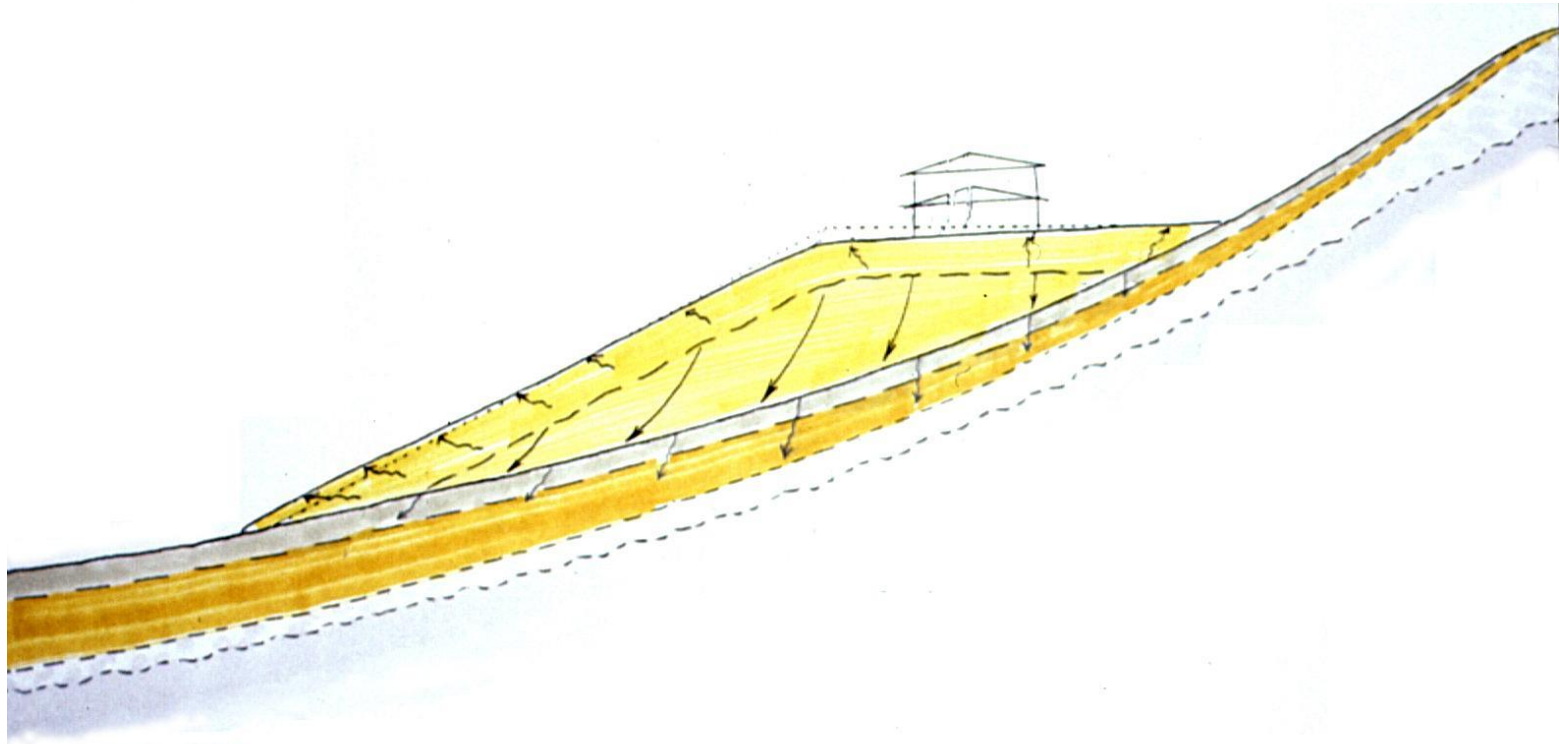
- Differential settlement is almost unavoidable at severe **cut-fill transitions**, such as the one shown here. Such concentrated movement can sever buried utilities.

LONG TERM SETTLEMENT OF A SLIVER FILL

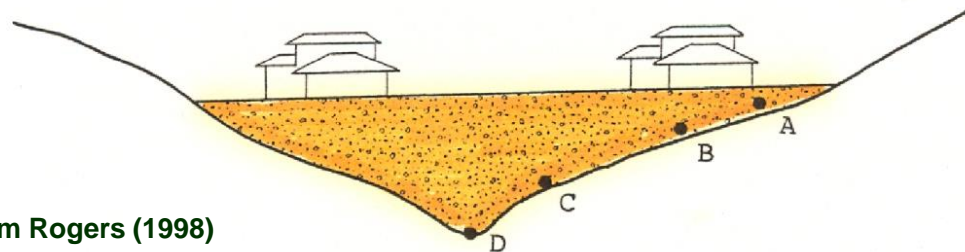
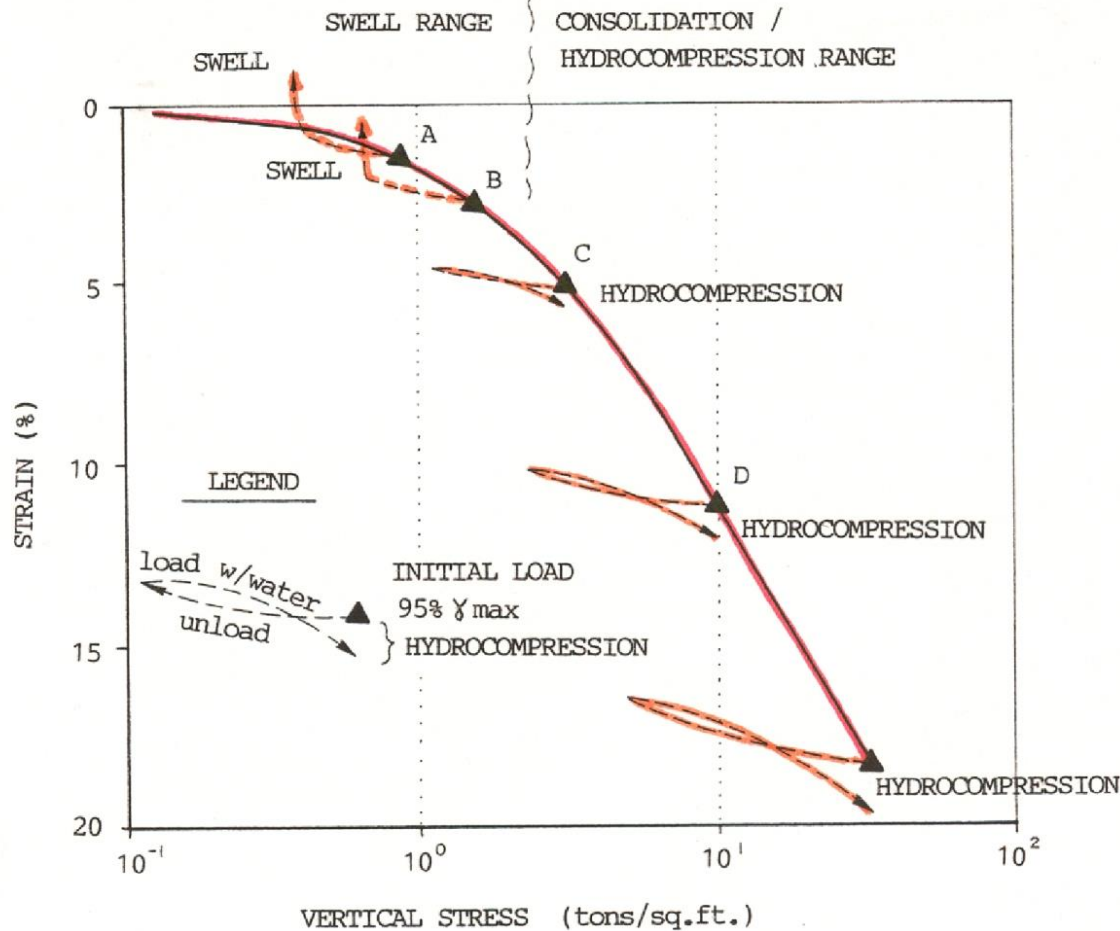


- The fill and the structure create a surcharge on underlying topsoil and colluvium, which may be normally consolidated or underconsolidated

SOURCES OF SETTLEMENT AND HEAVE



- Sketch illustrating expected vectors of motion for near-surface heave *and* long-term settlement, after the soils become soaked. This may take several decades.
- The interpretation of inclinometer records from such sites can be exceedingly difficult and tedious.



From Rogers (1998)

- Hydrocompression and swell can occur simultaneously in silty sandy mixtures containing expansive soils
- This combination can cause excessive lot tilt because shallow fills will tend to heave while deeper portions will settle more than predicted with 1D consolidation analyses
- Note that overall settlement is **not proportional** to fill thickness!

About the Presenter



J. David Rogers, Ph.D., P.E., P.G. holds the Karl F. Hasselmann Chair in Geological Engineering at the Missouri University of Science & Technology. He can be contacted at rogersda@mst.edu

- Professor Rogers owned engineering consulting firms in Los Angeles and San Francisco and a general engineering contracting firm prior to entering academia.
- He served as Chair of the Building Codes Committee of the Association of Environmental & Engineering Geologists between 1990-97 and was AEG's representative to the International Conference of Building Officials (ICBO) during development of the 1991, 1994 and 1997 UBC's, and the 2000 IBC.
- Since 1984 he has taught short courses on grading and excavation codes for the International Conference of Building Officials in CA, OR, WA, HI, and Taiwan, as well as the University of Wisconsin, University of California, the Association of Bay Area Governments, and the City of Los Angeles. He was on the CE faculty at U.C. Berkeley between 1994-2001.

