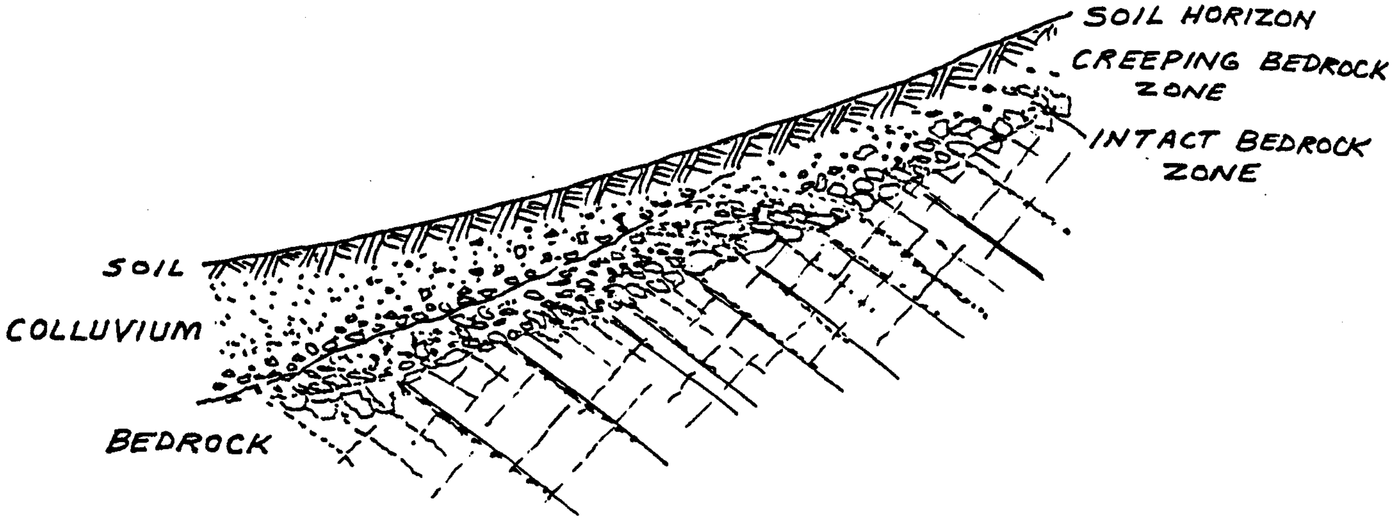
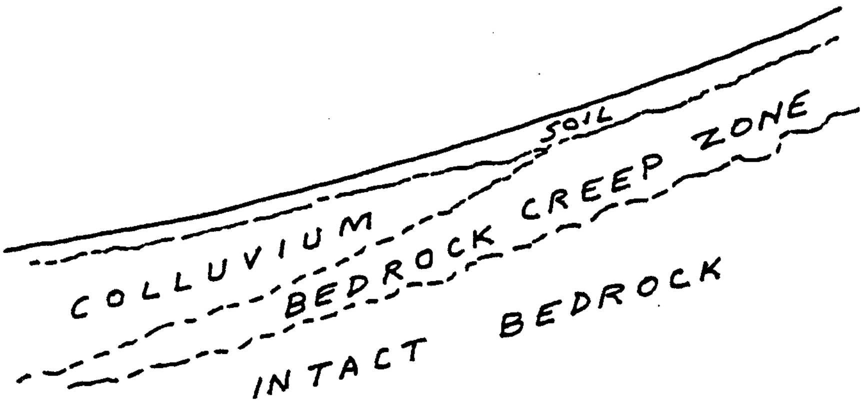
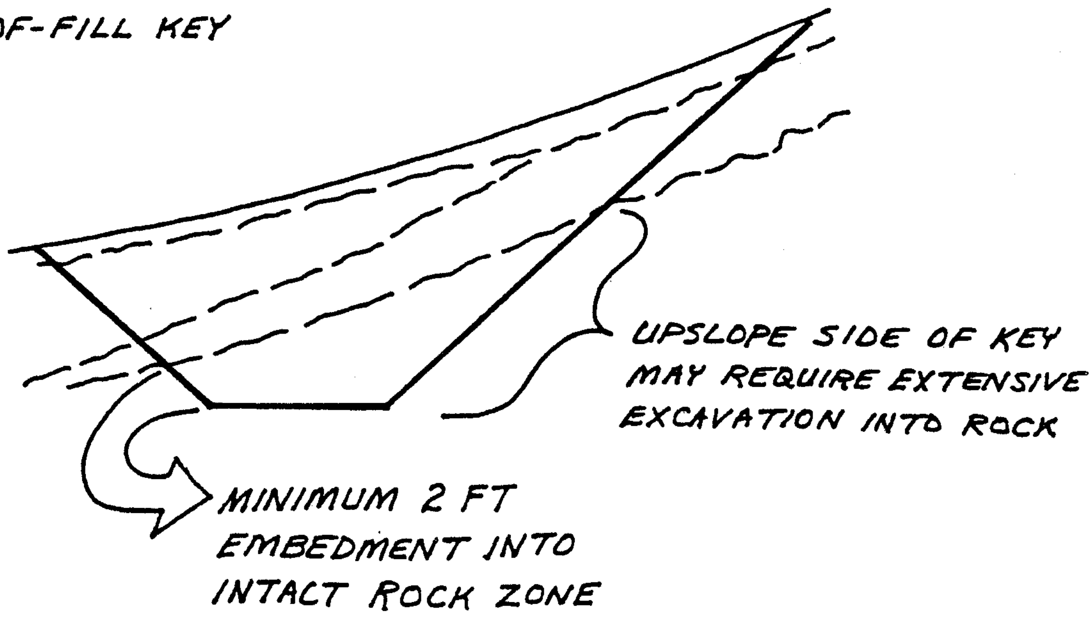
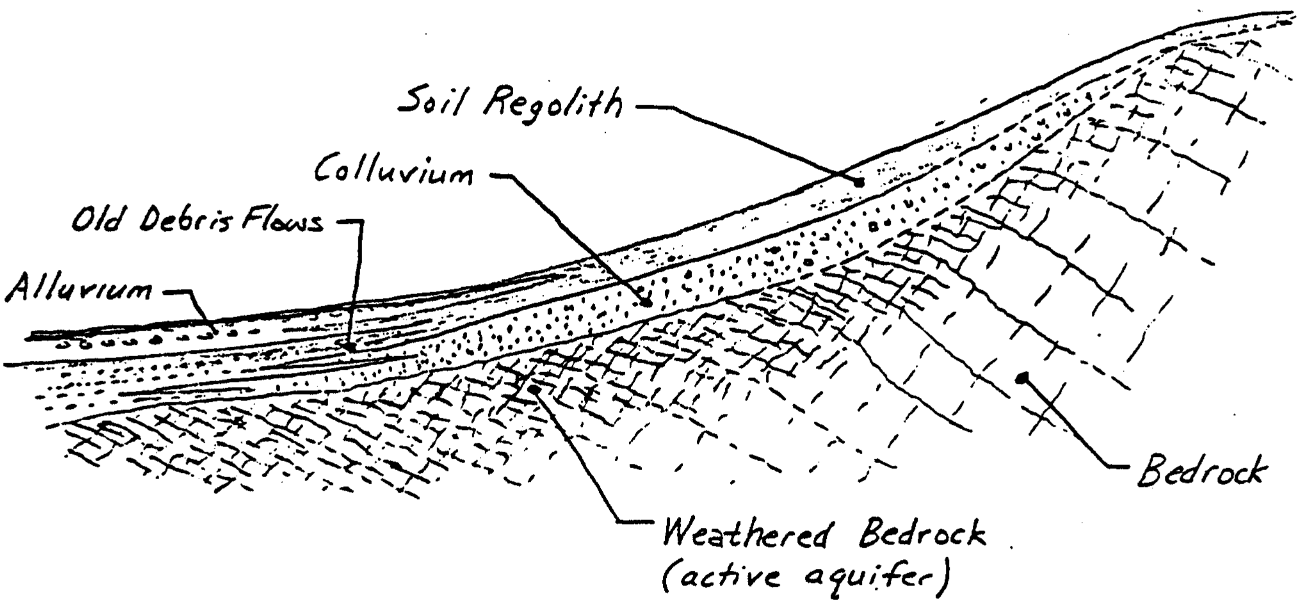




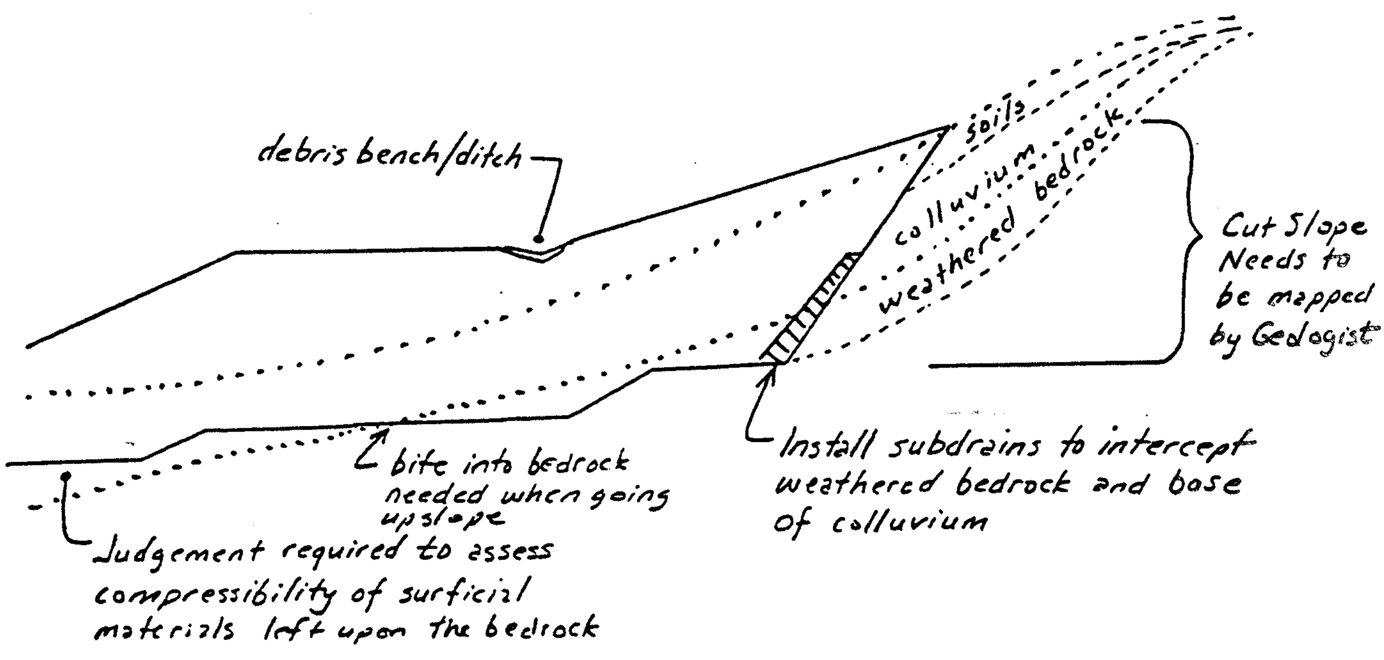
TOE-OF-FILL KEY



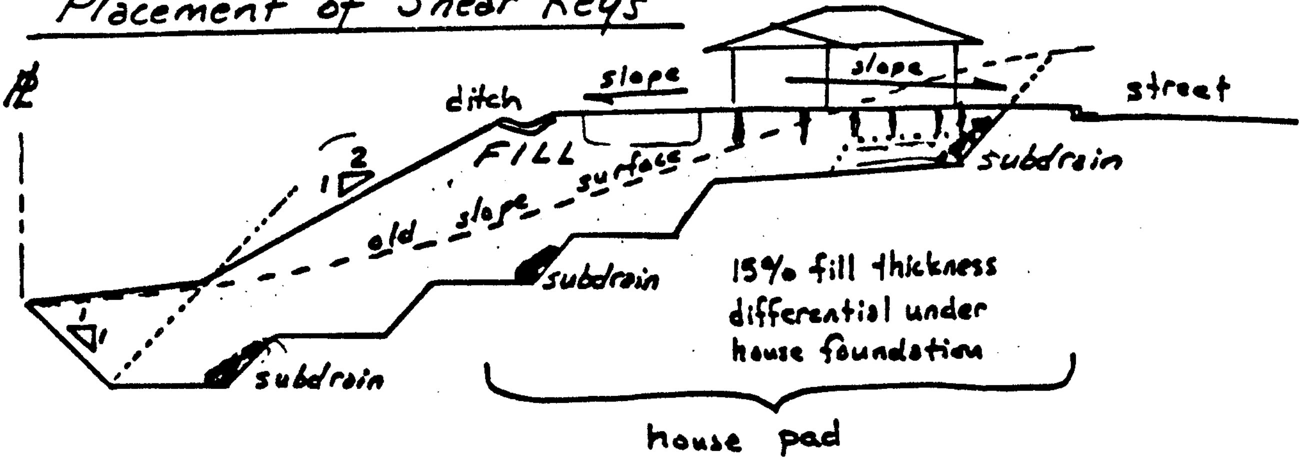
Standard Buttress Design



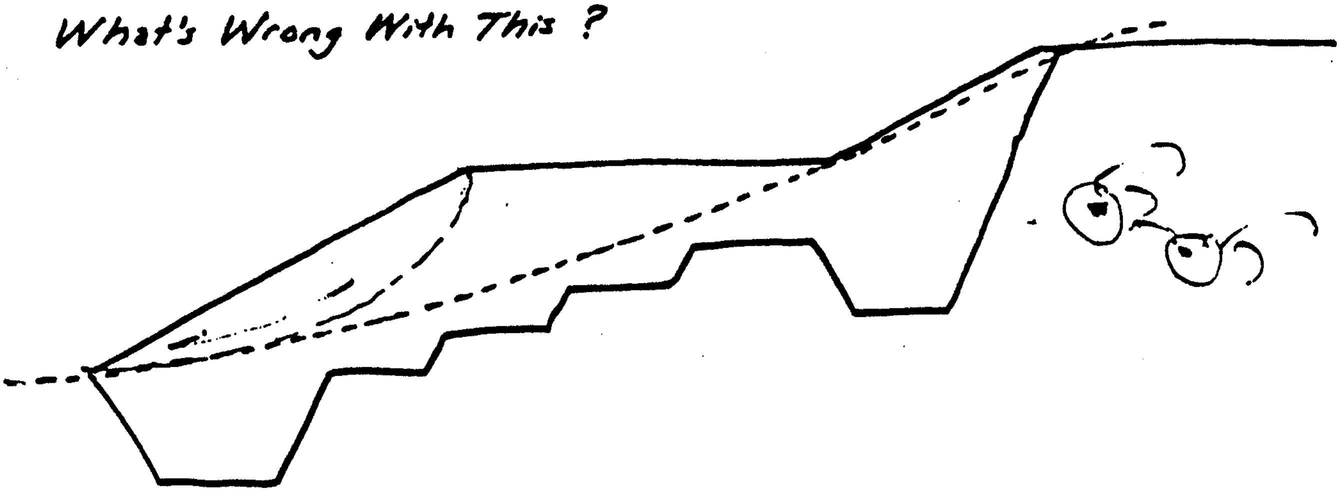
Amount of Near-Surface Groundwater Increases Downslope due to aereal accretion. Weathered Zone geneally increases downslope, mimicing groundwater flow patterns, and vice versa



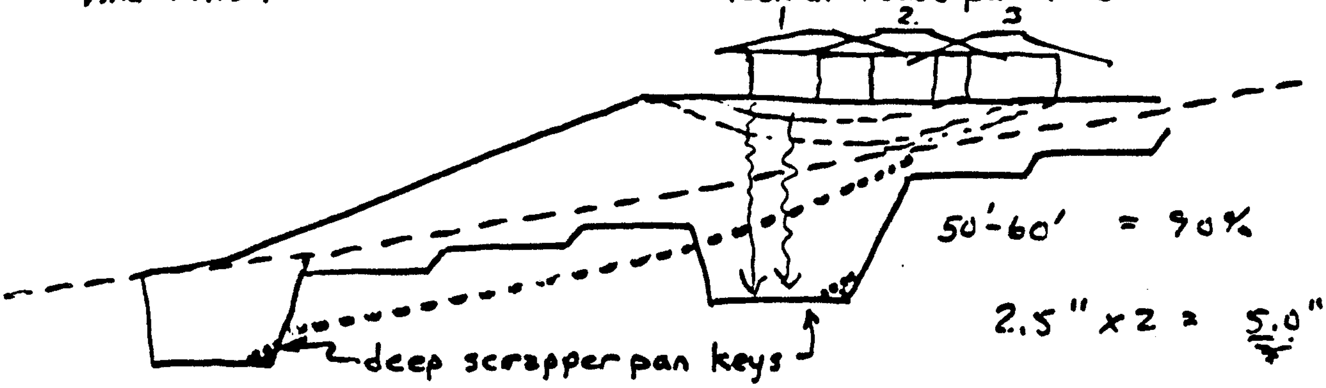
Placement of Shear Keys

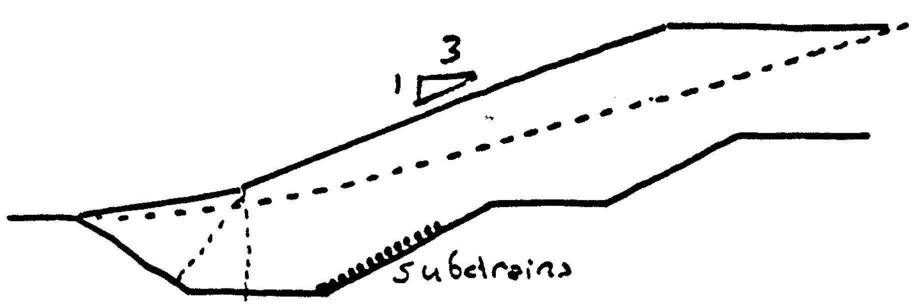


What's Wrong With This ?



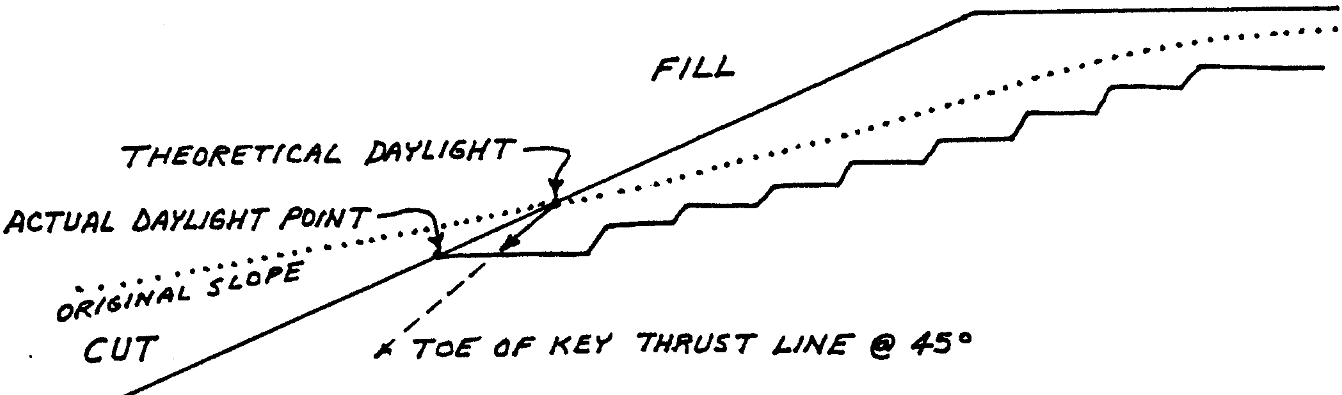
And This ?

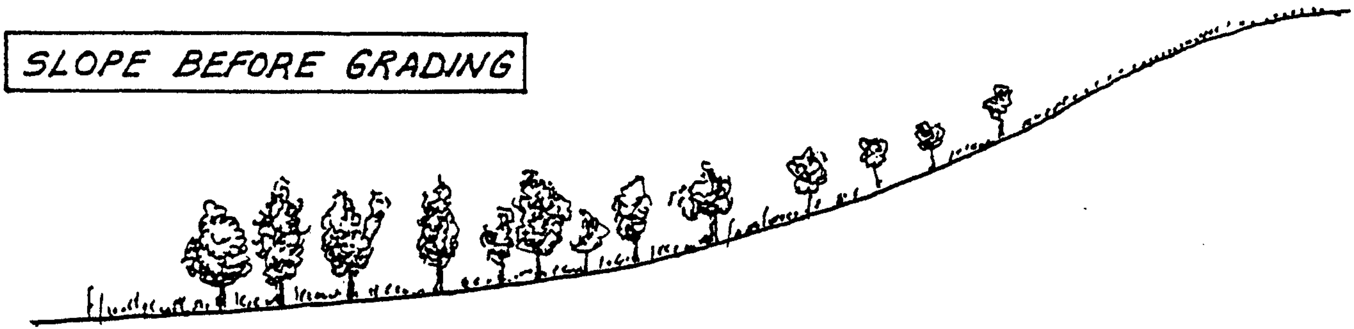


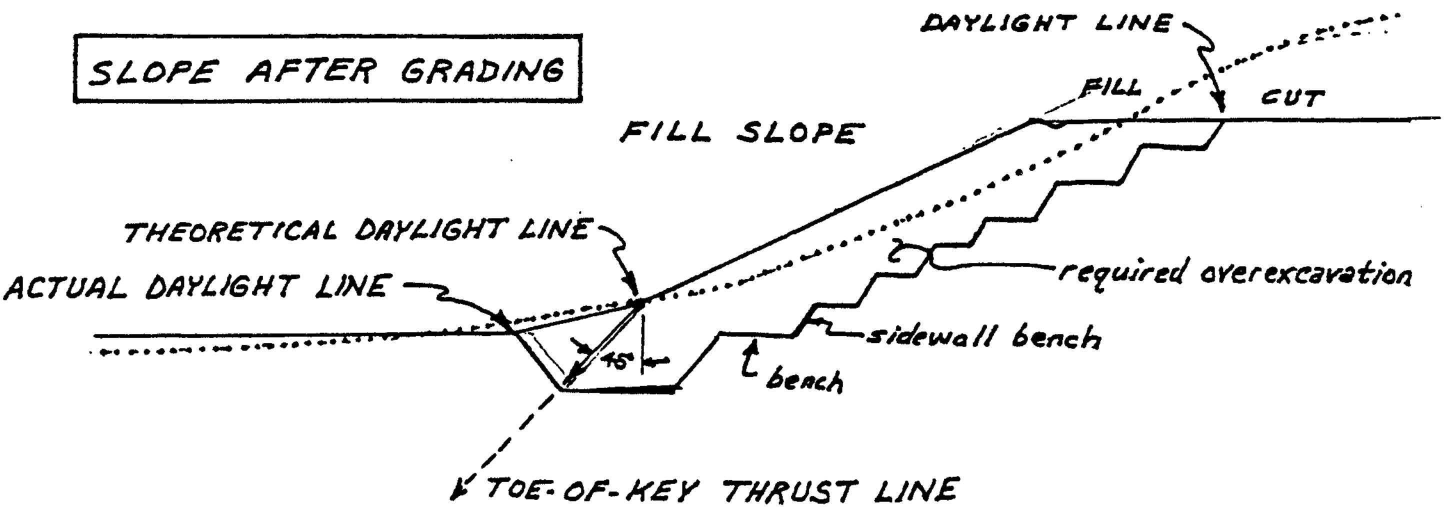


NATURAL SLOPE BEFORE GRADING

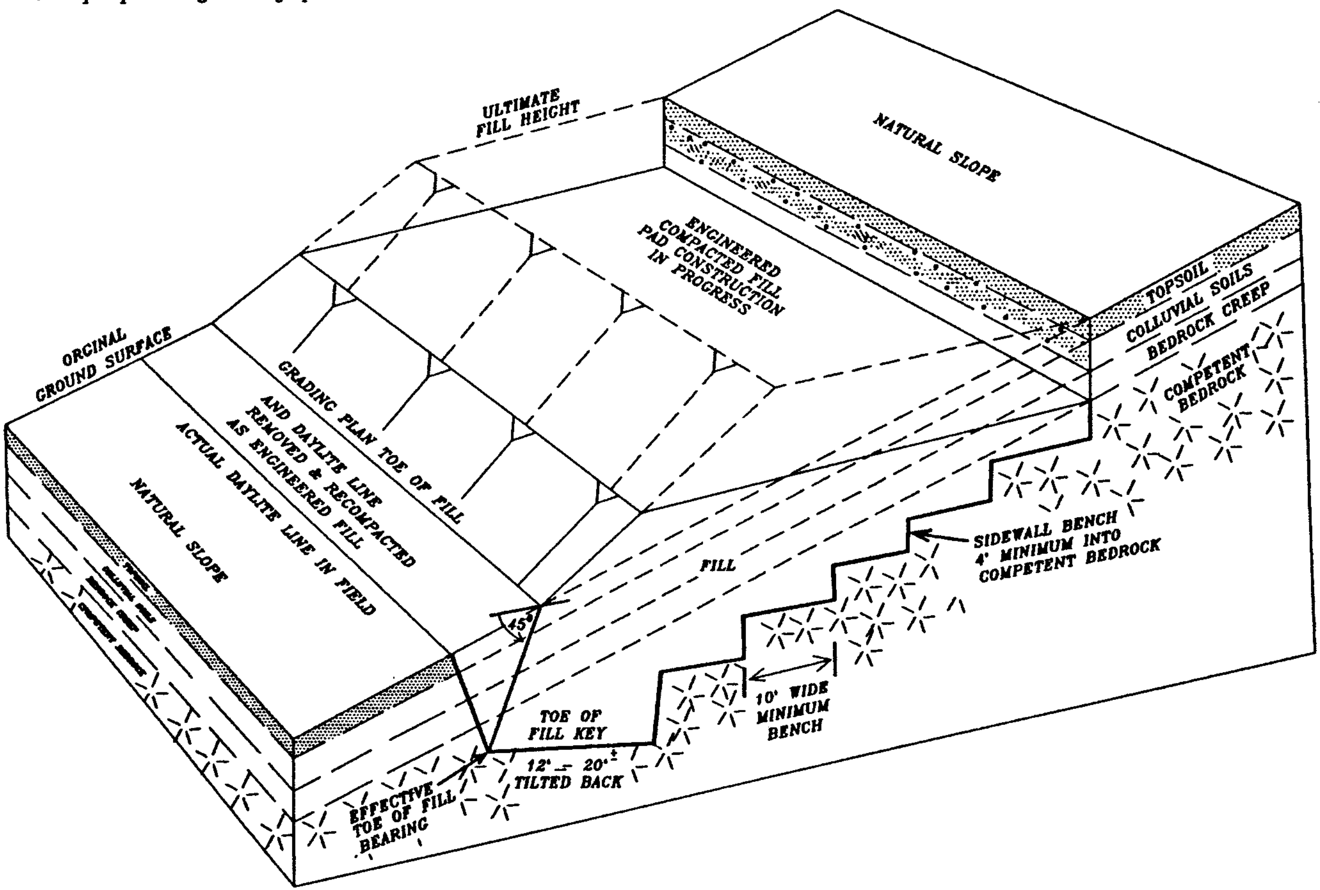
FILL OVER CUT SITUATION



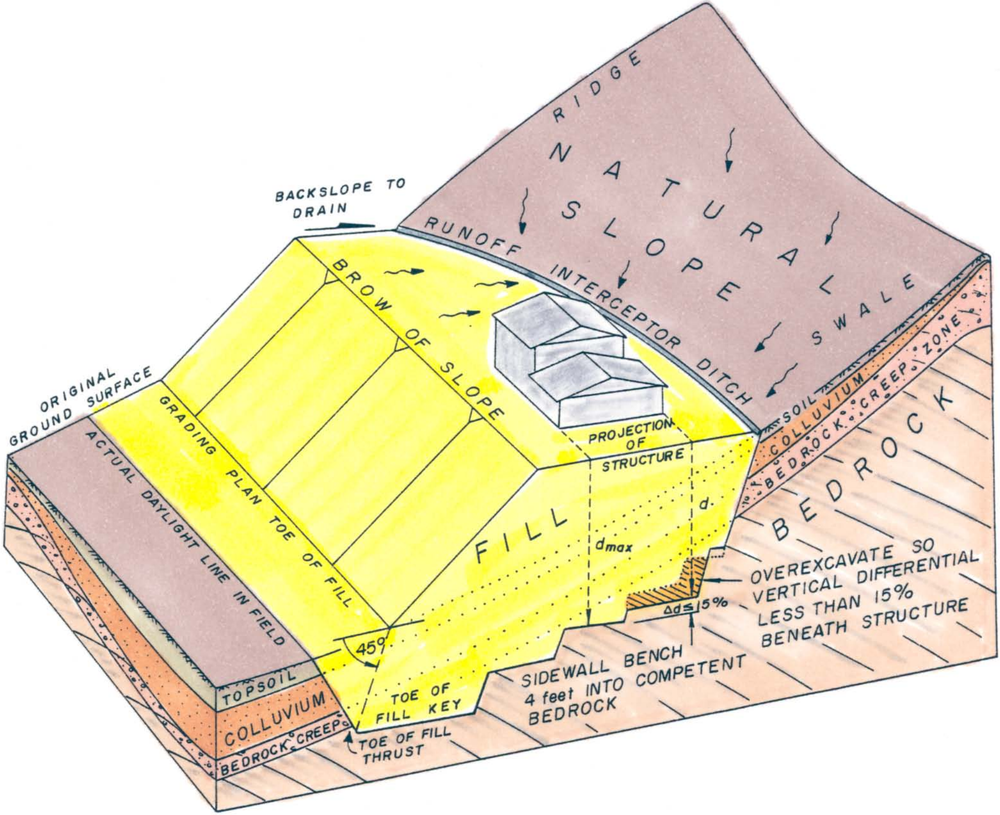

SLOPE BEFORE GRADING

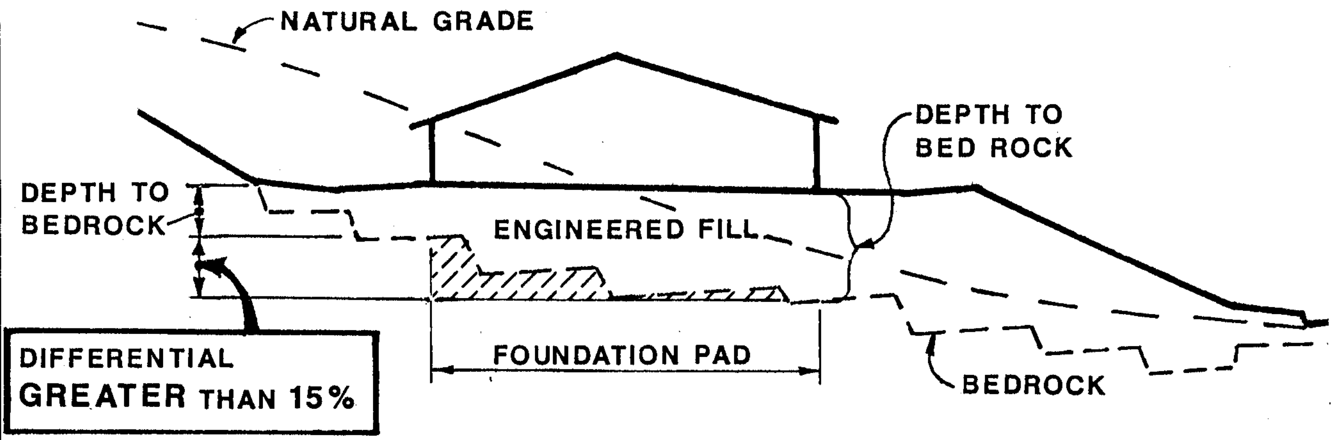

SLOPE AFTER GRADING
DAYLIGHT LINE
FILL
CUT
FILL SLOPE
THEORETICAL DAYLIGHT LINE
ACTUAL DAYLIGHT LINE
required overexcavation
sidewall bench
45°
bench
TOE-OF-KEY THRUST LINE

A Typical toe-of-fill key for the construction of a sidehill fill in siltstone or shale terrain. The toe-of-fill key frequently requires keying and benching through several feet of topsoil, several feet of colluvium, and several feet of bedrock creep in order to key into competent bedrock. Toe-of-fill keys 10-20 ft. deep are common in such areas. Note that the effective bearing point of this toe of fill (45 degrees from the horizontal) moves laterally downslope from the proposed grading plan toe.

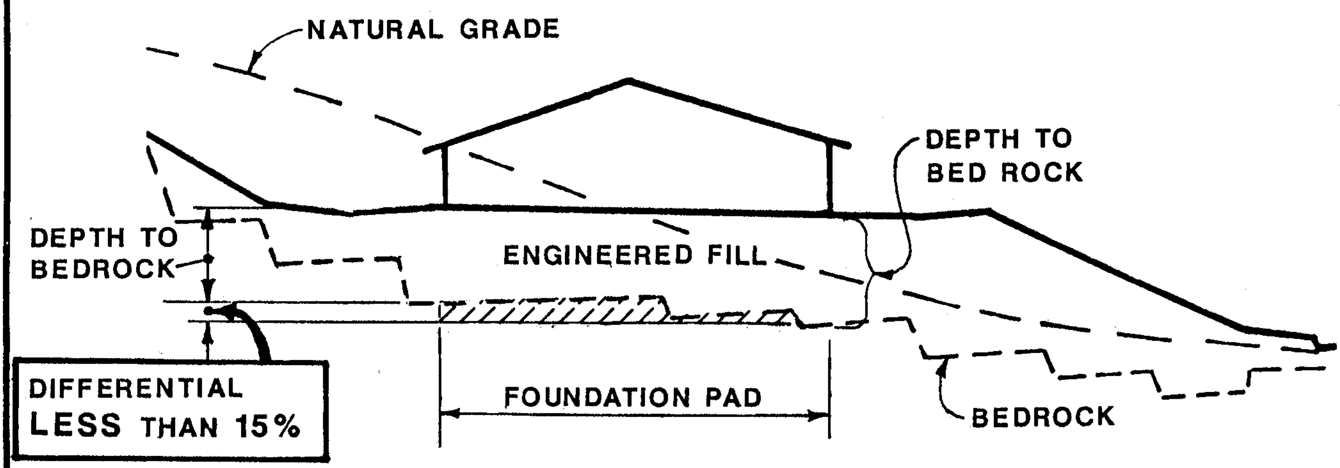


FROM C. MICHAEL SCULLIN, 1983
EXCAVATION & GRADING CODE ADMINISTRATION, INSPECTION AND ENFORCEMENT


RIDGE
NATURAL SLOPE
SWALE
BACKSLOPE TO DRAIN
RUNOFF INTERCEPTOR DITCH
BROW OF SLOPE
ORIGINAL GROUND SURFACE
ACTUAL DAYLIGHT LINE IN FIELD
GRADING PLAN TOE OF FILL
PROJECTION OF STRUCTURE
d.
dmax
FILL
SOIL
COLLUVIUM
BEDROCK CREEP ZONE
BEDROCK
OVEREXCAVATE SO VERTICAL DIFFERENTIAL LESS THAN 15% BENEATH STRUCTURE
Δd≤15%
SIDEWALL BENCH 4 feet INTO COMPETENT BEDROCK
45°
TOE OF FILL KEY
TOE OF FILL THRUST
TOPSOIL
COLLUVIUM
BEDROCK CREEP



FOUNDATION CROSS SECTION (A) UNACCEPTABLE



FOUNDATION CROSS SECTION (B) ACCEPTABLE

Structures founded upon fill as in Section A could be subject to damage resulting from differential settlement of fill. This damage potential can be reduced by overexcavation as shown in Section B. Drilled piers would also reduce this damage potential.

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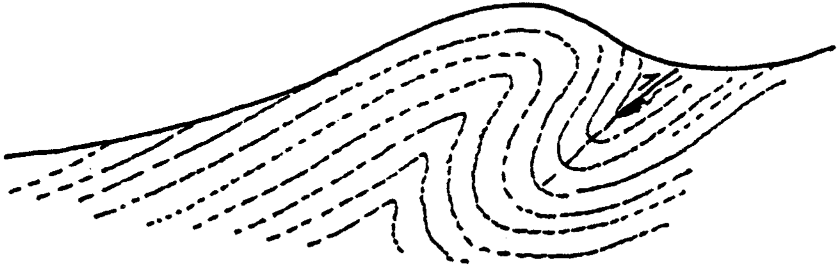
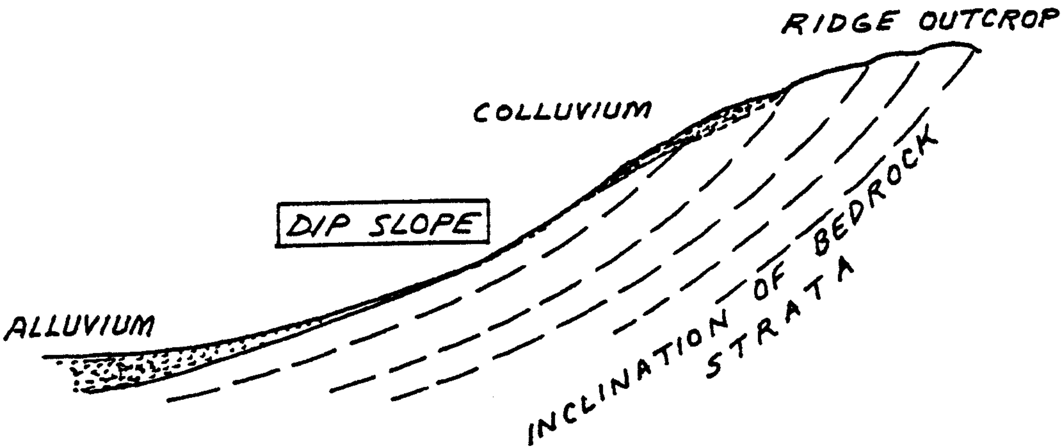
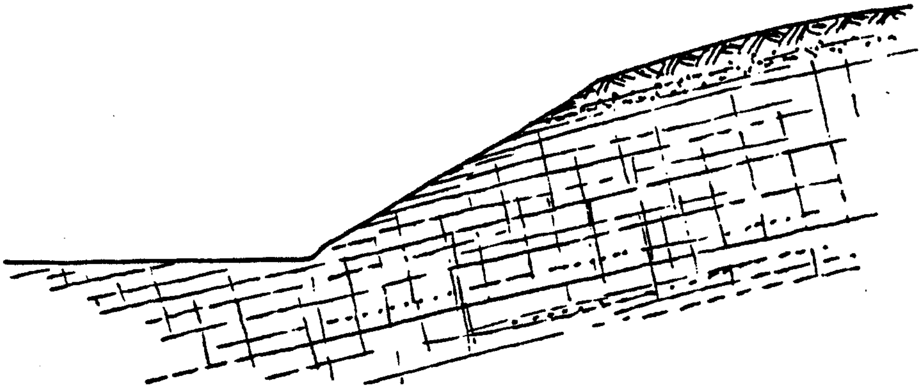
FOUNDATION SECTION TO REDUCE DIFFERENTIAL SETTLEMENT		
PROJECT NO.	DATE	Figure

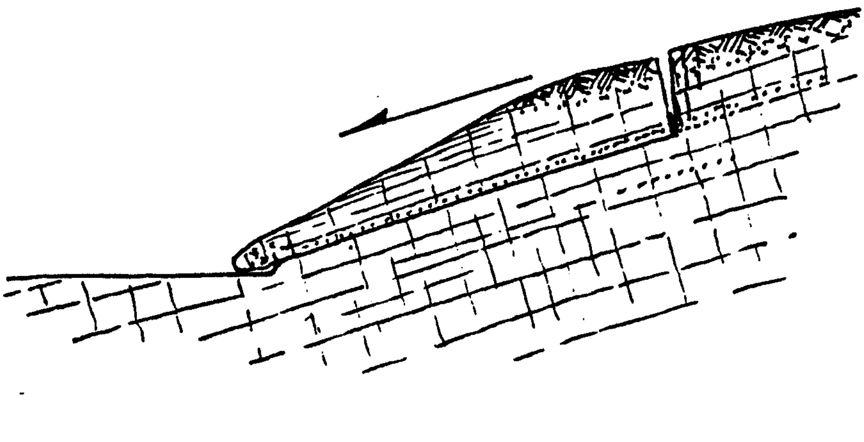


STRUCTURAL CONTROL OF SLOPE FORM BY UNDERLYING GEOLOGY

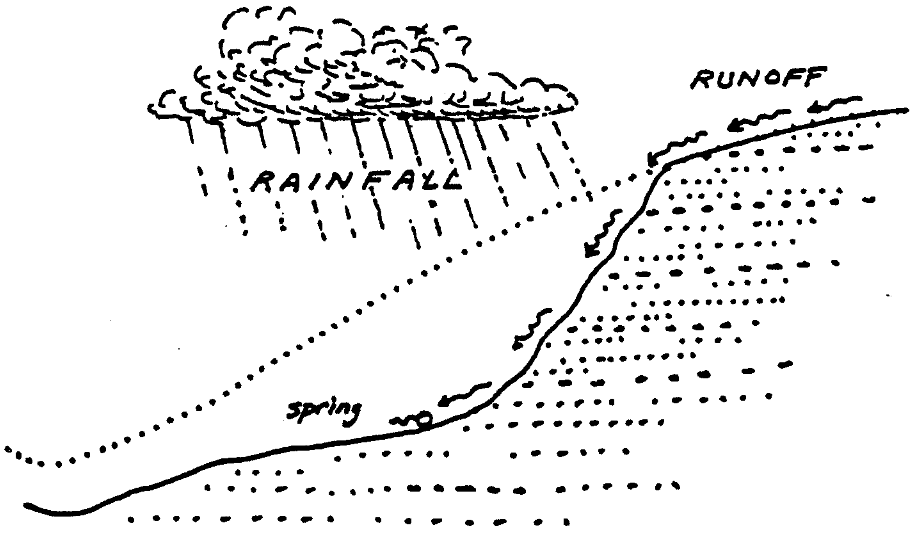


OUT-OF-SLOPE DIP

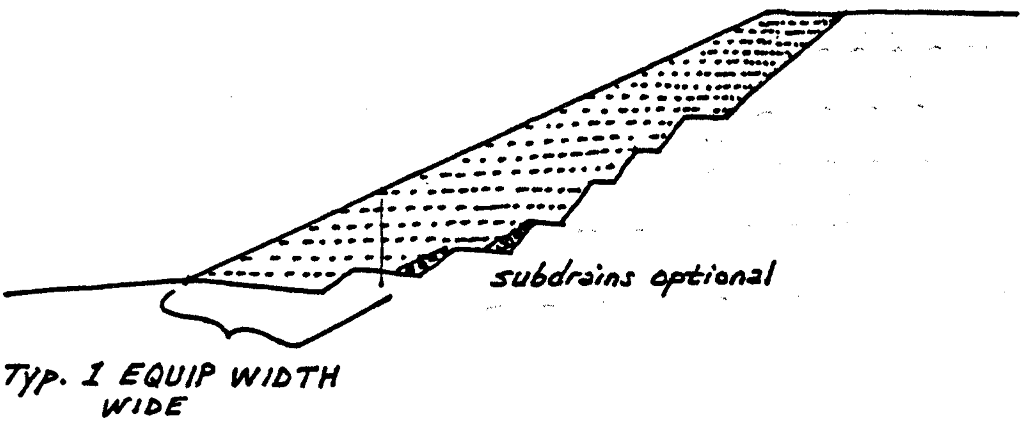




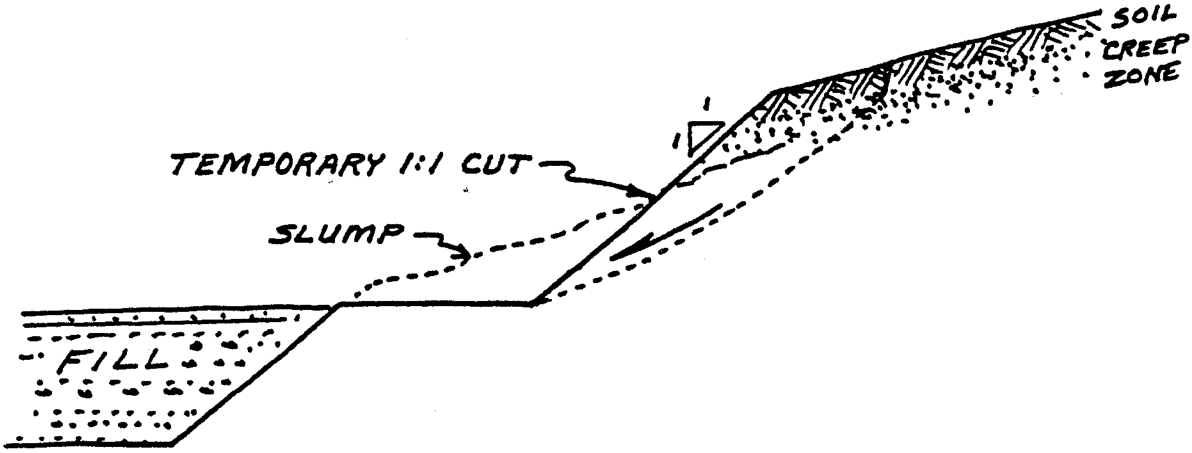
DAYLIGHTED BLOCK MOVES ALONG GEOLOGIC DISCONTINUITY INTO EXCAVATED AREA



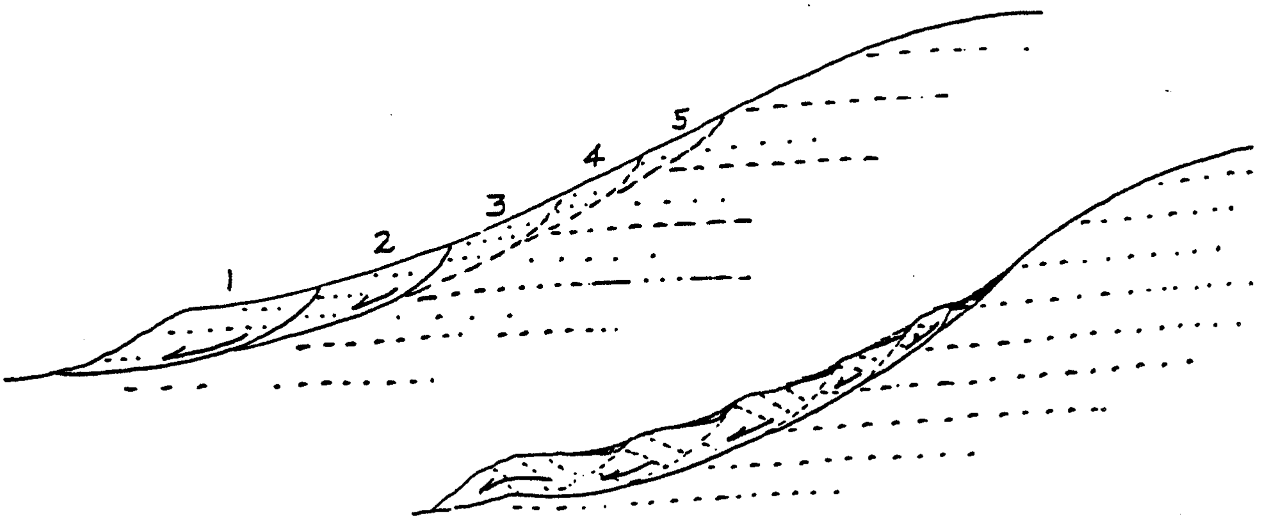
STABILITY FILL



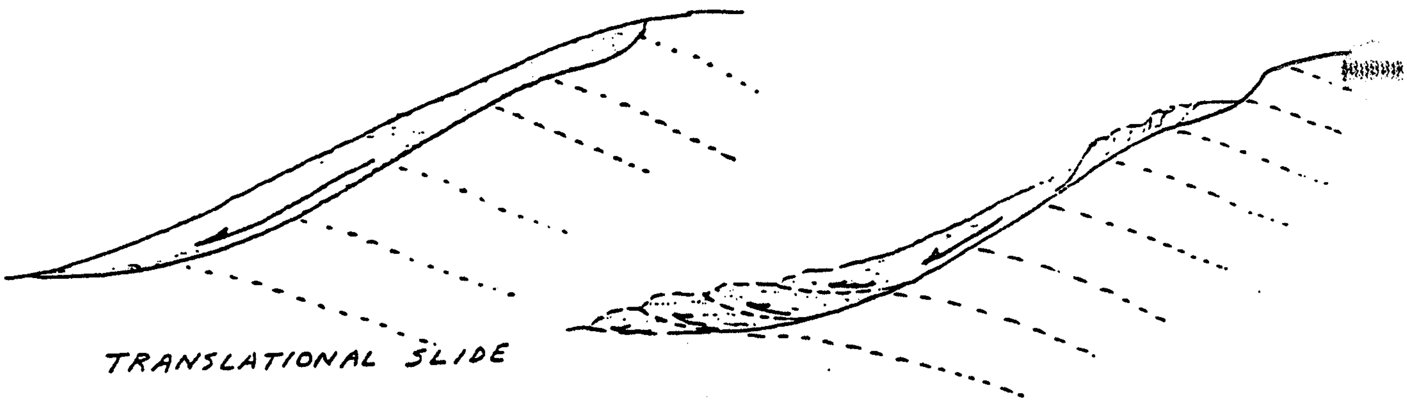
BACKSLOPE FAILURE



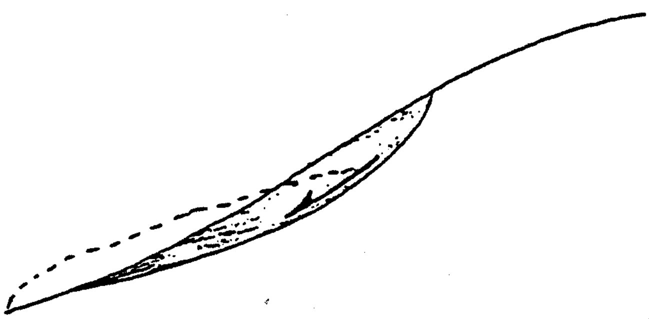
Brief Overview of Types of Slope Failures



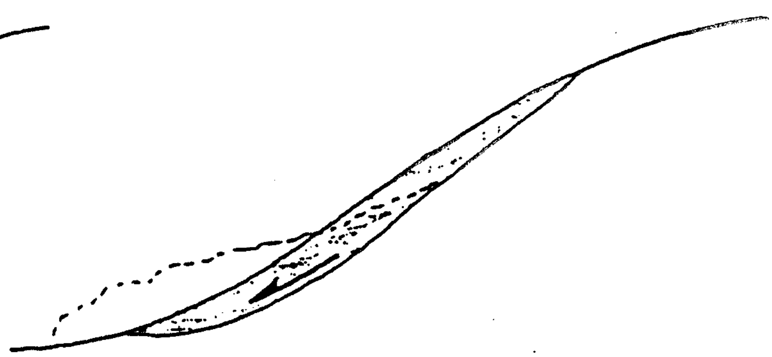
Retrogressive Slump Blocks



TRANSLATIONAL SLIDE

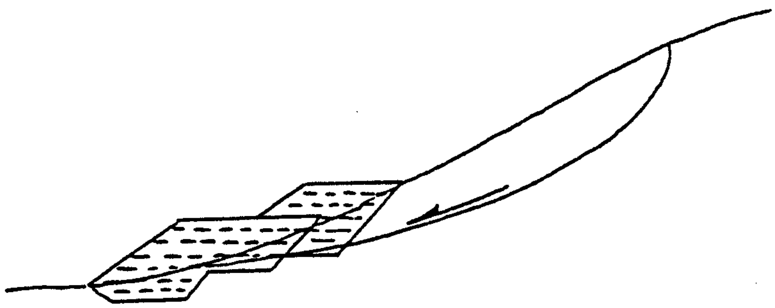


Circular Failure Surfaces in Clays

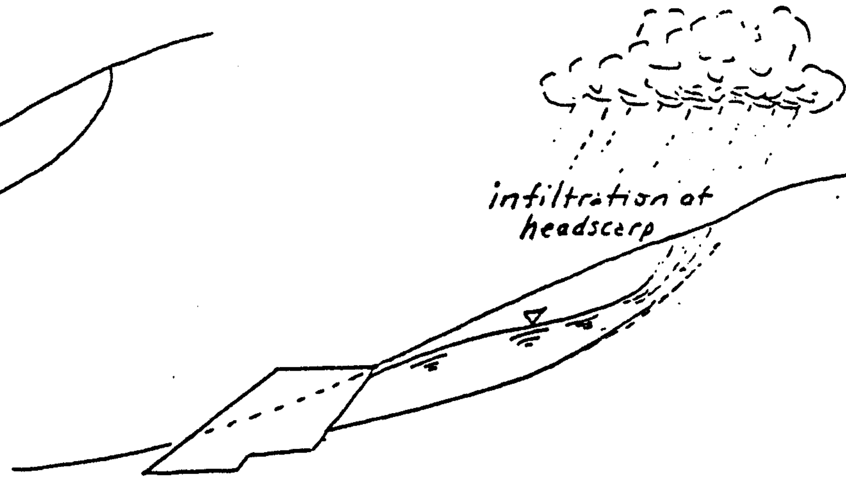


More Planar Failure Surfaces in Sandy Mtls or bedrock

Types of Buttress Fills



TOE BUTTRESS



Excessive Groundwater Pressures Can Build Up Behind Toe Buttresses

FORCES

Dead Weight W of buttress resists sliding thru

F_s is lateral force exerted by landslide

$N = W\cos\alpha$

Shear Strength $S = (N-\mu)\tan\phi + c'$

where:

α = slope inclination

N = Normal Force on Potential Slide Plane

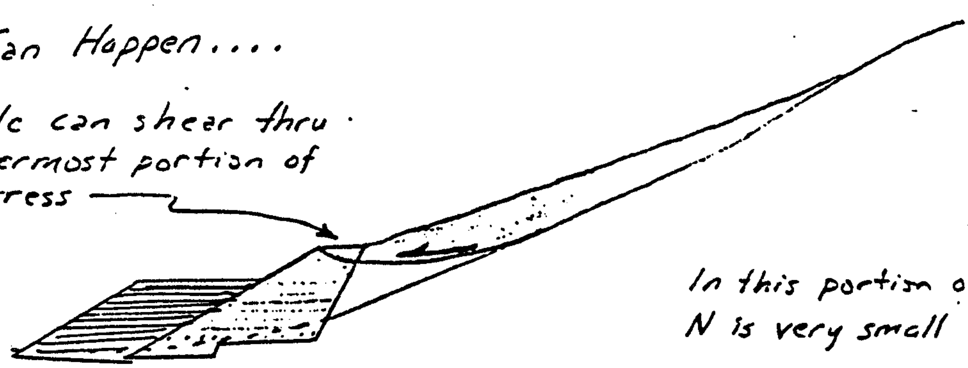
ϕ = Angle of Internal Friction of Soil

μ = Water Pressure = $\gamma_w h$

c' = effective cohesion of Soil

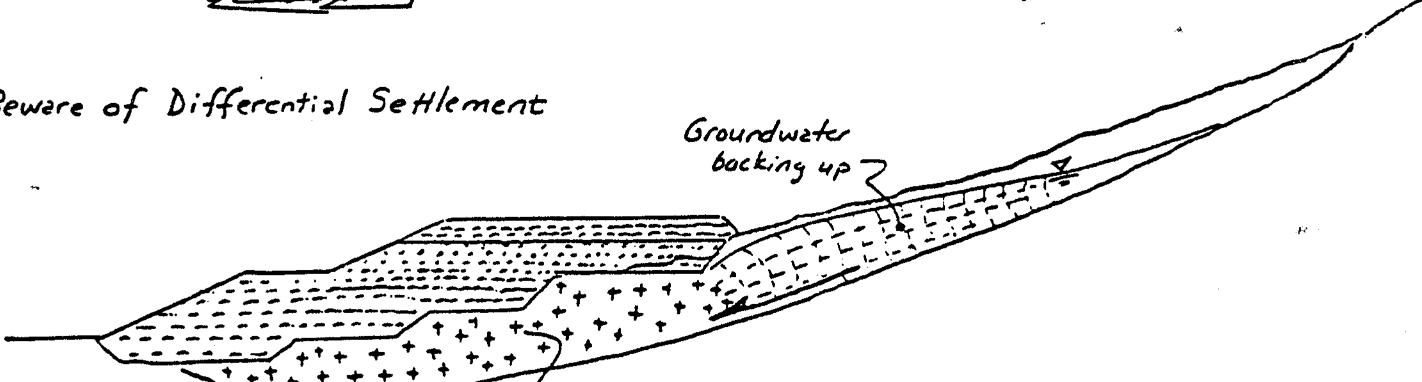
What Can Happen....

slide can shear thru uppermost portion of buttress



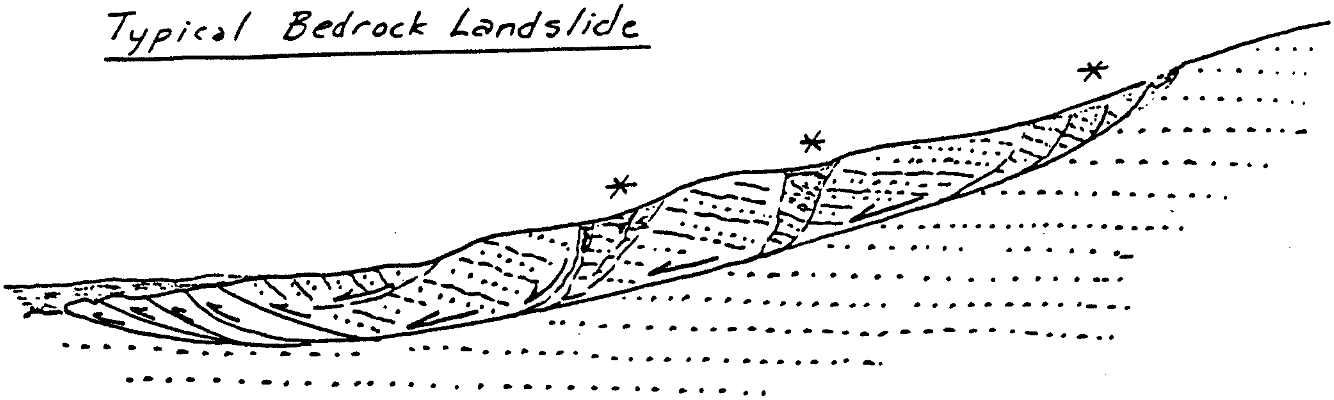
In this portion of buttress N is very small

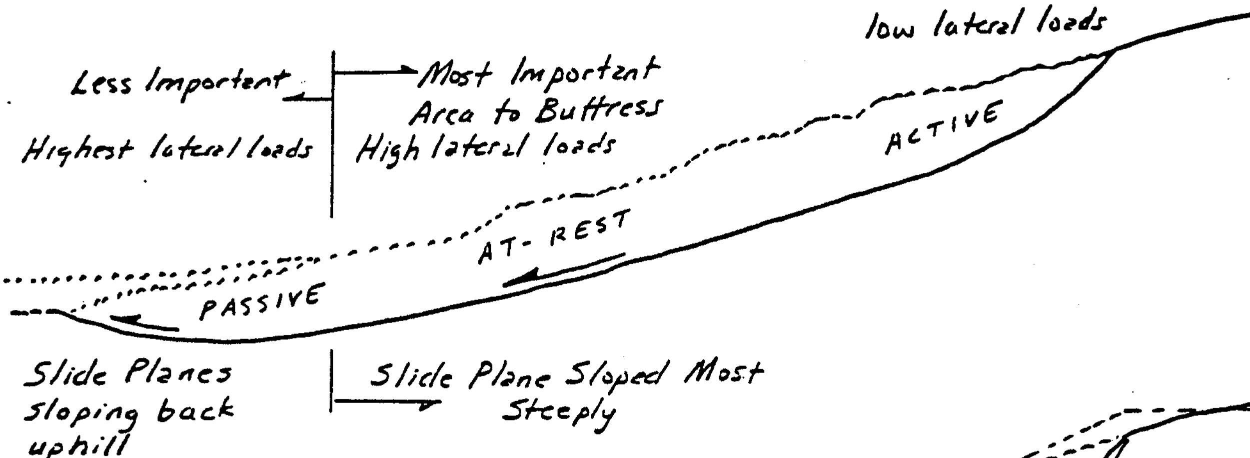
Beware of Differential Settlement

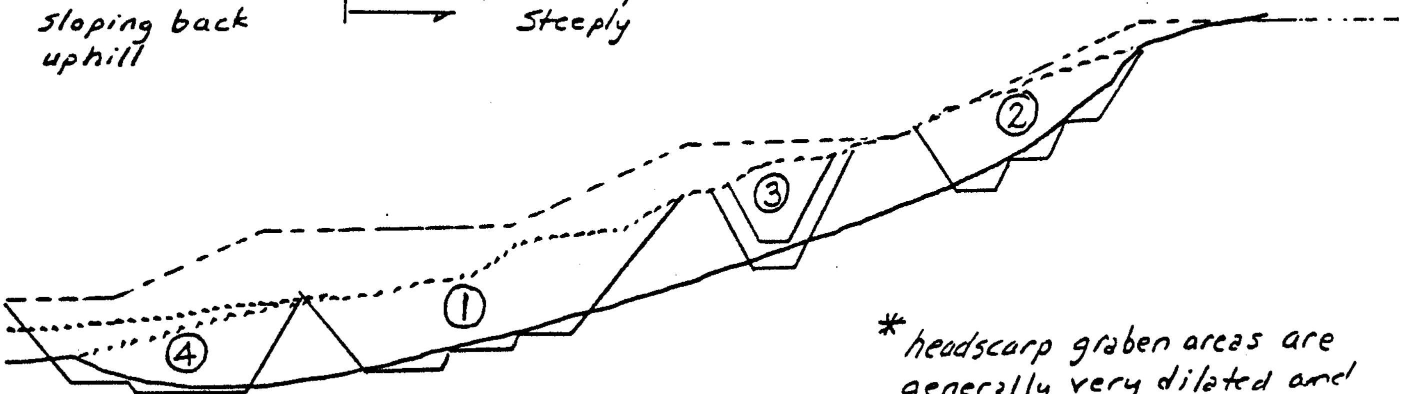


landslide debris consolidating under load of toe buttress. Groundwater backs up underneath

Typical Bedrock Landslide

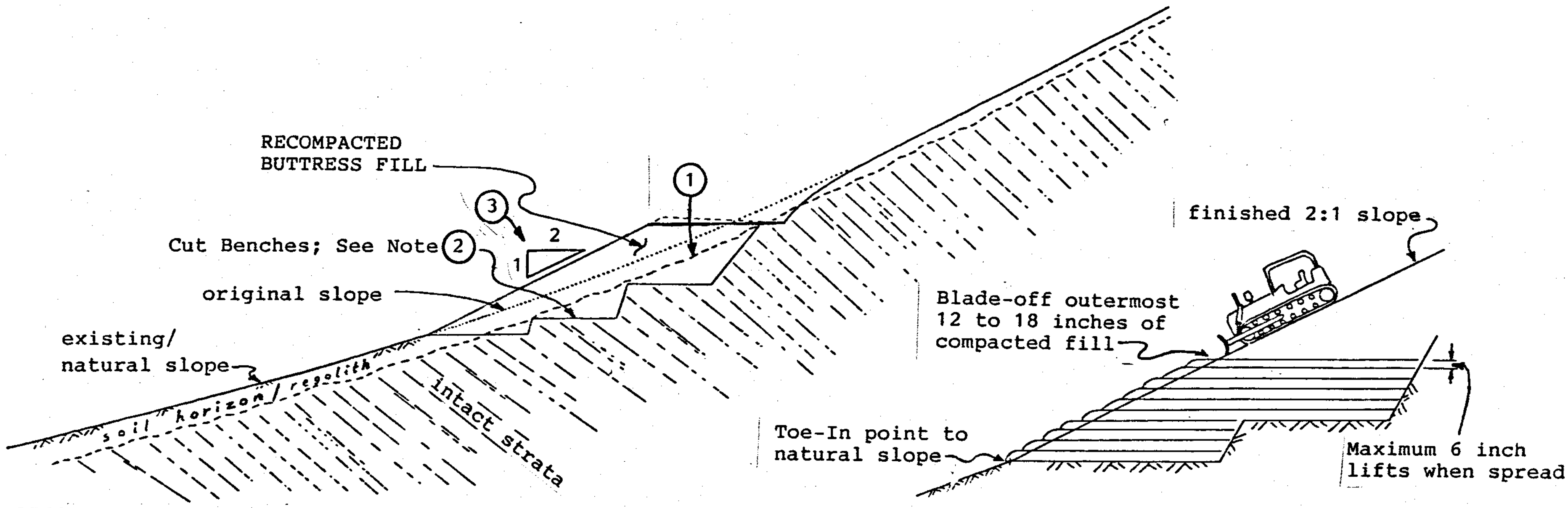






* headscarp graben areas are generally very dilated and loose. Fills on these areas will be subject to settlement

Most Geotechnical Practioners recommed toe buttresses first, and tend to leave uphill portions of ancient landslide slip planes in-place. From a slope stability viewpoint, the toe area is inherently most stable, as the slip surfaces level out and turn <u>uphill</u>. Intercepting the slide plane and installing subdrainage is most critical where the slide plane is steeply inclined downslope. The effectiveness of the buttress is a function of overburden height and subdrainage. Highly cohesive soils better resist short-term earthquake loading.



NOTES:

1. Grub & scarify slope prior to earthwork activities. Minimum organic content 2% (by weight) in structural fill.
2. Benches/Excavation to extend a minimum of 0.50 feet beneath soil or regolith horizon at all locations. Bench widths are at the discretion of the contractor. The required depth of excavation is to be confirmed in the field during construction by either the soils engineer or the engineering geologist.
3. The maximum finish slope is to be 2:1 (horizontal to vertical).

COMPACTION: All structural fill is to be compacted to a minimum value of 90% relative compaction @ to ASTM D1557-79.

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STRUCTURAL FILL DETAIL

PROJECT NO.	DATE	Figure

CONCEPT OF "DEFENSE IN DEPTH" IN SETBACK AREAS