# Ground Anchors

A structural element which is used to transmit tensile loads into the ground. It is installed in soils and/or rocks.

It is used for different objectives.

For the construction of highways

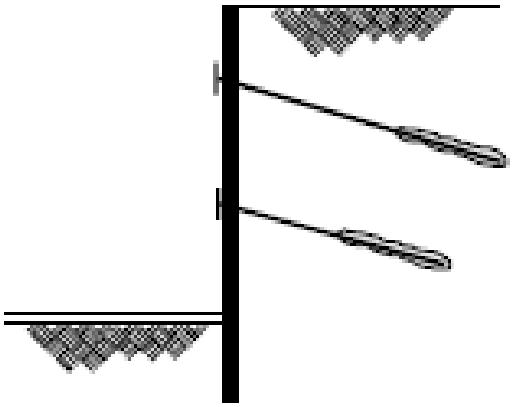
For the construction of abutments of bridges

For the remedy of stability of slopes

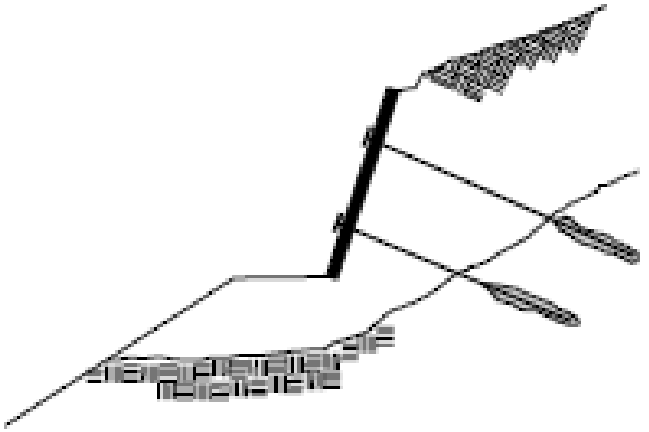
For the remedy of stability of cuts

For the remedy of stability of dams

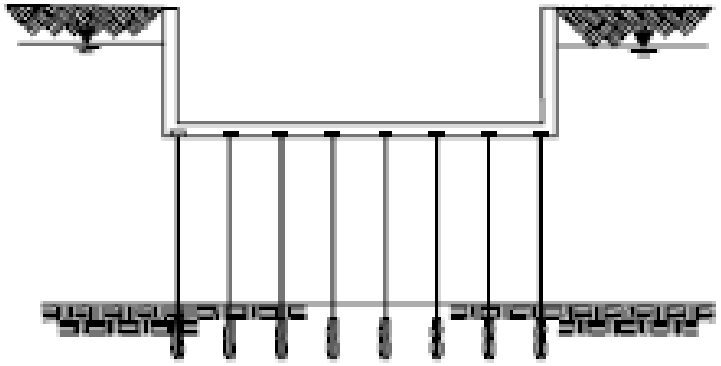
For the resistance against vertical uplift forces



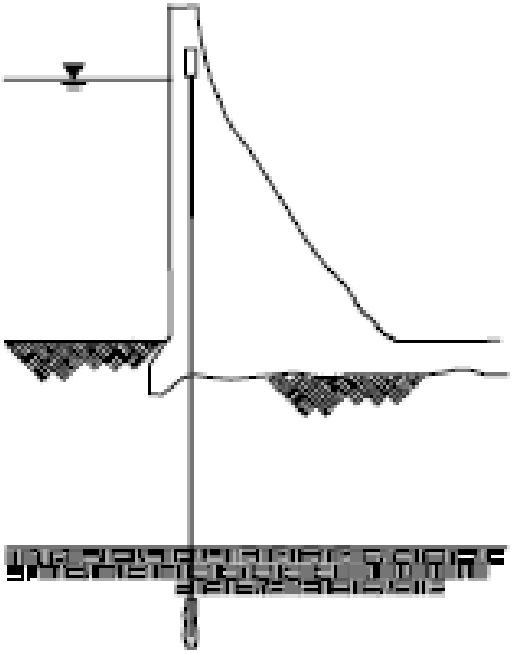
(a) Highway Retaining Wall



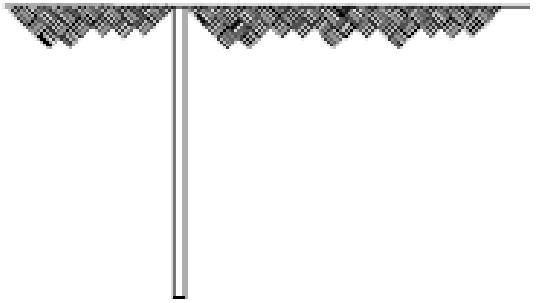
(b) Slope Stabilization



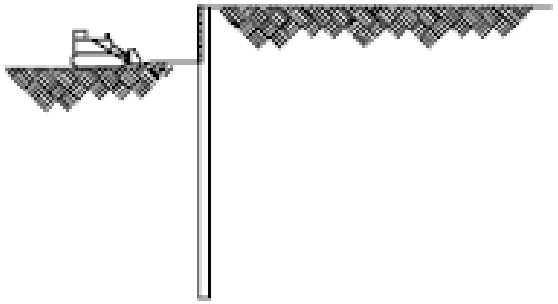
(c) Uplift Slab



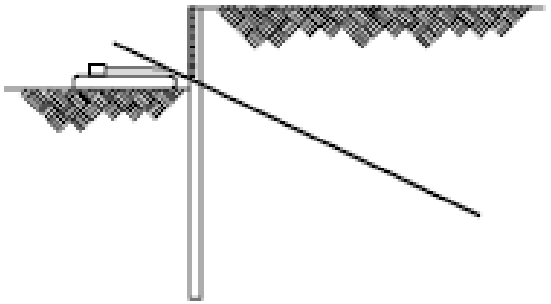
(d) Concrete Dam Stabilization



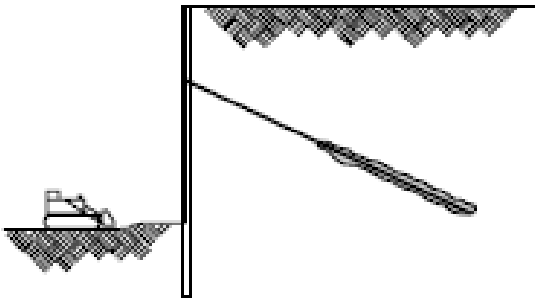
STEP 1: Install soldier beam



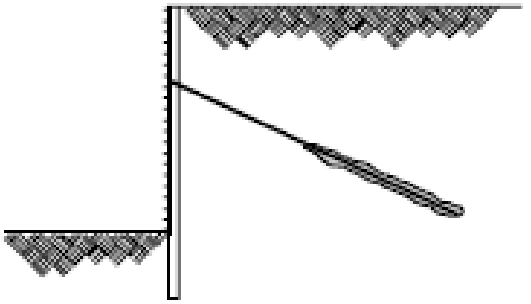
STEP 2: Excavate and install lagging



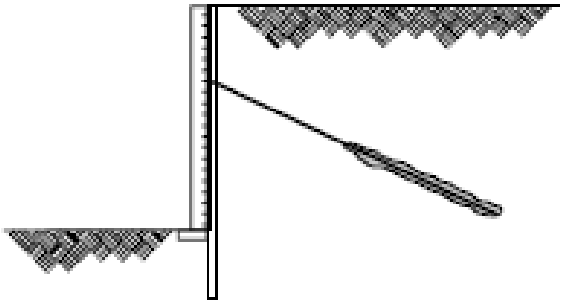
STEP 3: Install and test ground anchor



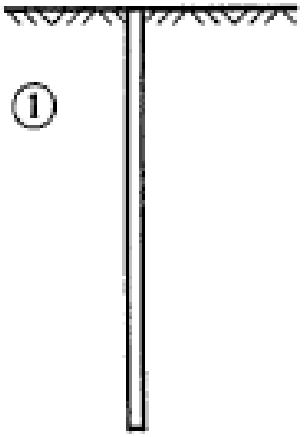
STEP 4: Complete excavation



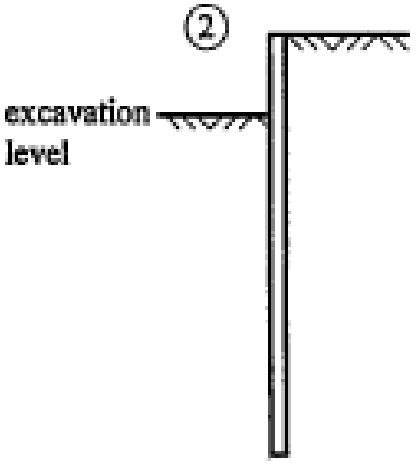
STEP 5: Install headed studs and prefabricated drainage



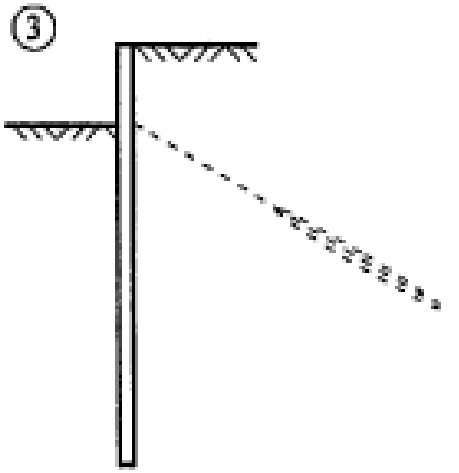
STEP 6: Pour cast-in-place facing



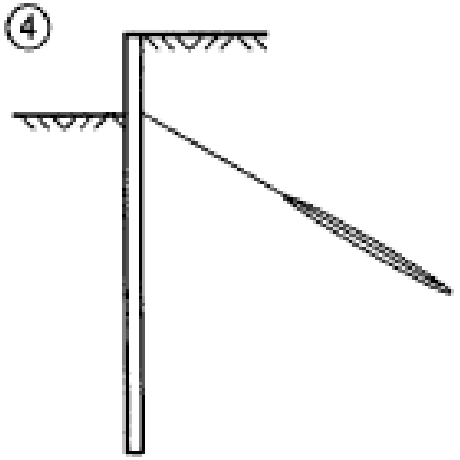

a) Installation of wall
(prior to general excavation)



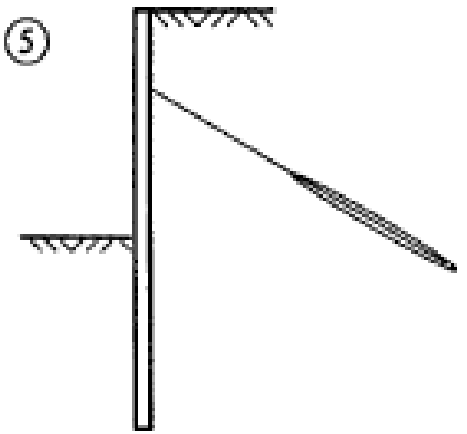

b) Excavation to
first tieback level



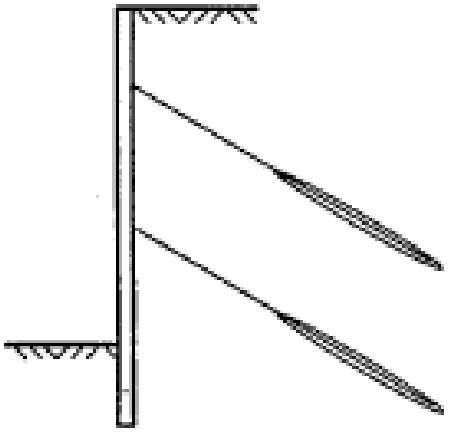

c) Installation
of tiebacks




d) Stressing of tiebacks




e) Excavation
below a tieback



f) Repeat Stages 3,4, and
5 until excavation
reaches design grade

A ground anchor has mainly three parts

anchor head

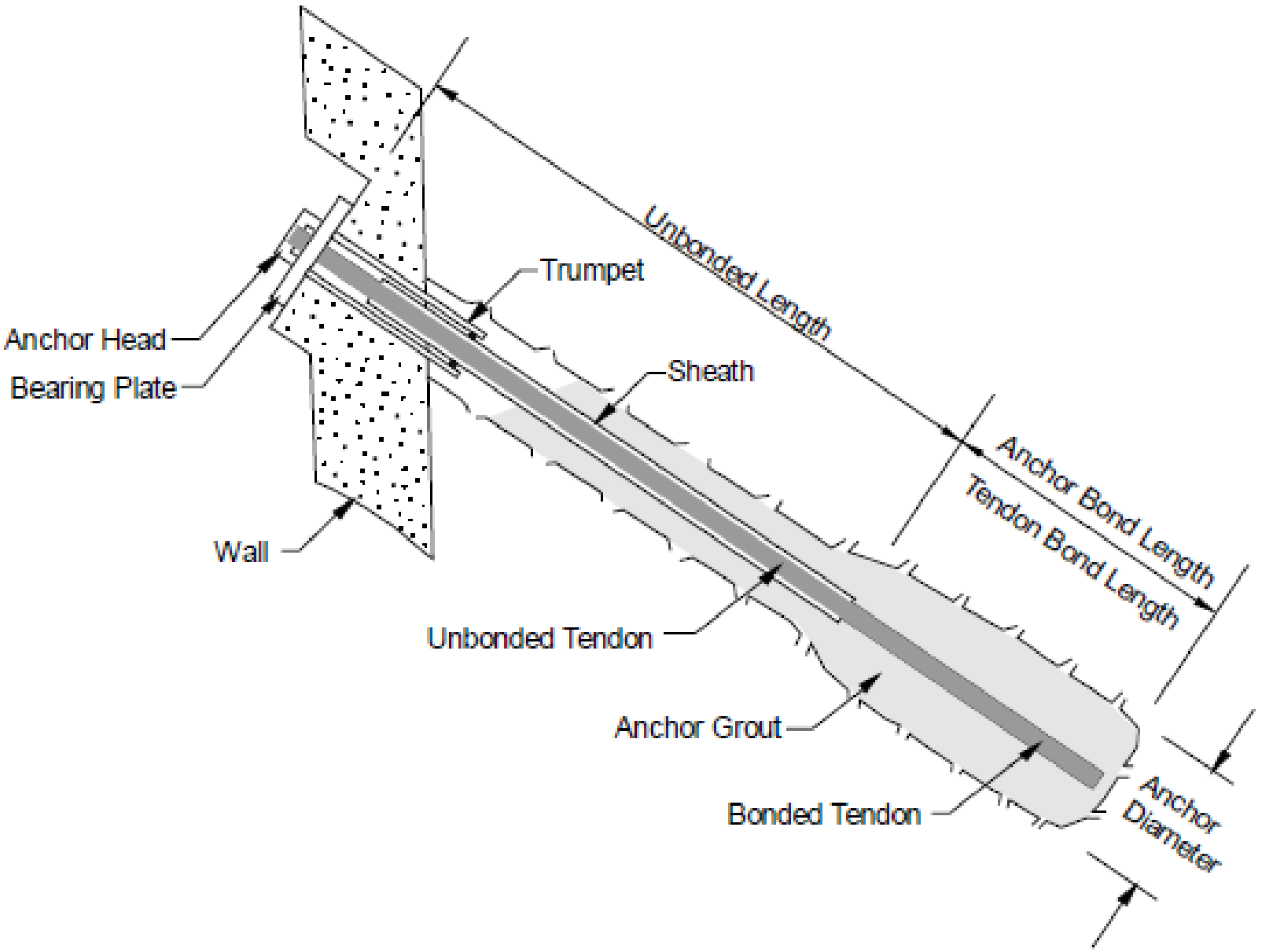
free length (unbonded length)

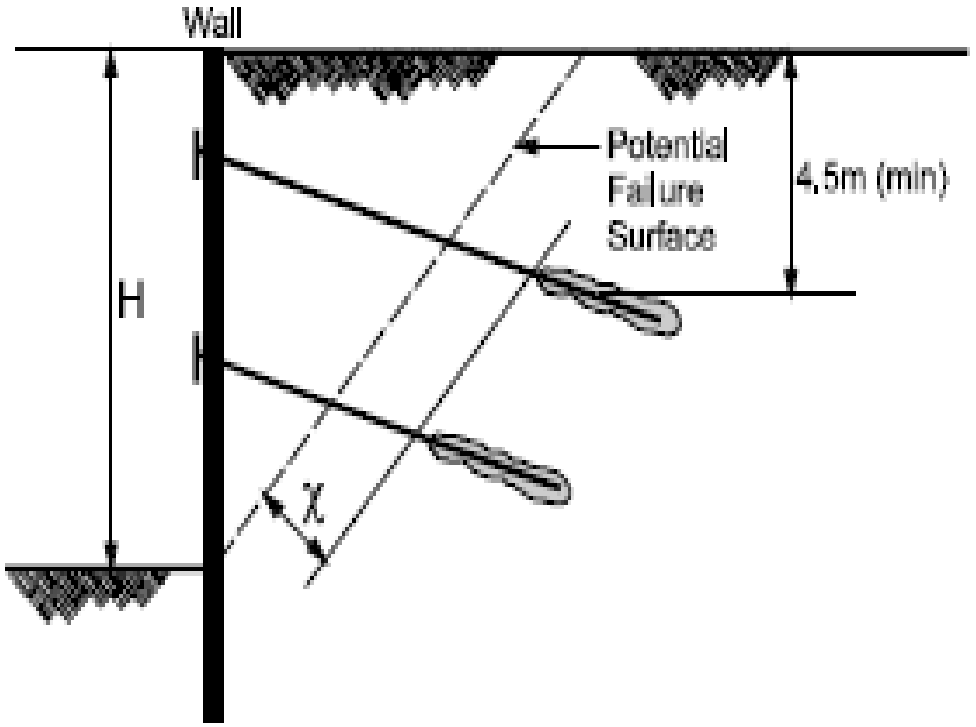
bond length

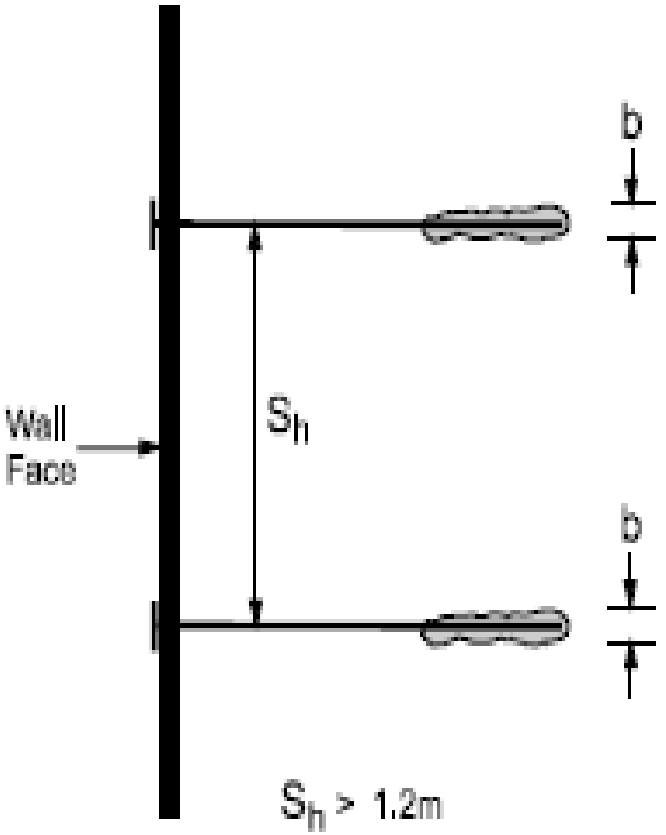
NOTE1: The carrying part is the bond length.

NOTE2: The bond length is between 3m and 11m.

NOTE3: The free length is used to place the bond length into a safe zone.


Anchor Head
Bearing Plate
Wall
Trumpet
Sheath
Unbonded Length
Anchor Bond Length
Tendon Bond Length
Unbonded Tendon
Anchor Grout
Bonded Tendon
Anchor Diameter

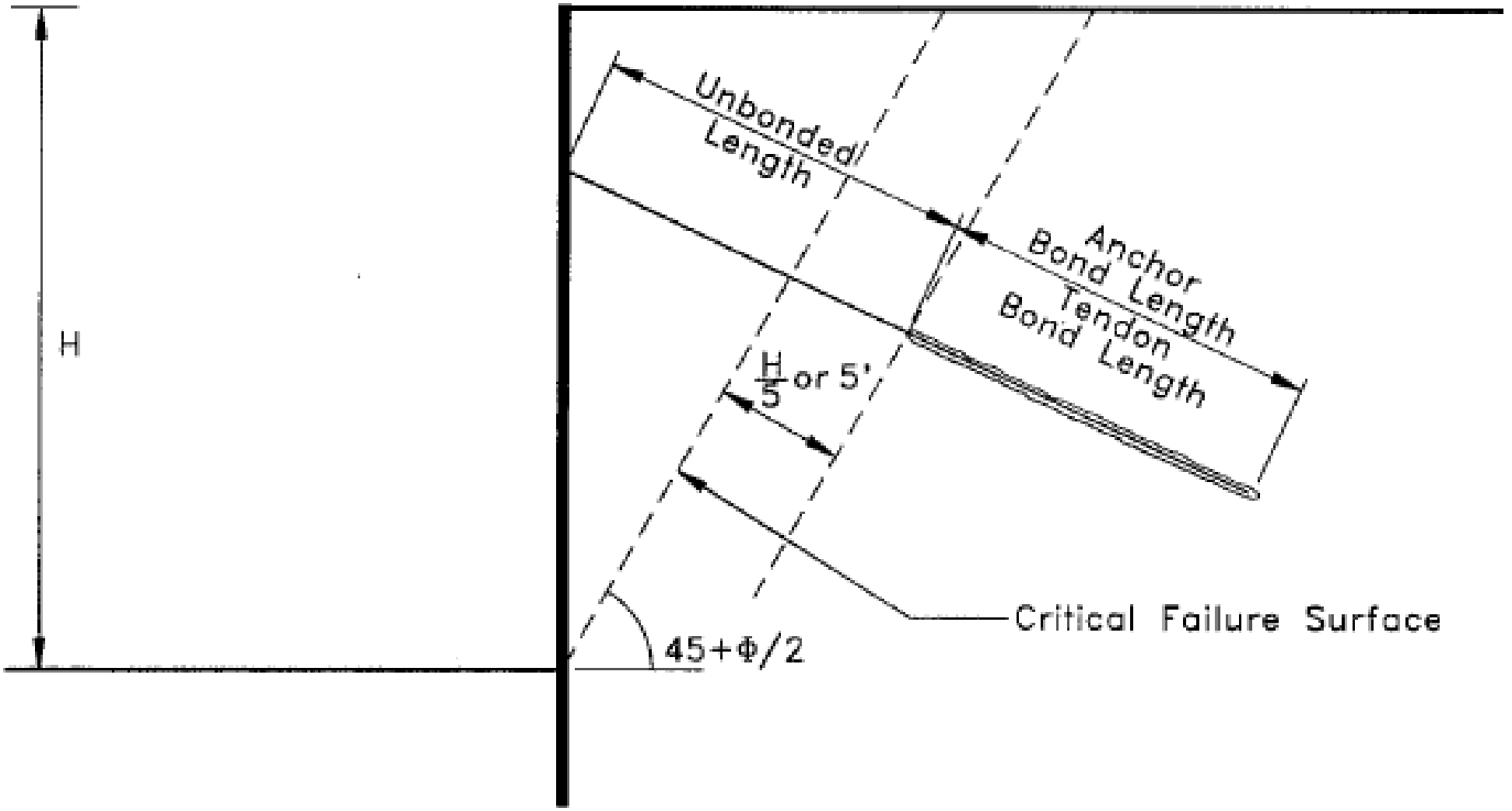



Minimum unbonded length = 3m (bar)
4.5m (strand)

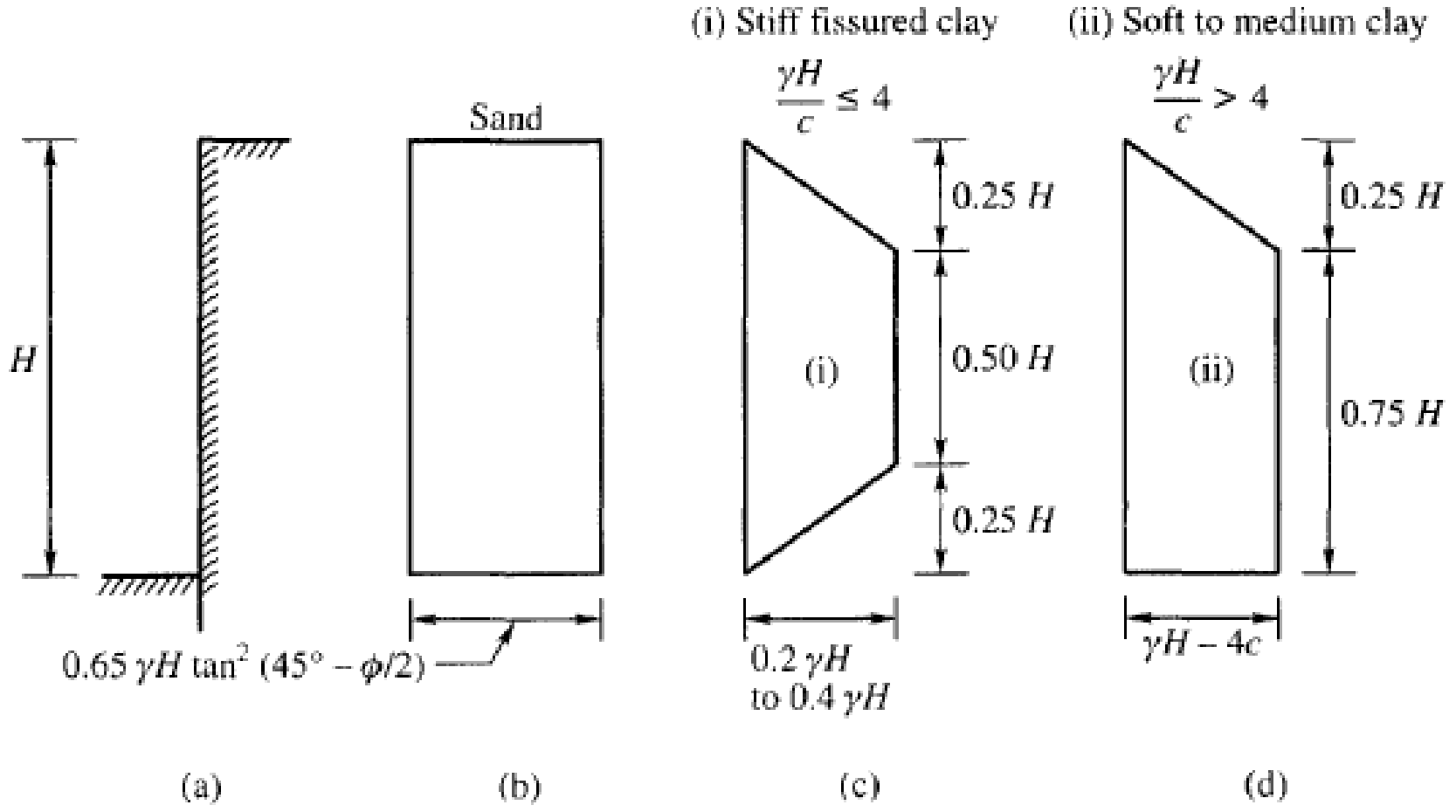
$\chi$ = 1.5m or 0.2H, whichever is greater

$S_h > 1.2m$


H
Unbonded Length
Anchor Bond Length
Tendon Bond Length
H/5 or 5'
Critical Failure Surface
45+Φ/2

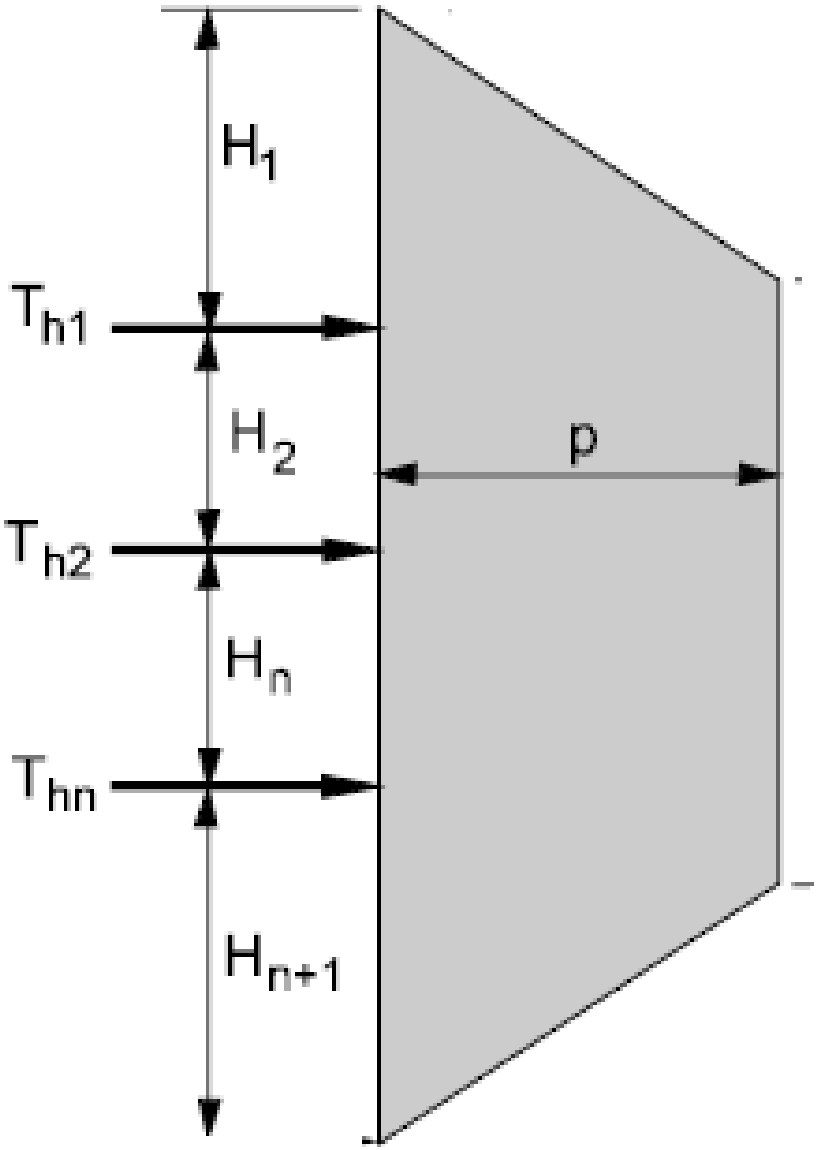
# Steps for designing of anchors

- determine the pressure diagram




Apparent pressure diagram for calculating loads in struts of braced cuts: (a) sketch of wall of cut, (b) diagram for cuts in dry or moist sand, (c) diagram for clays if $\gamma H/c$ is less than 4 (d) diagram for clays if $\gamma H/c$ is greater than 4 where $c$ is the average undrained shearing strength of the soil (Peck, 1969)

- calculate the $T_h$ values at each point



find the $T_i$ values ( $for\ example\ T_1$=( $\frac{T_{h1}}{cos10°\ or\ cos15°}$) $s_h$

find the $T_{imax}$ values

- determine the type of soil and the value of $P_{ult}$

Presumptive ultimate values of load transfer for preliminary design of small diameter straight shaft gravity-grouted ground anchors in soil.

| Soil type | Relative density/Consistency (SPT range)[1] | Estimated ultimate transfer load (kN/m) |
|---|---|---|
| Sand and Gravel | Loose (4-10)<br>Medium dense (11-30)<br>Dense (31-50) | 145<br>220<br>290 |
| Sand | Loose (4-10)<br>Medium dense (11-30)<br>Dense (31-50) | 100<br>145<br>190 |
| Sand and Silt | Loose (4-10)<br>Medium dense (11-30)<br>Dense (31-50) | 70<br>100<br>130 |
| Silt-clay mixture with low plasticity or fine micaceous sand or silt mixtures | Stiff (10-20)<br>Hard (21-40) | 30<br>60 |

- determine the bond length

using $L_{Bond} = \frac{2T_{max}}{P_{ult}}$

# Example

In a construction site containing a deep sand soil ($N_{ave}$=10, and no gravel), an anchored-wall has been selected as retaining structure for an excavation of 5.5m. The anchored-wall will consist two anchors. The vertical spacing and horizontal spacing between these two anchors are 2 m and 2.2m. One of them will carry 148 kN/m of horizontal force and the other one will carry 157 kN/m of horizontal force. Calculate the bond length of the anchor.

$$T_1 = \left(\frac{T_{h1}}{cos10}\right) s_h = \left(\frac{148kN/m}{cos10}\right) 2.2m = 330kN$$

$$T_2 = \left(\frac{T_{h2}}{cos10}\right) s_h = \left(\frac{157kN/m}{cos10}\right) 2.2m = 350kN$$

$$T_{max} = 350kN$$

$$L_{Bond} = \frac{2T_{max}}{P_{ult}} = \frac{2x350kN}{100kN/m} = 7 \text{ m}$$