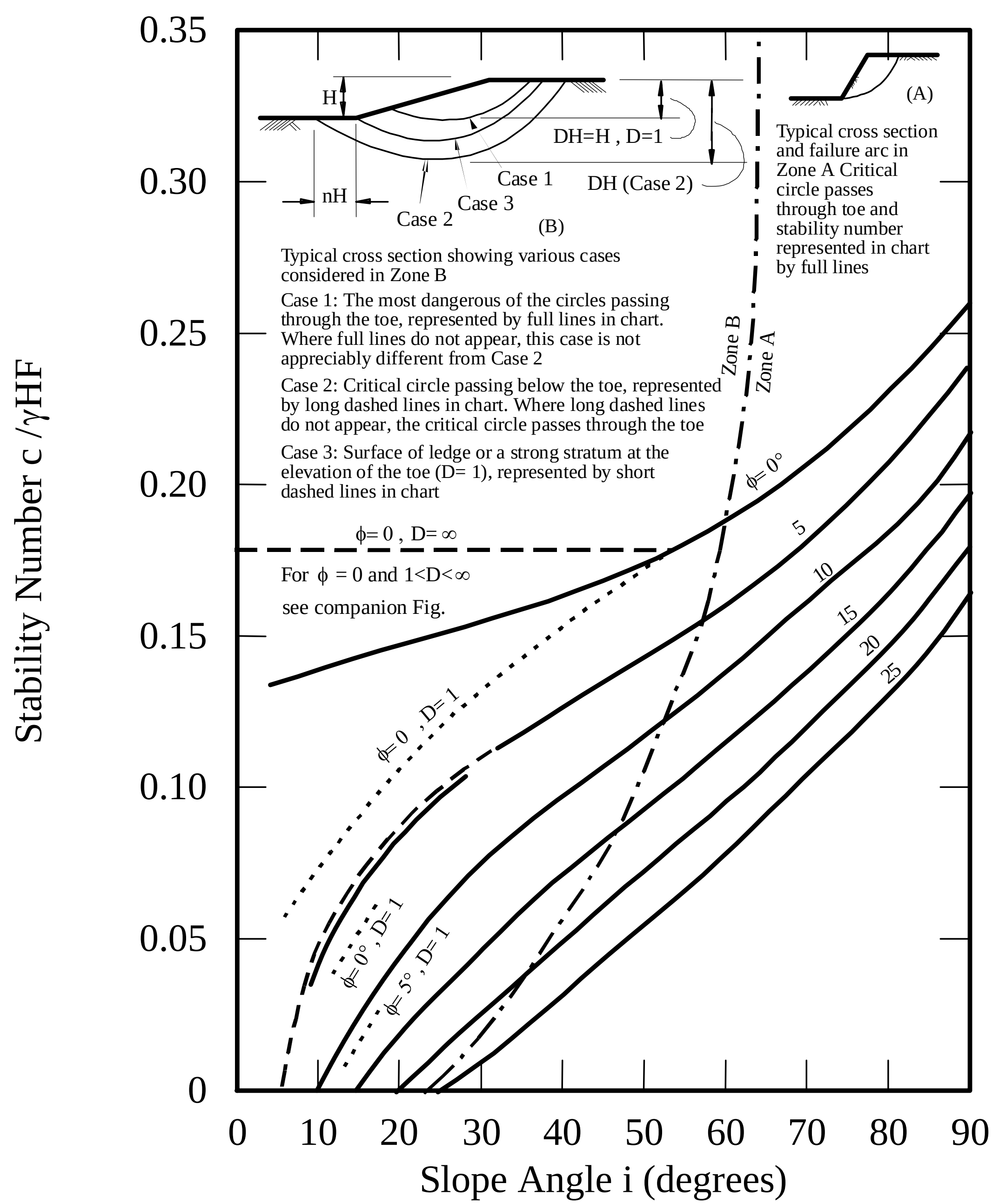
Stability Number

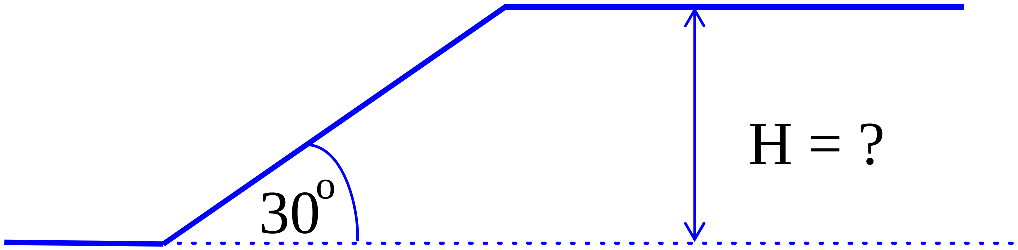
- A variety of charted solutions exist for the simple geometry considered above.
- For the undrained (total stress) analysis of slopes charts produced by Taylor are often used.
- The charts are based on the analysis of circular failure surfaces, and assume that soil strength is given by a Mohr-Coulomb analysis
- Tension cracks are not considered

Taylor's Chart



Taylor's Chart

Example - 1



c_u = 20 kN/m^2
ϕ_u = 10^o
γ_{bulk} = 15 kN/m^3
F.S. = 1.5

Since the factor of safety is given, then the problem indicates a design of a new slope

Solution:

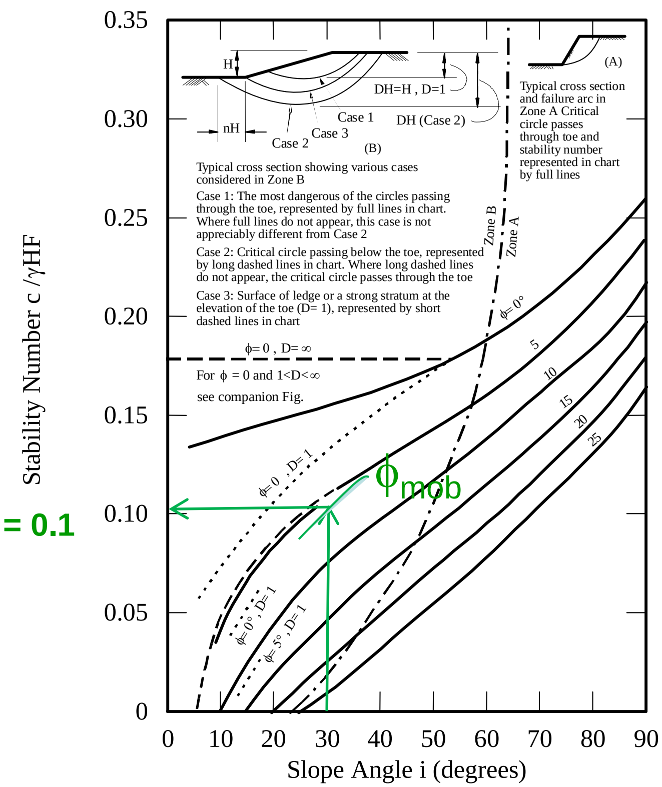
$\phi_{mobilized} = \phi_{developed}$

Use the chart with *i* = 30^o, and $\phi_{mob} = \tan^{-1}\left(\frac{\tan 10^o}{1.5}\right) = 6.7^o$

$$SN = 0.1 = \frac{20/1.5}{15 \times H_{design}}$$

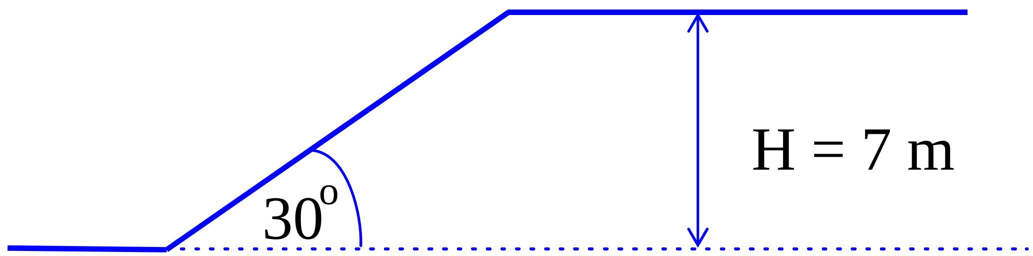
$$H_{design} = \frac{20/1.5}{15 \times 0.1} = 8.88 \text{ m}$$

SN = 0.1



Taylor's Chart

Example - 2



$c_u = 20 \text{ kN/m}^2$

$\phi_u = 10^o$

$\gamma_{bulk} = 15 \text{ kN/m}^3$

F.S. = ????

Since the factor of safety is not given, then the problem indicates an existing slope which we need to analyze it for its stability.

$\phi_{mobilized} = \phi_{developed}$

Solution:

Trial # 1

1- Assume $FS_\phi = 1$

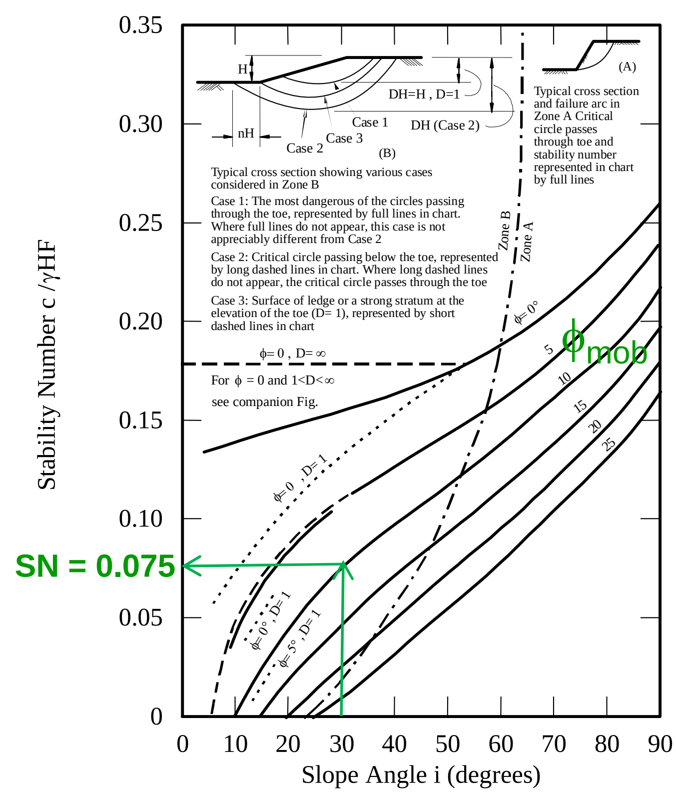
2- Use the chart with $i = 30^o$, and $\phi_{mob} = \tan^{-1}\left(\frac{\tan 10^o}{1.0}\right) = 10^o$

3- Go to the chart and find SN for $\phi_{mob} = 10^o$

$$SN = 0.075 = \frac{c_{mob}}{15 \times 7}$$

4- $c_{mob} = 15 \times 7 \times 0.075 = 7.87 \text{ kN/m}^2$

5- $FSc = c / c_{mob} = 20/7.87 = 2.5$



Therefore the Assumed $FS\phi \neq$ the calculated FS_c

This means the assumed factor of safety was not the right one. So we need to assume another FS_ϕ and solve the problem again for FS_c.

Trial # 2

1- Assume $FS_\phi = 1.5$

2- Use the chart with $i = 30^o$, and $\phi_{mob} = \tan^{-1}\left(\frac{\tan 10^o}{1.5}\right) = 6.7^o$

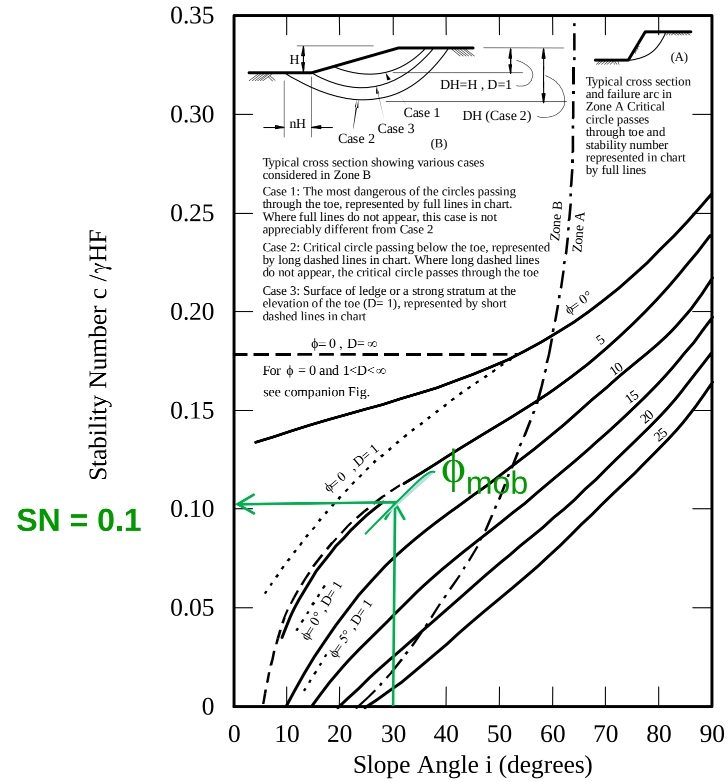
3- Go to the chart and find SN for $\phi_{mob} = 6.7^o$

$$SN = 0.1 = \frac{c_{mob}}{15 \times 7}$$

4- $c_{mob} = 15 \times 7 \times 0.10 = 10.5\ kN/m^2$

5- $FSc = c / c_{mob} = 20/10.5 = 1.9$

Therefore the Assumed $FS\phi \neq$ the calculated FS_c



This means the assumed factor of safety was not the right one. So we need to assume another $FS\phi$ and solve the problem again for FS_c.

Trial # 3

1- Assume $FS_\phi = 1.8$

2- Use the chart with $i = 30^o$, and $\phi_{mob} = \tan^{-1}\left(\frac{\tan 10^o}{1.8}\right) = 5.5^o$

3- Go to the chart and find SN for $\phi_{mob} = 5.5^o$

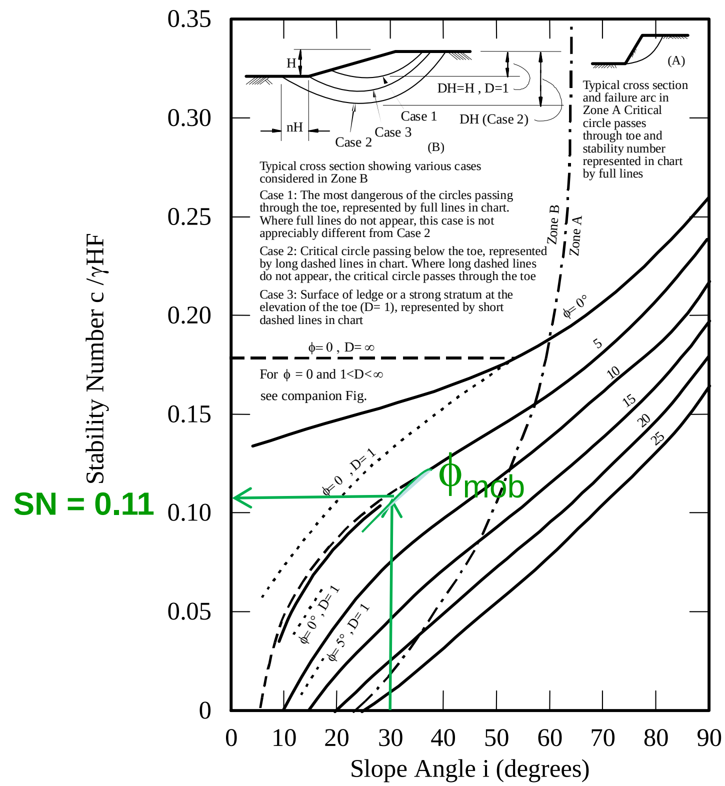
$$SN = 0.11 = \frac{c_{mob}}{15 \times 7}$$

4- $c_{mob} = 15 \times 7 \times 0.11 = 11.55 \text{ kN/m}^2$

5- $FSc = c / c_{mob} = 20/11.55 = 1.73$

Therefore the Assumed $FS\phi \neq$ the calculated FS_c

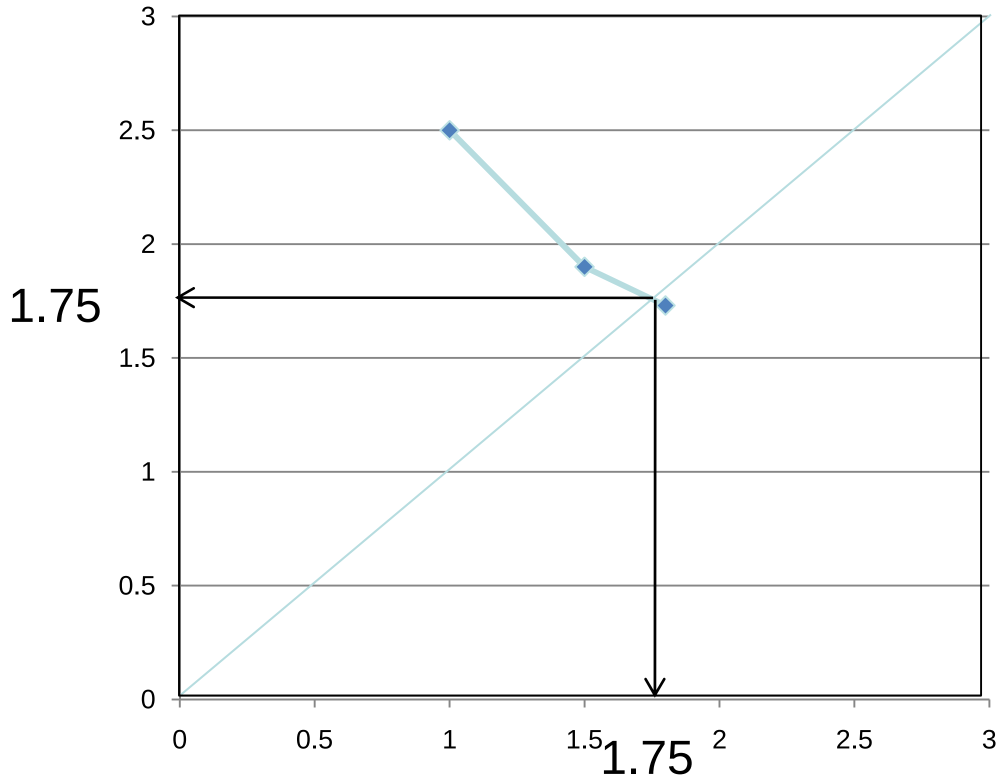
This means the assumed factor of safety was not the right one. So we need to assume another $FS\phi$ and solve the problem again for FS_c.



Since we complied three different trials, we are ready to find the right factor of safety by using the 45^o line method

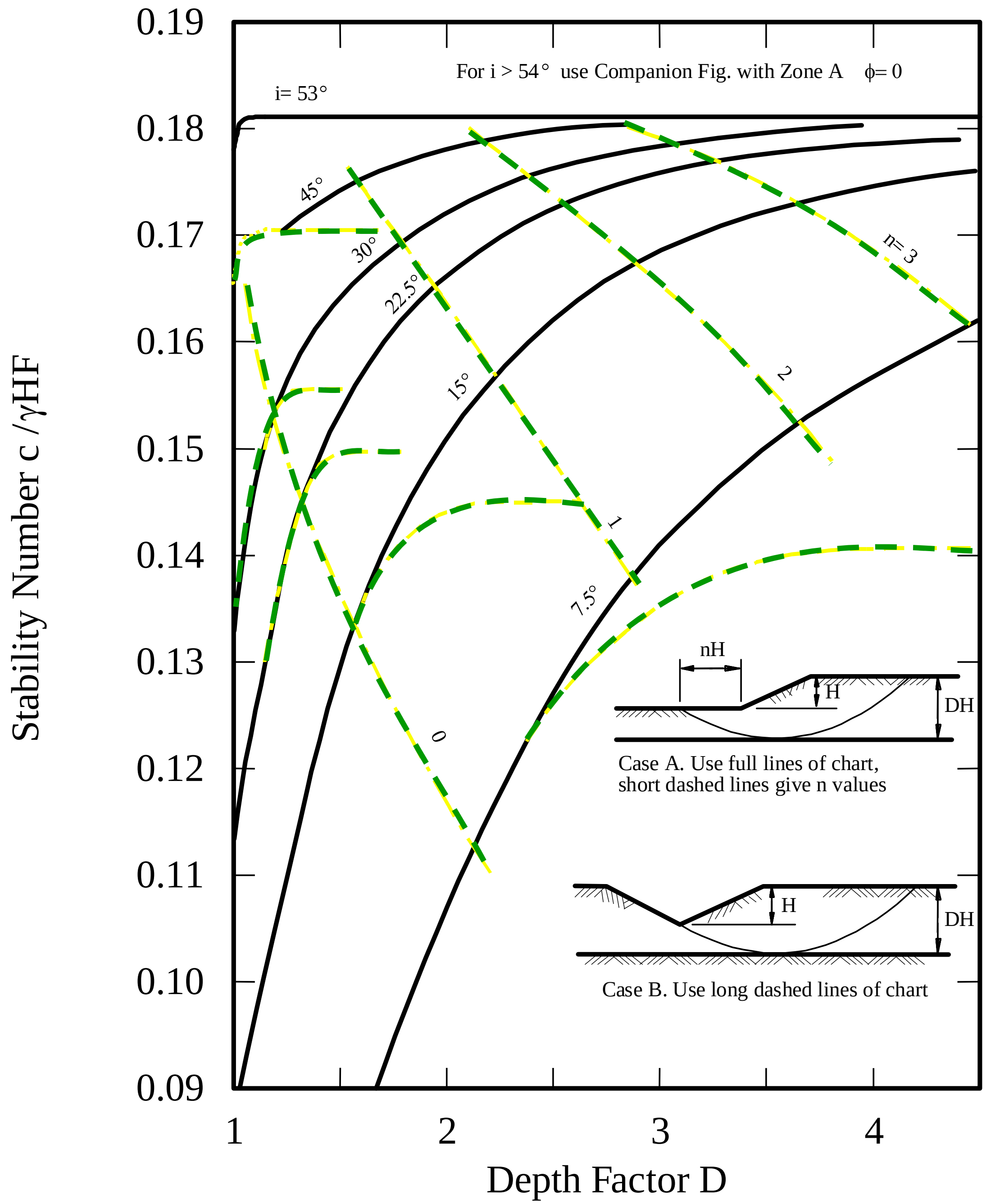
Assumed FSϕ	Calculated FS_c
1.0	2.5
1.5	1.9
1.8	1.73

So the correct FS is 1.75



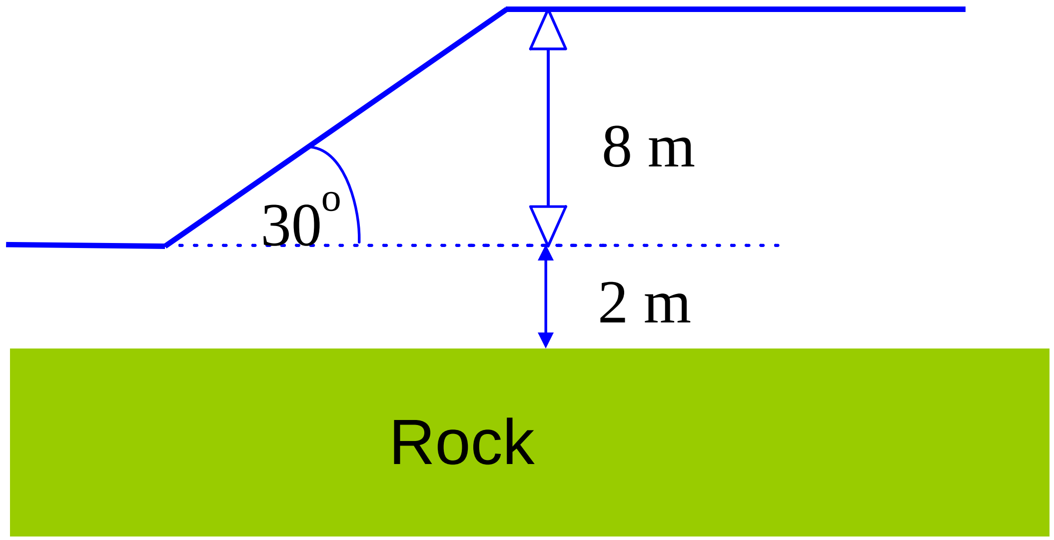
Taylor's Chart - example

- Zones are marked on the chart indicating whether the failure mode will be shallow or deep-seated.
- If a deep-seated failure is indicated the soil layer must be sufficiently deep to enable this mechanism to occur.
- There is a second chart due to Taylor which can be used when the depth of soil below the base of the slope is limited
- This chart is only valid for $\phi = 0$



For i > 54° use Companion Fig. with Zone A ϕ= 0
i= 53°
45°
30°
22.5°
15°
7.5°
n= 3
2
1
0
nH
H
DH
Case A. Use full lines of chart, short dashed lines give n values
Case B. Use long dashed lines of chart
Stability Number c /γHF
Depth Factor D
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
1
2
3
4

Taylor's Chart - example with finite depth



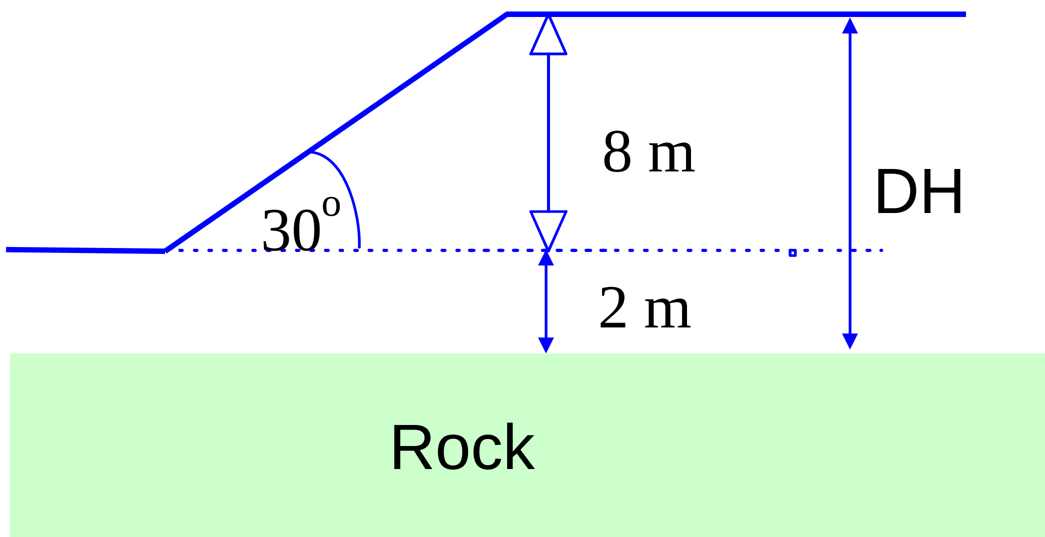
$c_u = 20 \text{ kN/m}^2$

$\phi_u = 0$

$\gamma_{bulk} = 15 \text{ kN/m}^3$

Calculate the Depth Factor D

Taylor's Chart - example with finite depth



$c_u = 20\ kN/m^2$

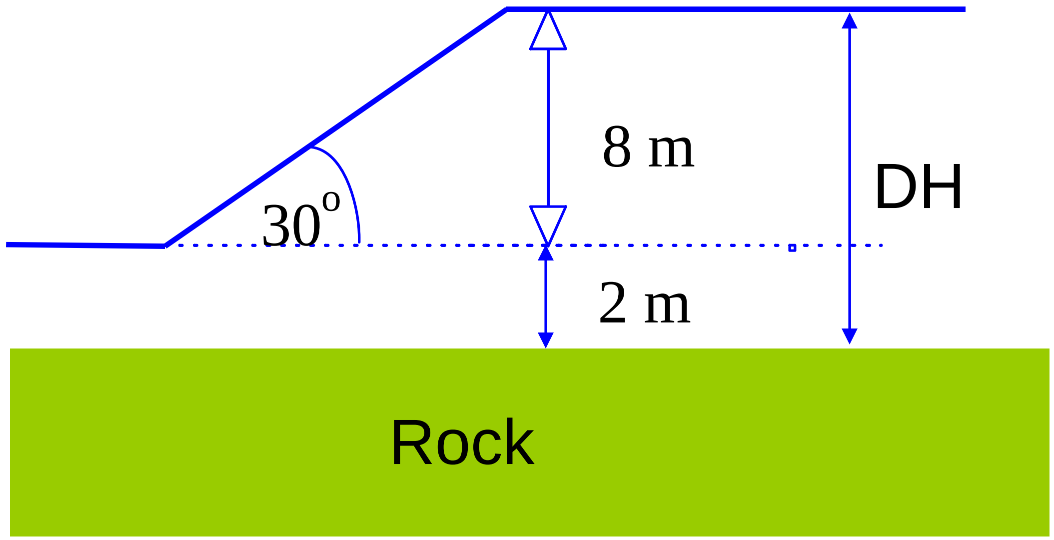
$\phi_u = 0$

$\gamma_{bulk} = 15\ kN/m^3$

Calculate the Depth Factor D

DH = 10 m

Taylor's Chart - example with finite depth



c_u = 20 kN/m^2

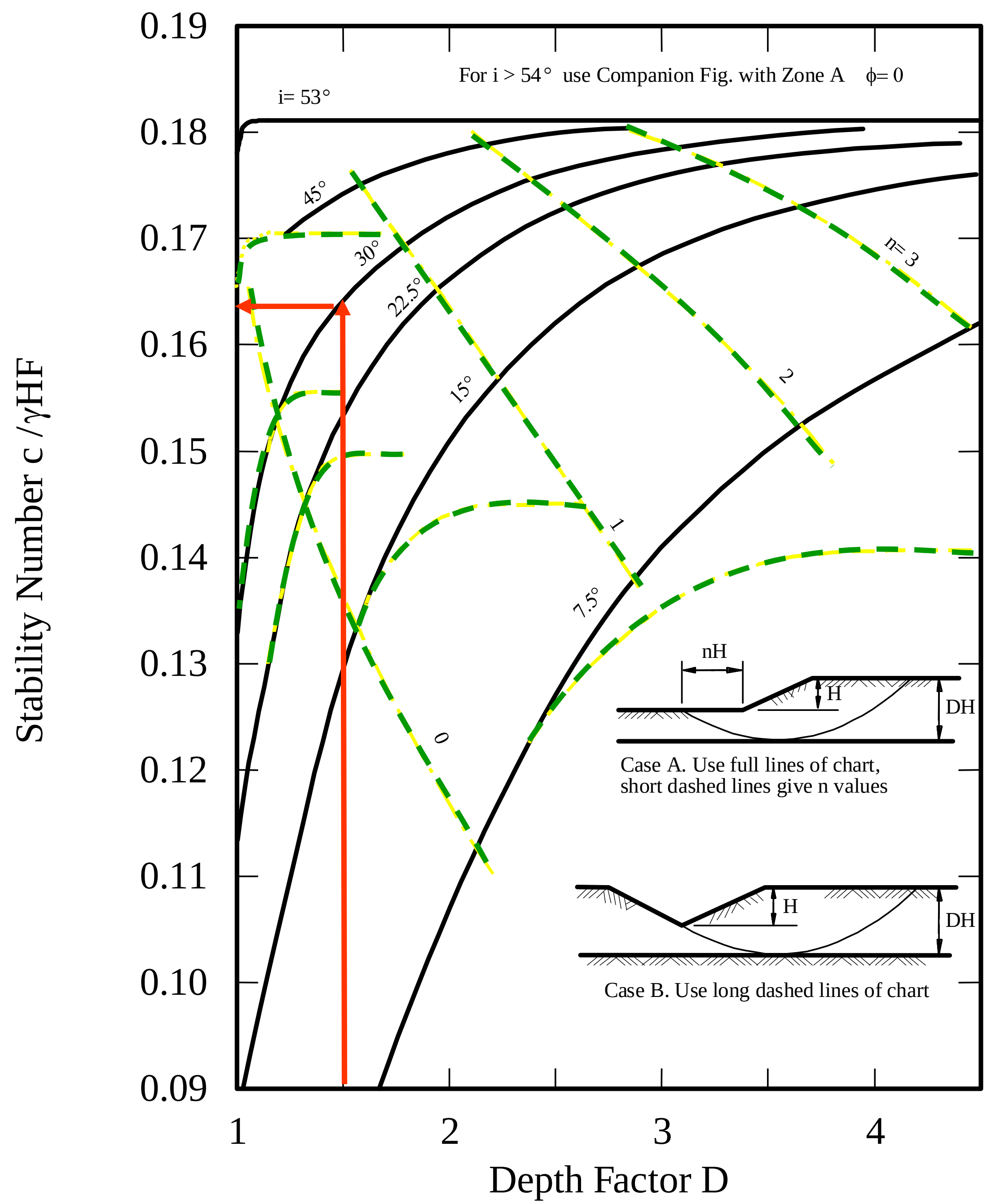
ϕ_u = 0

γ_{bulk} = 15 kN/m^3

Calculate the Depth Factor D

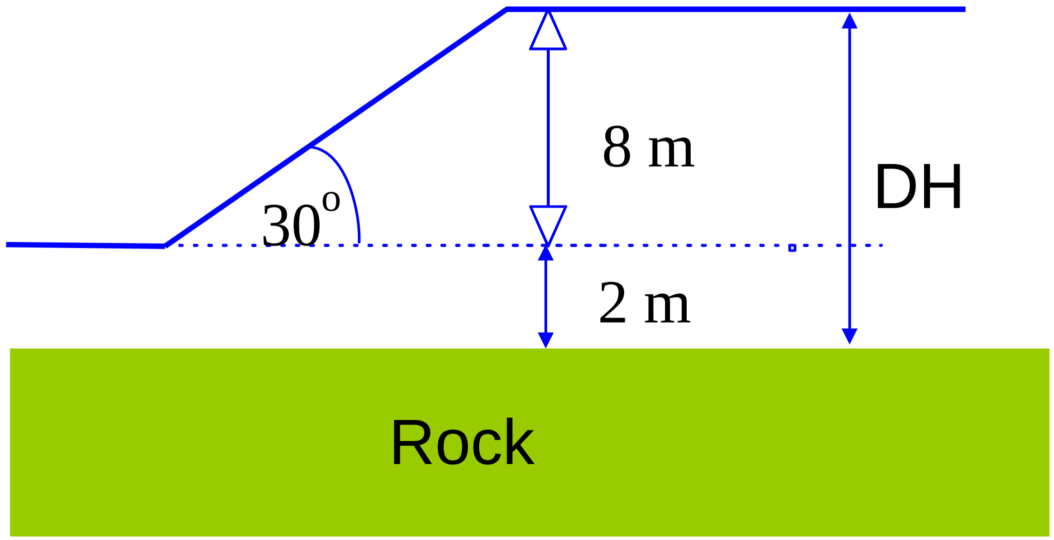
DH = 10 m, H = 8m

D = 1.25



0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
Stability Number c /γHF
1
2
3
4
Depth Factor D
For i > 54° use Companion Fig. with Zone A ϕ= 0
i= 53°
45°
30°
22.5°
15°
7.5°
n= 3
2
1
0
nH
H
DH
Case A. Use full lines of chart, short dashed lines give n values
H
DH
Case B. Use long dashed lines of chart

Taylor’s Chart - example with finite depth



c_u = 20 kN/m^2

ϕ_u = 0

γ_{bulk} = 15 kN/m^3

D = 1.25

$$\frac{C_{dev}}{\gamma H} = \frac{C_{dev}}{15 \times 8} = 0.165$$

C_{dev} = 0.165 x 15 x 8 = 19.8 kN/m^2

FS = 1.01