Soil water regime management - Assignment 5

Exercise 1

In [1]:
```
ø = 0.11; # m
α = 60; # °
p = 6*100000; # Pa
ρ = 2300; # kg/m3

Q = 0.028; # m3/s
```

Out[1]: 0.028

We take only the pressure forces into account. A preliminary result has shown the compared to the pressure forces the forces generated by the conservation of momentum can be neglected. (given by the assignement)

We can therefore caluclate:

In [2]:
```
K = 2*sind(α/2); # taking into account two surfaces slanted by α/2
S = (ø/2)^2 * π;
F = K*p*S;

# find weight P such that: F/P<0.577
m = F/(0.577*9.81) # kg
```

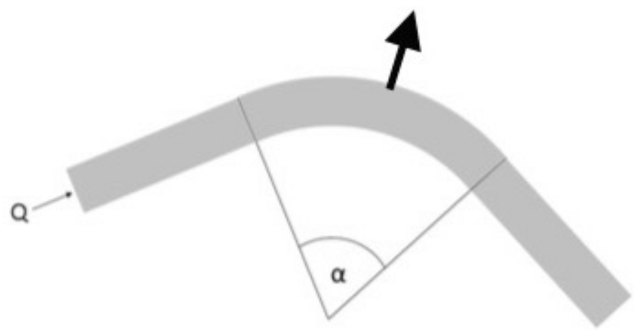
Out[2]: 1007.3529939324593

In [3]:
```
V = m/ρ # m3
```

Out[3]: 0.43797956257933013

RESULT: For the anchorage 1007.4 kg are needed, which correspond to about 0.44 m3 concrete.

The resultant force points approximately in the following direction (i.e. $\alpha/2$):



Exercise 2

In [4]:
```
# soil parameters
    # slope = 1-2 % and sandy soil lead to:
        coeff_restitution = 0.9;
    K = 8e-5; # m/s
    μ = 0.06;
        #K_s_lower = 2e-8; # m/s
        #μ_lower = 0.01;
# drain parameters
    ø_drain = 0.08; #m
    depth_drain = 1; #m
```

Out[4]: 1

1) Effective rainfall

In [5]:
```
T = [2,5,10,20,50,100]; # years
mm_in3days_T = [72, 90, 102, 114, 128, 139]; # mm in 3 days
return_period = 5; # years

qc = 90/3*coeff_restitution/24/1000/3600; # m/s
```

Out[5]: 3.1249999999999997e-7

2) Permanent regime - Hooghoudt's analogy

In [6]:
```
using Roots
lowering_of_table_permanent = 0.5; #m
D = 2.4 - depth_drain; # 1.4m
h = depth_drain-lowering_of_table_permanent; # 0.5m
u = ø_drain/2*π;

d1(E) = D/(8*D/(pi*E)*log(D/u)+1);
d2(E) = π*E/(8*log(E/u));
f1(E) = E^2 - ( 8*K*h*d1(E)/qc + 4*K*h^2/qc);
f2(E) = E^2 - ( 8*K*h*d2(E)/qc + 4*K*h^2/qc);

# find spacing with d1
fzero(f1,10,90)
```

Out[6]: 37.7312320296453

In [7]:
```
# find spacing with d1
fzero(f2,10,80)
```

Out[7]: 67.71646403502311

Only the first result is valid. The second approach does not fulfill the requirement D>E/4. For the permanent regime a spacing of 37.7m is needed.

3) Drying up regime - Glover-Dumm's equation

In [8]:
```
delay = 24*3600; #s
Δ = 0.5; #m lowering_of_table_transient
h0 = 1; #m initial_table close to the surface

g1(E) = E^2 - π^2*K*delay*d1(E)/μ*(log(1.16*h0/(h0-Δ)))^-1
g2(E) = E^2 - π^2*K*delay*d2(E)/μ*(log(1.16*h0/(h0-Δ)))^-1

fzero(g1,10,60)
```

Out[8]: 39.40538496371933

In [9]:
```
fzero(g2,10,100)
```

Out[9]: 81.88173857733017

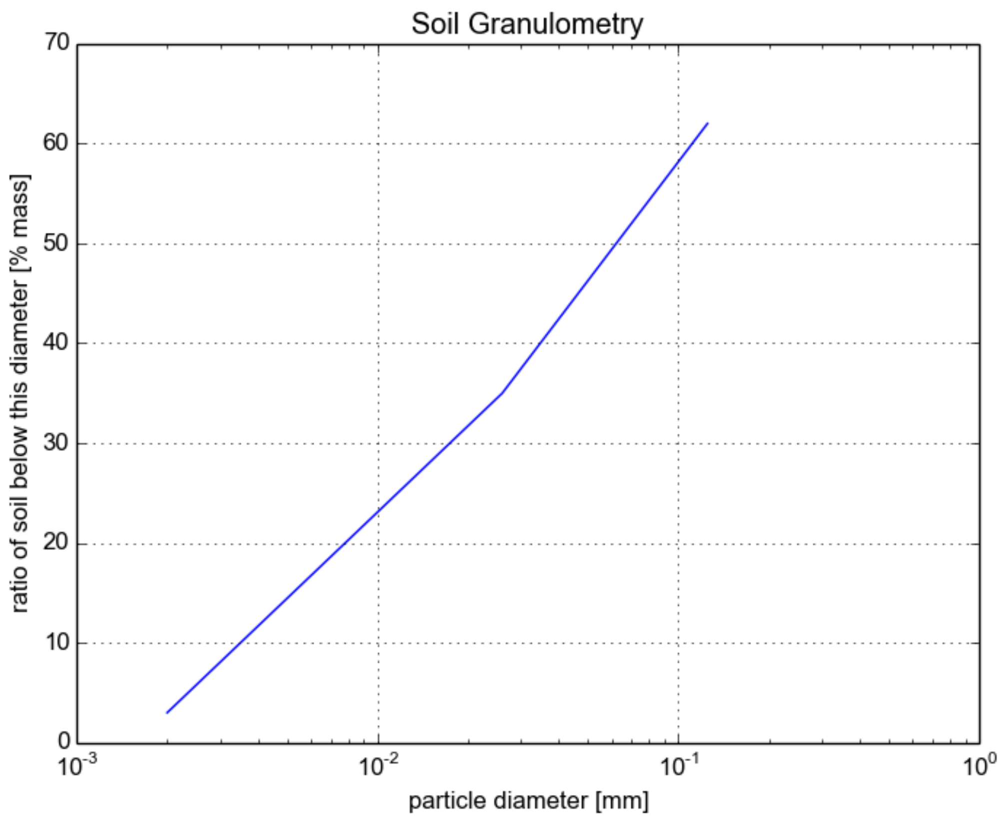
Again, only the first approach is valid. For the transient regime the equation of Glover-Dumm proposes a spacing of 39.4m.

4) Granulometry of coating

In [10]:
```
percentages = [3, 35, 62]
particles = [0.002, 0.026, 0.125]

using PyPlot
semilogx(particles, percentages)
title("Soil Granulometry")
xlabel("particle diameter [mm]")
ylabel("ratio of soil below this diameter [% mass]")
grid("on")
```

```
INFO: Loading help data...
```



RESULT: With a d_60 of around 0.2 mm, we need a coating category 3 according to the given table (USBR):

```
                    D_100   D_60   D_30    D_5   D_0
lower limit (mm)     9.5     4.0    1.3    0.3   0.074
upper limit (mm)    38.1    15.0   13.1     -    0.59
```

Exercise 3

Integration on dh and dx

$$\int_{x_1}^{x_2} q dx = \int_{h1}^{h2} -k_s h dh$$

the assumption of constant q and k_s:

$$q \int_{x_1}^{x_2} dx = -k_s \int_{h1}^{h2} h dh \Leftrightarrow q(x_2 - x_1) = k_s \frac{(h_2^2 - h_1^2)}{2}$$

and finally:

$$q = \frac{k_s}{2(x_2 - x_1)} (h_2^2 - h_1^2)$$

We can now calculate for the situation without ($x_2 - x_1 = L$) and with trench ($x_2 - x_1 = \frac{L}{2}$):

In [11]:
```
ks = 0.002; # m/s
b = 500; # m
L = 1000; # m
h1 = 10; # m/s
h2 = 8; # m/s

h_trench = h2;

q_initial = ks/(2*L)*(h1^2 -h2^2)
q_with_trench = ks*2/(2*L)*(h1^2 -h_trench^2)

Q_initial = q_initial*b # m3/s
Q_with_trench = q_with_trench*b # m3/s
```

Out[11]:
```
0.036000000000000004
```

The trench needs to evacuate $0.036 \, \frac{m3}{s}$ ($36 \, \frac{l}{s}$).

Or $7.2e{-5} \, \frac{m2}{s}$ ($\frac{m3}{s}$ per meter width).