Design of a low-level outlet

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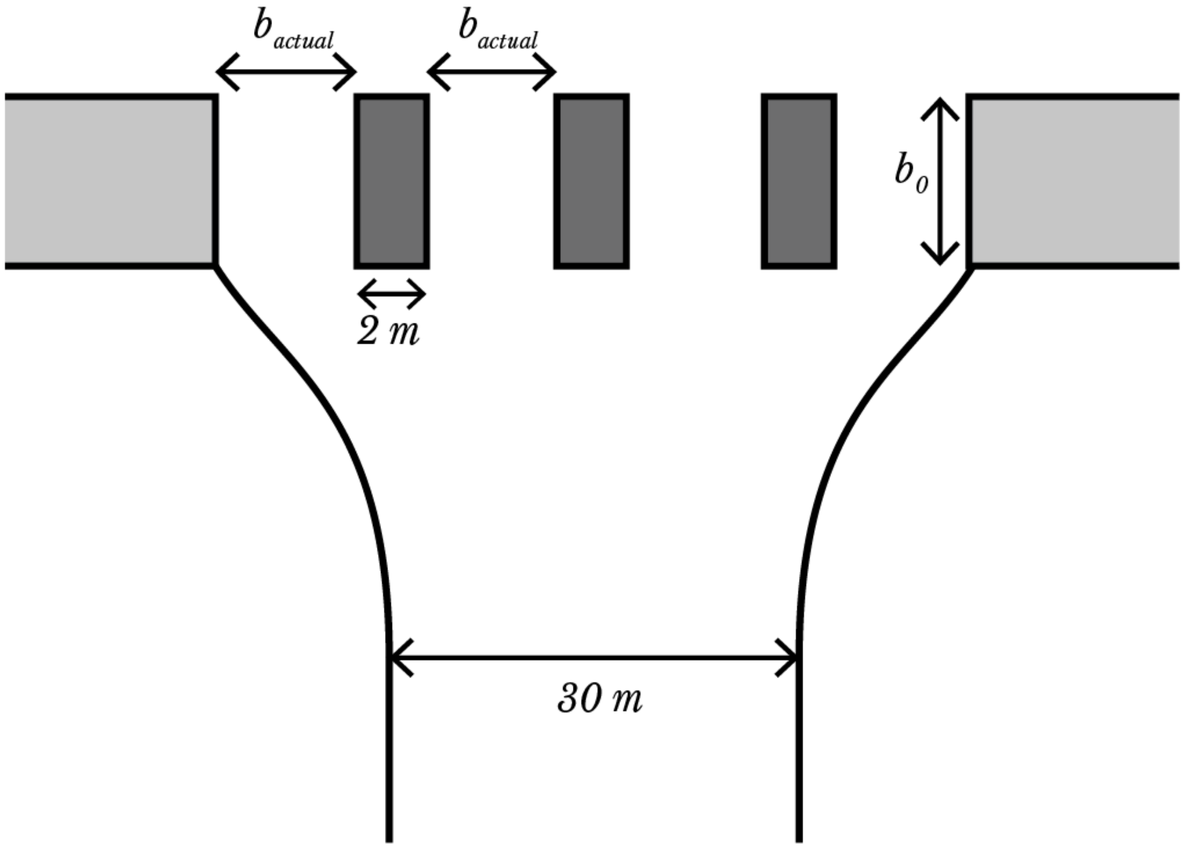
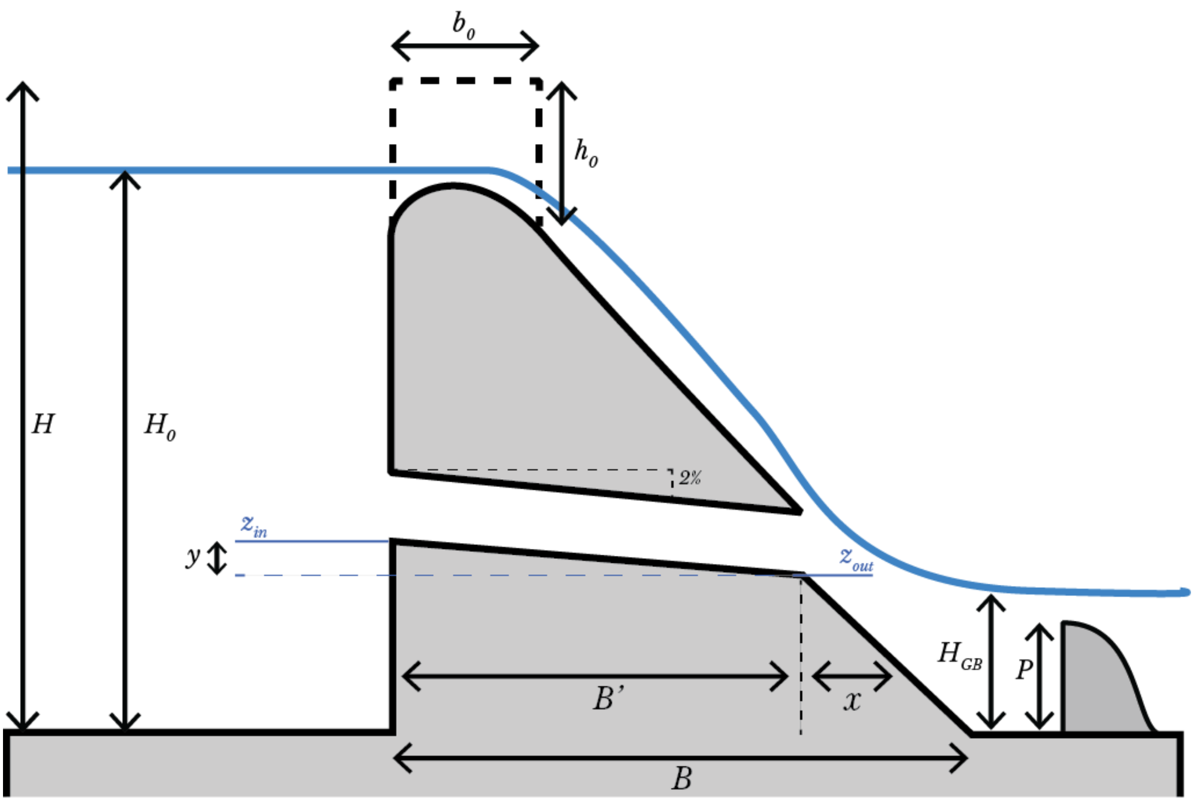


b_{actual}
b_{actual}
b_0
$2\ m$
$30\ m$



b_0
h_0
H
H_0
2%
z_{in}
y
z_{out}
H_{GB}
P
B'
x
B

Dimension

The intake is a quadratic cross section with a side D, such as $F = D^2$.

<u>With the Thales theorem :</u> $\frac{B-b_0}{H-h_0} = \frac{x}{P}$

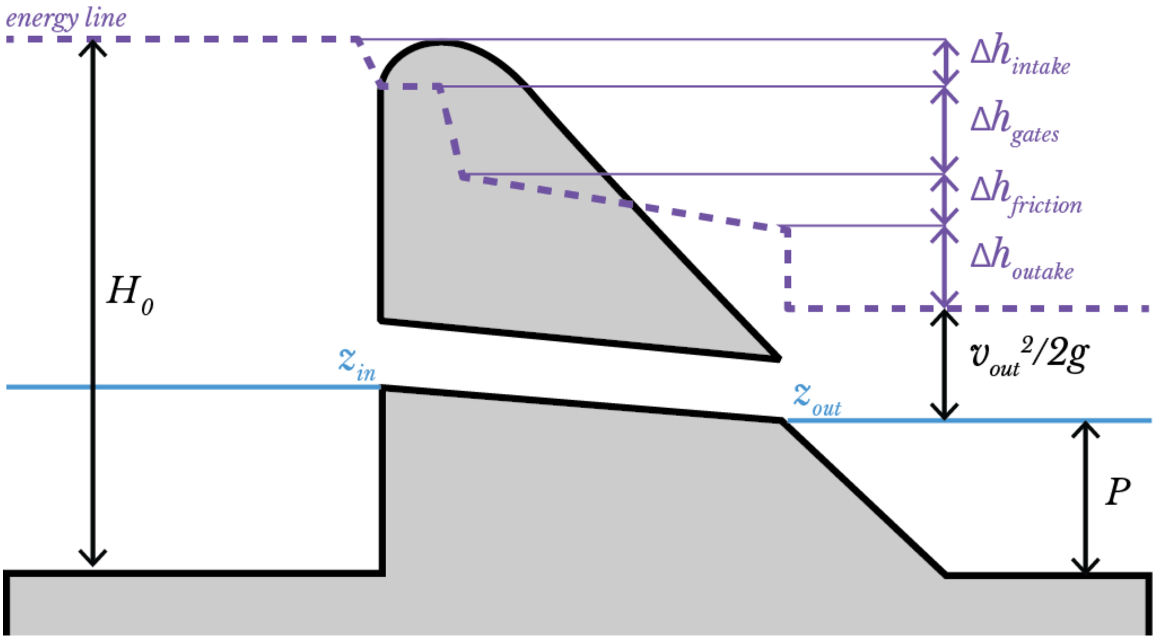
$x = \frac{P.(B-B_0)}{H-h_0} = \frac{9(56-8)}{70-10} = 7,2$ m

<u>And :</u> $B' = B - x = 56,8 - 7,2 = 49,6$ m

<u>For the intake height :</u>

- $y = 0,02 * B' = 0,02 * 49,6 = 1$ m
- $z_{in} = z_{out} + y = 8 + 1 = 9$ m
- $L_p = \sqrt{B'^2 + y^2} = 49,61$ m

Hydraulic losses



Local losses

Hydraulic losses at the intake :

$\xi_{in} = 0,5$

$\Delta h_{intake} = \xi_{in} \frac{Q^2}{F^2.2g}$

Hydraulic losses due to the trash racks at the intake :

$\xi_{trash} = \chi.\beta(\frac{s}{l})^{4/3}.sin(\alpha) = 1 * 2,42(\frac{10}{50})^{4/3} * sin(70) = 0,26$

$\Delta h_{trash} = \xi_{trash} \frac{Q^2}{F^2.2g}$

Hydraulic losses at the hydraulic gates :

$\xi_{in} = 0,1$

$\Delta h_{gates} = \xi_{gates} \frac{Q^2}{F^2.2g}$

Hydraulic losses at the outtake :

$\xi_{out} = 2$

$\Delta h_{out} = \xi_{out} \frac{Q^2}{F^2.2g}$

Friction losses

$\lambda = 0,02$, the friction coefficient
$L_p = 49,61$ m
$\Delta h_{friction} = \frac{Q^2}{2g} . \frac{\lambda . L_p}{D} . \frac{1}{F^2}$

Equilibrium equation

$$H_0 - P = \sum \Delta h_{local} + \Delta h_{friction} + \frac{v_{out}^2}{2g}$$

$$H_0 - P = \frac{Q^2}{2g.\, F^2}(\xi_{in} + \xi_{trash} + \xi_{gates} + \xi_{out} + \frac{\lambda L_p}{D} + 1)$$

$$F = \sqrt{\frac{Q^2}{2g.\,()H_0 - P}(\xi_{in} + \xi_{trash} + \xi_{gates} + \xi_{out} + \frac{\lambda L_p}{D} + 1)}$$

Final calculus

In order to find the right D, we used a calculus by iteration. We start our loop with $D = 4$ m

```
from math import *
##Initialisation
Q=70
g=9.81
H0=65
P=9.2
C=(Q**2)/(2*g*(H0-P))
Ein=0.5
Etrash=0.26
Egates=0.1
Eout=2
Lambda=0.02
Lp=49.61
D=4
print(D)
##Loop to iterate
for k in range(10):
    F=sqrt(C*(Ein+Etrash+Egates+Eout+1+((Lambda*Lp)/(D))))
    D=sqrt(F)
    print(D)
```

For a 10 loop iteration we have the following results :

```
2.0707355989956264
2.0992635758413654
2.0984755778874224
2.0984970679599178
2.098496481683014
2.0984964976772513
2.0984964972409115
2.0984964972528153
2.0984964972524907
2.0984964972524995
```

We can therefore conclude that : $D = 2,1$ m