European Commission

Worked example – T-shaped gravity wall

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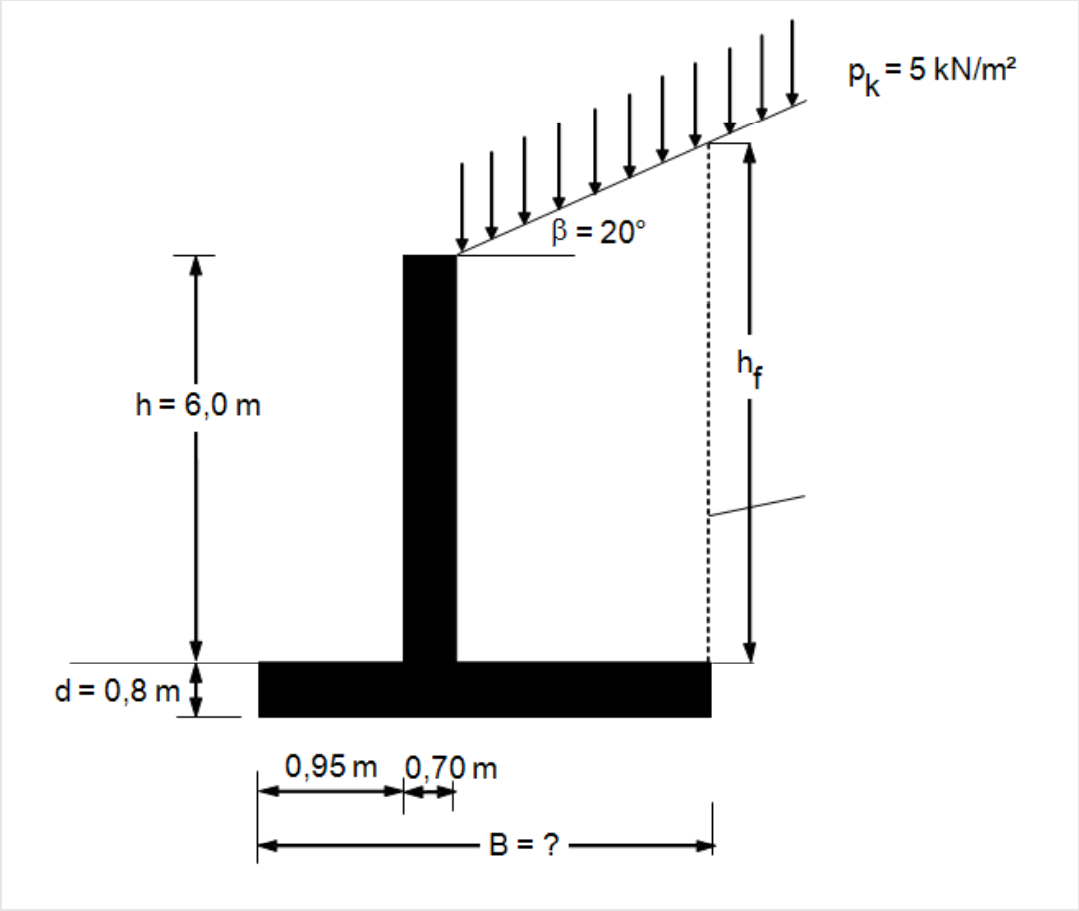
DESIGN SITUATION

Design situation for gravity wall example



Earth pressure theory

Use Rankine's equation for K_a:

$$K_{a,\beta} = \left(\frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\varphi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\varphi}} \right) \cos\beta$$

Horizontal and vertical component of K_a are:

$$K_{a,h} = K_{a,\beta} \times \cos\beta$$

$$K_{a,v} = K_{a,\beta} \times \sin\beta \left(= K_{a,h} \times \tan\beta \right)$$

Some numbers to save you time...

Self-weight of wall stem

$$W_{stem,k} = \gamma_{c,k} \times t_s \times H$$
$$= 25 \times 0.7 \times 6 = 105\,kN/m$$

Self-weight of wall base

$$W_{base,k} = \gamma_{c,k} \times t_b \times B$$
$$= 25 \times 0.8 \times 3.9 = 78\,kN/m$$

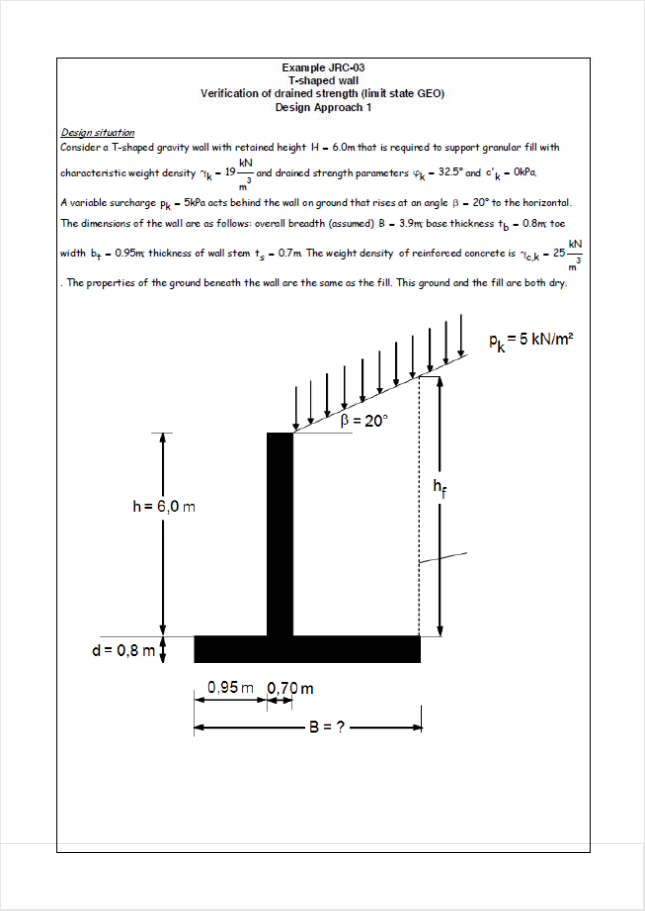
Self-weight of backfill

$$W_{fill,k} = \gamma_k \times b_{heel} \times \left(\frac{H + h_f}{2} \right)$$
$$= 19 \times 2.25 \times \left(\frac{6 + 6.82}{2} \right) = 274\,kN/m$$

Bearing capacity coefficients

φ	N_q	φ	N_q
20	6.4	30	18.4
21	7.1	31	20.6
22	7.8	32	23.2
23	8.7	33	26.1
24	9.6	34	29.4
25	10.7	35	33.3
26	11.9	36	37.8
27	13.2	37	42.9
28	14.7	38	48.9
29	16.4	39	56.0

Worksheet – T-shaped gravity wall



Example JRC-03
T-shaped wall
Verification of drained strength (limit state GEO)
Design Approach 1

Design situation

Consider a T-shaped gravity wall with retained height H = 6.0m that is required to support granular fill with characteristic weight density $\gamma_k = 19 \frac{kN}{m^3}$ and drained strength parameters $\varphi_k = 32.5°$ and $c'_k = 0kPa$.

A variable surcharge $p_k = 5kPa$ acts behind the wall on ground that rises at an angle $\beta = 20°$ to the horizontal.

The dimensions of the wall are as follows: overall breadth (assumed) B = 3.9m; base thickness $t_b = 0.8m$; toe width $b_t = 0.95m$; thickness of wall stem $t_s = 0.7m$. The weight density of reinforced concrete is $\gamma_{c,k} = 25 \frac{kN}{m^3}$. The properties of the ground beneath the wall are the same as the fill. This ground and the fill are both dry.

Calculate:

1. Earth pressure coefficient K_a
2. Moments about wall toe, the determine eccentricity of loading
3. Bearing resistance under eccentric, inclined loads
4. Sliding resistance
5. Toppling resistance

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SOLUTION

Solutions DA1 / DA2* – T-shaped gravity wall

Verification	DA1		DA2*	Traditional
	DA1-1	DA1-2		
Sliding	66%	85%	99%	F_s = 1.52
Bearing	125%	230%	93%	F_b = 2.03
Eccentricity	0.92 m	0.64 m	0.42 m	Same as DA2*
Effective width	2.05 m	2.63 m	3.06 m	
Toppling	31%	31%	31%	F_O = 4.35

Summary of key points

DA2* requires a wall base of width $B \geq 3.9$ m

Equivalent to traditional $F_s = 1.5$ and $F_b = 2.0$

DA1 requires a wall base of width $B \geq 5.1$ m

Equivalent to traditional $F_s = 1.86$ and $F_b = 3.93$

Main difference between DAs 1 and 2* is bearing resistance

- Calculated load eccentricity is very different
- Effective width is much smaller in DA1

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