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Marston's formula

In the design of embedded pipe, if the overburden from top of pipe to ground surface is more than 2m, Marston's formula is used to estimate the vertical load due to backfill material.

Marston's formula is expressed below.

$$W_V = C_c \cdot w \cdot D_c \tag{1}$$

$$C_c = \frac{1 - e^{-2K\mu(H/D_c)}}{2K\mu} \qquad (H \leqq H_e) \tag{2}$$

$$C_c = \frac{1 - e^{-2K\mu(H_e/D_c)}}{2K\mu} + \left(\frac{H}{D_c} - \frac{H_e}{D_c}\right) \cdot e^{-2K\mu(H_e/D_c)} \qquad (H_e < H) \tag{3}$$

$$K = \frac{1 - \sin\phi}{1 + \sin\phi} \qquad \mu = \tan\phi \qquad (\phi : \text{Internal friction angle})$$

H_e should be obtained from following equation.

$$\begin{aligned} &\frac{1 - e^{-2K\mu(H_e/D_c)}}{2K\mu}\left\{\frac{1}{2K\mu} - \left(\frac{H}{D_c} - \frac{H_e}{D_c}\right) + \frac{r_{sd} \cdot p}{3}\right\} \\ &- \frac{1}{2}\left(\frac{H_e}{D_c}\right)^2 - \frac{r_{sd} \cdot p}{3}\left(\frac{H}{D_c} - \frac{H_e}{D_c}\right) \cdot e^{-2K\mu(H_e/D_c)} \\ &- \frac{1}{2K\mu} \cdot \frac{H_e}{D_c} + \frac{H}{D_c} \cdot \frac{H_e}{D_c} = -r_{sd} \cdot p \cdot \frac{H}{D_c} \end{aligned}$$

W_V	:	Soil load on full width of pipe
C_c	:	Load coefficient for positive projecting condition
w	:	Unit weight of backfill material
D_c	:	Outside diameter of pipe
H	:	Height of fill above top of pipe
H_e	:	Height derived above equation
p	:	Positive projection ratio ($p = 1.0$)
r_{sd}	:	Settlement ratio ($r_{sd} = -0.1$)