

ORIGIN := 1

Manuell beregning Vindlast

NS-EN 1991-1-4:2005+NA:2009

Vindhastighet, Trondheim kommune gitt "normale" forhold

$$c_{season} := 1.0 \quad c_{dir} := 1.0 \quad c_{alt} := 1.0 \quad c_{prob} := 1.0$$

$$v_{b,0} := 26 \frac{m}{s} \quad \text{Referansevindhastighet Trondheim kommune}$$

$$v_b := c_{dir} \cdot c_{season} \cdot c_{alt} \cdot c_{prob} \cdot v_{b,0} = 26 \frac{m}{s} \quad (4.1)$$

Vindhastighet med variasjon i høyde gitt terengkategori 4

$$c_0 := 1.0 \quad k_r := 0.24 \quad z_0 := 1.0 \quad k_1 := 1 \quad z_{min} := 16$$

$$c_r(z) := k_r \cdot \ln\left(\frac{z}{z_0}\right) \quad (4.4)$$

$$c_r(24.2) = 0.765$$

$$v_m(z) := c_0 \cdot c_r(z) \cdot v_b \quad (4.3)$$

$$v_m(24.2) = 19.883 \frac{m}{s}$$

Vindturbulens

$$\sigma_v := k_r \cdot v_b \cdot k_1 = 6.24 \frac{m}{s}$$

$$I_v(z) := \frac{\sigma_v}{v_m(z)} \quad (4.7)$$

$$I_v(24.2) = 0.314$$

Vindhastighetstrykk

$$\rho := 1.25 \frac{kg}{m^3} \quad (\text{lufttetthet})$$

$$q_p(z) := (1 + 7 \cdot I_v(z)) \cdot 0.5 \cdot \rho \cdot (v_m(z))^2 \quad (4.8)$$

$$q_p(24.2) = 789.881 \text{ Pa}$$

Utvendig vindtrykk

$$b := 23.46 \text{ m} \quad h_e := 24.2 \text{ m} \quad e := b \quad h_p := 0.32 \text{ m} \quad d := 21.6 \text{ m}$$

Alle cpe verdier er hentet fra
NS-EN 1991-1-4 Tabell 7.1
for vegger
og tabell 7.2 for tak

$$\begin{array}{ll} c_{pe.10.A} := -1.2 & c_{pe.1.A} := -1.4 \\ c_{pe.10.B} := -0.8 & c_{pe.1.B} := -1.1 \end{array} \quad \frac{h_e}{d} = 1.12$$

$$w_{ebunn.10} := q_p(b) \cdot c_{pe.10} \quad w_{etopp.10} := q_p(h_e) \cdot c_{pe.10} \quad (5.1)$$

$$w_{e.bunn.1} := q_p(b) \cdot c_{pe.1} \quad w_{e.topp.1} := q_p(h_e) \cdot c_{pe.1} \quad (5.1)$$

$$w_{e.bunn.10.A} := q_p(23.46) \cdot c_{pe.10.A} = -0.936 \frac{\text{kN}}{\text{m}^2}$$

$$w_{e.topp.10.A} := q_p(24.2) \cdot c_{pe.10.A} = -0.948 \frac{\text{kN}}{\text{m}^2}$$

$$w_{e.bunn.10.B} := q_p(23.46) \cdot c_{pe.10.B} = -0.624 \frac{\text{kN}}{\text{m}^2}$$

$$w_{e.topp.10.B} := q_p(24.2) \cdot c_{pe.10.B} = -0.632 \frac{\text{kN}}{\text{m}^2}$$

$$w_{e.bunn.1.A} := q_p(23.46) \cdot c_{pe.1.A} = -1.092 \frac{\text{kN}}{\text{m}^2}$$

$$w_{e.topp.1.A} := q_p(24.2) \cdot c_{pe.1.A} = -1.106 \frac{\text{kN}}{\text{m}^2}$$

$$w_{e.bunn.1.B} := q_p(23.46) \cdot c_{pe.1.B} = -0.858 \frac{\text{kN}}{\text{m}^2}$$

$$w_{e.topp.1.B} := q_p(24.2) \cdot c_{pe.1.B} = -0.869 \frac{\text{kN}}{\text{m}^2}$$

Tak

$$z_e := h_e + h_p = 24.52 \text{ m}$$

$$\frac{h_p}{z_e} = 0.013$$

$$w_{eTAK} := q_p(z_e) \cdot c_{pe}$$

$$c_{pe.10.F} := -1.6 \quad c_{pe.10.G} := -1.1 \quad c_{pe.10.H} := -0.7 \quad c_{pe.10.I.p} := 0.2 \quad c_{pe.10.I.n} := -0.2$$

$$c_{pe.1.F} := -2.2 \quad c_{pe.1.G} := -1.8 \quad c_{pe.1.H} := -1.2 \quad c_{pe.1.I.p} := 0.2 \quad c_{pe.1.I.n} := -0.2$$

Tilfelle 1: (I, positiv)

$$w_{e.10.F} := q_p(24.2) \cdot c_{pe.10.F} = -1.264 \frac{kN}{m^2}$$

$$w_{e.10.G} := q_p(24.2) \cdot c_{pe.10.G} = -0.869 \frac{kN}{m^2}$$

$$w_{e.10.H} := q_p(24.2) \cdot c_{pe.10.H} = -0.553 \frac{kN}{m^2}$$

$$w_{e.10.I.p} := q_p(24.2) \cdot c_{pe.10.I.p} = 0.158 \frac{kN}{m^2}$$

$$w_{e.1.F} := q_p(24.2) \cdot c_{pe.1.F} = -1.738 \frac{kN}{m^2}$$

$$w_{e.1.G} := q_p(24.2) \cdot c_{pe.1.G} = -1.422 \frac{kN}{m^2}$$

$$w_{e.1.H} := q_p(24.2) \cdot c_{pe.1.H} = -0.948 \frac{kN}{m^2}$$

$$w_{e.1.I.p} := q_p(24.2) \cdot c_{pe.1.I.p} = 0.158 \frac{kN}{m^2}$$

Tilfelle 2: (I, negativ virkning)

$$\begin{aligned}
 w_{e.10.F} &:= q_p(24.2) \cdot c_{pe.10.F} = -1.264 \frac{kN}{m^2} \\
 w_{e.10.G} &:= q_p(24.2) \cdot c_{pe.10.G} = -0.869 \frac{kN}{m^2} \\
 w_{e.10.H} &:= q_p(24.2) \cdot c_{pe.10.H} = -0.553 \frac{kN}{m^2} \\
 w_{e.10.I.n} &:= q_p(24.2) \cdot c_{pe.10.I.n} = -0.158 \frac{kN}{m^2} \\
 w_{e.1.F} &:= q_p(24.2) \cdot c_{pe.1.F} = -1.738 \frac{kN}{m^2} \\
 w_{e.1.G} &:= q_p(24.2) \cdot c_{pe.1.G} = -1.422 \frac{kN}{m^2} \\
 w_{e.1.H} &:= q_p(24.2) \cdot c_{pe.1.H} = -0.948 \frac{kN}{m^2} \\
 w_{e.1.I.n} &:= q_p(24.2) \cdot c_{pe.1.I.n} = -0.158 \frac{kN}{m^2}
 \end{aligned}$$

Tilfelle 2, der vind treffer lengdesiden av bygget

Utvendig vindtrykk

$$b := 21.6 \text{ m} \quad h_e := 24.2 \text{ m} \quad e := b \quad h_p := 0.32 \text{ m} \quad d := 23.46 \text{ m}$$

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$$\begin{aligned}
 c_{pe.10.A} &:= -1.2 & c_{pe.1.A} &:= -1.4 & \frac{h_e}{d} &= 1.032 \\
 c_{pe.10.B} &:= -0.8 & c_{pe.1.B} &:= -1.1
 \end{aligned}$$

$$w_{e.bunn.10} := q_p(b) \cdot c_{pe.10} \quad w_{e.topp.10} := q_p(h_e) \cdot c_{pe.10} \quad (5.1)$$

$$w_{e.bunn.1} := q_p(b) \cdot c_{pe.1} \quad w_{e.topp.1} := q_p(h_e) \cdot c_{pe.1} \quad (5.1)$$

$$w_{e.bunn.10.A} := q_p(21.6) \cdot c_{pe.10.A} = -0.904 \frac{kN}{m^2}$$

$$w_{e.topp.10.A} := q_p(24.2) \cdot c_{pe.10.A} = -0.948 \frac{kN}{m^2}$$

$$w_{e.bunn.10.B} := q_p(21.6) \cdot c_{pe.10.B} = -0.603 \frac{kN}{m^2}$$

$$w_{e.topp.B.10} := q_p(24.2) \cdot c_{pe.10.B} = -0.632 \frac{kN}{m^2}$$

$$w_{e.bunn.1.A} := q_p(21.6) \cdot c_{pe.1.A} = -1.054 \frac{kN}{m^2}$$

$$w_{e.topp.1.A} := q_p(24.2) \cdot c_{pe.1.A} = -1.106 \frac{kN}{m^2}$$

$$w_{e.bunn.1.B} := q_p(21.6) \cdot c_{pe.1.B} = -0.829 \frac{kN}{m^2}$$

$$w_{e.topp.1.B} := q_p(24.2) \cdot c_{pe.1.B} = -0.869 \frac{kN}{m^2}$$

Tak

$$z_e := h_e + h_p = 24.52 \text{ m}$$

$$\frac{h_p}{z_e} = 0.013$$

$$w_{eTAK} := q_p(z_e) \cdot c_{pe}$$

$$c_{pe.10.F} := -1.6 \quad c_{pe.10.G} := -1.1 \quad c_{pe.10.H} := -0.7 \quad c_{pe.10.I.p} := 0.2 \quad c_{pe.10.I.n} := -0.2$$

$$c_{pe.1.F} := -2.2 \quad c_{pe.1.G} := -1.8 \quad c_{pe.1.H} := -1.2 \quad c_{pe.1.I.p} := 0.2 \quad c_{pe.1.I.n} := -0.2$$

Tilfelle 1: (I, positiv)

$$w_{e.10.F} := q_p(24.2) \cdot c_{pe.10.F} = -1.264 \frac{kN}{m^2}$$

$$w_{e.10.G} := q_p(24.2) \cdot c_{pe.10.G} = -0.869 \frac{kN}{m^2}$$

$$w_{e.10.H} := q_p(24.2) \cdot c_{pe.10.H} = -0.553 \frac{kN}{m^2}$$

$$w_{e.10.I.p} := q_p(24.2) \cdot c_{pe.10.I.p} = 0.158 \frac{kN}{m^2}$$

$$w_{e.1.F} := q_p(24.2) \cdot c_{pe.1.F} = -1.738 \frac{kN}{m^2}$$

$$w_{e.1.G} := q_p(24.2) \cdot c_{pe.1.G} = -1.422 \frac{kN}{m^2}$$

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$$w_{e.1.I.p} := q_p(24.2) \cdot c_{pe.1.I.p} = 0.158 \frac{kN}{m^2}$$

Tilfelle 2: (I, negativ virkning)

$$w_{e.10.F} := q_p(24.2) \cdot c_{pe.10.F} = -1.264 \frac{kN}{m^2}$$

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$$w_{e.10.H} := q_p(24.2) \cdot c_{pe.10.H} = -0.553 \frac{kN}{m^2}$$

$$w_{e.10.I.n} := q_p(24.2) \cdot c_{pe.10.I.n} = -0.158 \frac{kN}{m^2}$$

$$w_{e.1.F} := q_p(24.2) \cdot c_{pe.1.F} = -1.738 \frac{kN}{m^2}$$

$$w_{e.1.G} := q_p(24.2) \cdot c_{pe.1.G} = -1.422 \frac{kN}{m^2}$$

$$w_{e.1.H} := q_p(24.2) \cdot c_{pe.1.H} = -0.948 \frac{kN}{m^2}$$

$$w_{e.1.I.n} := q_p(24.2) \cdot c_{pe.1.I.n} = -0.158 \frac{kN}{m^2}$$

Innvendig vindtrykk

$$w_i := q_p(z_e) \cdot c_{pi} \quad \text{Mest sannsynligvis unødvendig}$$