



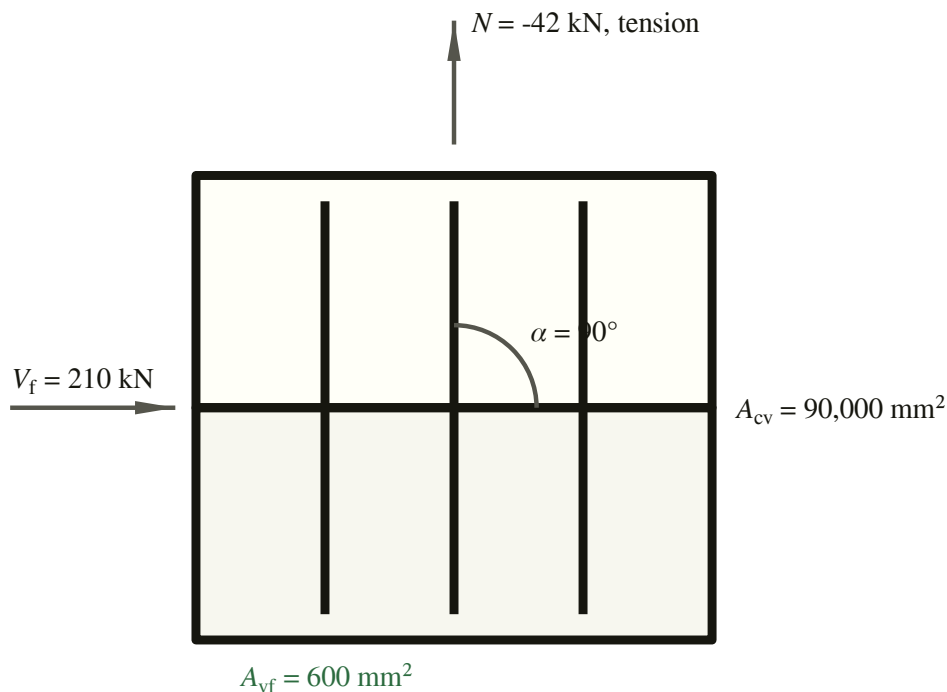
Concrete shear friction

Interface shear transfer by shear friction, to CSA A23.3.

Inputs

Symbol	Value	Unit	Description
A_{vf}	600	mm ²	Total area of rebar crossing the slip plane
A_{cv}	90000	mm ²	Area of the slip plane
V_f	210	kN	Factored shear force
N	-42	kN	Unfactored permanent axial force, negative in tension
f_y	400	MPa	Minimum yield strength of rebar
f_c	25	MPa	Specified compressive strength of concrete
α	90		Angle between rebar and slip plane, degrees
ϕ_c	0.65		Resistance factor, concrete
concrete _{type}	Normal (= 1.00)		Concrete density
case	Concrete placed monolithically		Interface case

Figures



The interface, the rebar at its rake, and which way each force acts.

Checks

Name	Check	Result
Rebar adequate	$A_{vf} \geq A_{s_{req}} \Rightarrow 600 \text{ mm}^2 \geq 521.2 \text{ mm}^2$	PASS
Stress adequate	$v_f \leq v_r \Rightarrow 2.333 \text{ MPa} \leq 2.652 \text{ MPa}$	PASS

Results

Quantity	Description	Value	Unit
$A_{s_{req}}$	Minimum reinforcement required across the interface	521.2	mm ²
σ	Compressive stress clamping the slip plane	2.2	MPa
v_r	Factored shear stress resistance of the interface	2.652	MPa
v_{allow}	Cap on the cohesion and friction term	4.062	MPa

Derivation

$$\lambda = 1$$

Concrete density factor, from the concrete type | Cl. 8.6.5

$$c = 1 \text{ MPa}$$

Cohesion, from the interface case | Cl. 11.5.2

$$\mu = 1.4$$

Friction coefficient, from the interface case | Cl. 11.5.2

$$\phi_s = 0.85$$

Resistance factor, reinforcing bars | Cl. 8.4.3 a)

$$\begin{aligned}
 v_f &= \frac{V_f}{A_{cv}} \\
 &= \frac{210 \text{ kN}}{90000 \text{ mm}^2} \\
 &= 2.333 \text{ MPa}
 \end{aligned}$$

$$\begin{aligned}
 \rho_v &= \frac{A_{vf}}{A_{cv}} && \text{A23.3 Cl. 11.5.4, Eq. 11.28} \\
 &= \frac{600 \text{ mm}^2}{90000 \text{ mm}^2} \\
 &= 0.006667
 \end{aligned}$$

$$\begin{aligned}
 \sigma &= \rho_v \cdot f_y \cdot \sin\left(\frac{\alpha \cdot \pi}{180}\right) + \frac{N}{A_{cv}} && \text{A23.3 Cl. 11.5.4, Eq. 11.27} \\
 &= 0.006667 \cdot 400 \text{ MPa} \cdot \sin\left(\frac{90 \cdot \pi}{180}\right) + \frac{-42 \text{ kN}}{90000 \text{ mm}^2} \\
 &= 2.2 \text{ MPa}
 \end{aligned}$$

$$\begin{aligned}
 v_c &= \lambda \cdot \phi_c \cdot (c + \mu \cdot \sigma) && \text{A23.3 Cl. 11.5.1, Eq. 11.25, cohesion and friction} \\
 &= 1 \cdot 0.65 \cdot (1 \text{ MPa} + 1.4 \cdot 2.2 \text{ MPa}) \\
 &= 2.652 \text{ MPa}
 \end{aligned}$$

$$\begin{aligned}
 v_{\text{allow}} &= 0.25 \cdot \phi_c \cdot f_c && \text{A23.3 Cl. 11.5.1, cap on the cohesion and friction term} \\
 &= 0.25 \cdot 0.65 \cdot 25 \text{ MPa} \\
 &= 4.062 \text{ MPa}
 \end{aligned}$$

$$\begin{aligned}
 v_s &= \phi_s \cdot \rho_v \cdot f_y \cdot \cos\left(\frac{\alpha \cdot \pi}{180}\right) && \text{A23.3 Cl. 11.5.1, Eq. 11.25, dowel term} \\
 &= 0.85 \cdot 0.006667 \cdot 400 \text{ MPa} \cdot \cos\left(\frac{90 \cdot \pi}{180}\right) \\
 &= 0 \text{ Pa}
 \end{aligned}$$

$$\begin{aligned}
 v_r &= \min(v_c, v_{\text{allow}}) + v_s && \text{A23.3 Cl. 11.5.1, Eq. 11.25} \\
 &= \min(2.652 \text{ MPa}, 4.062 \text{ MPa}) + 0 \text{ Pa} \\
 &= 2.652 \text{ MPa}
 \end{aligned}$$

$$\begin{aligned}
 \text{shear}_{\text{utilization}} &= \frac{v_f}{v_r} \\
 &= \frac{2.333 \text{ MPa}}{2.652 \text{ MPa}} \\
 &= 0.8798
 \end{aligned}$$

$$\begin{aligned}
 A_{s_{\text{req}}} &= \frac{v_f - \lambda \cdot \phi_c \cdot \left(c + \frac{\mu \cdot N}{A_{cv}}\right)}{f_y \cdot \left(\lambda \cdot \phi_c \cdot \mu \cdot \sin\left(\frac{\alpha \cdot \pi}{180}\right) + \phi_s \cdot \cos\left(\frac{\alpha \cdot \pi}{180}\right)\right)} \cdot A_{cv} \\
 &= \frac{2.333 \text{ MPa} - 1 \cdot 0.65 \cdot \left(1 \text{ MPa} + \frac{1.4 \cdot (-42 \text{ kN})}{90000 \text{ mm}^2}\right)}{400 \text{ MPa} \cdot \left(1 \cdot 0.65 \cdot 1.4 \cdot \sin\left(\frac{90 \cdot \pi}{180}\right) + 0.85 \cdot \cos\left(\frac{90 \cdot \pi}{180}\right)\right)} \cdot 90000 \text{ mm}^2 \\
 &= 521.2 \text{ mm}^2
 \end{aligned}$$

$$\begin{aligned}\text{rebar}_{\text{utilization}} &= \frac{A_{\text{sreq}}}{A_{\text{vf}}} \\ &= \frac{521.2 \text{ mm}^2}{600 \text{ mm}^2} \\ &= 0.8687\end{aligned}$$