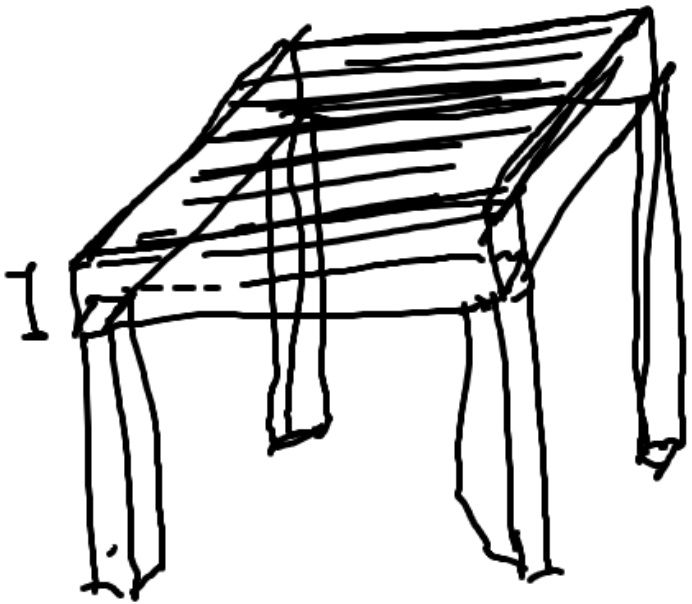
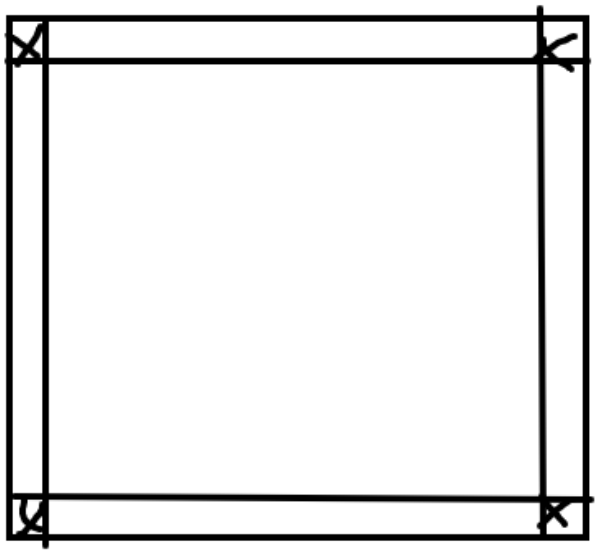
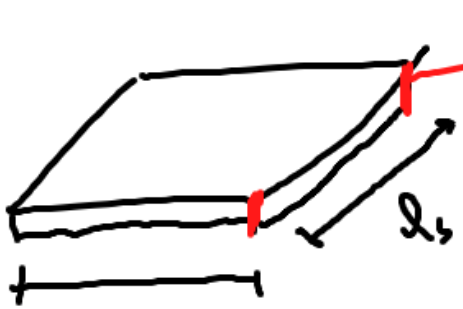


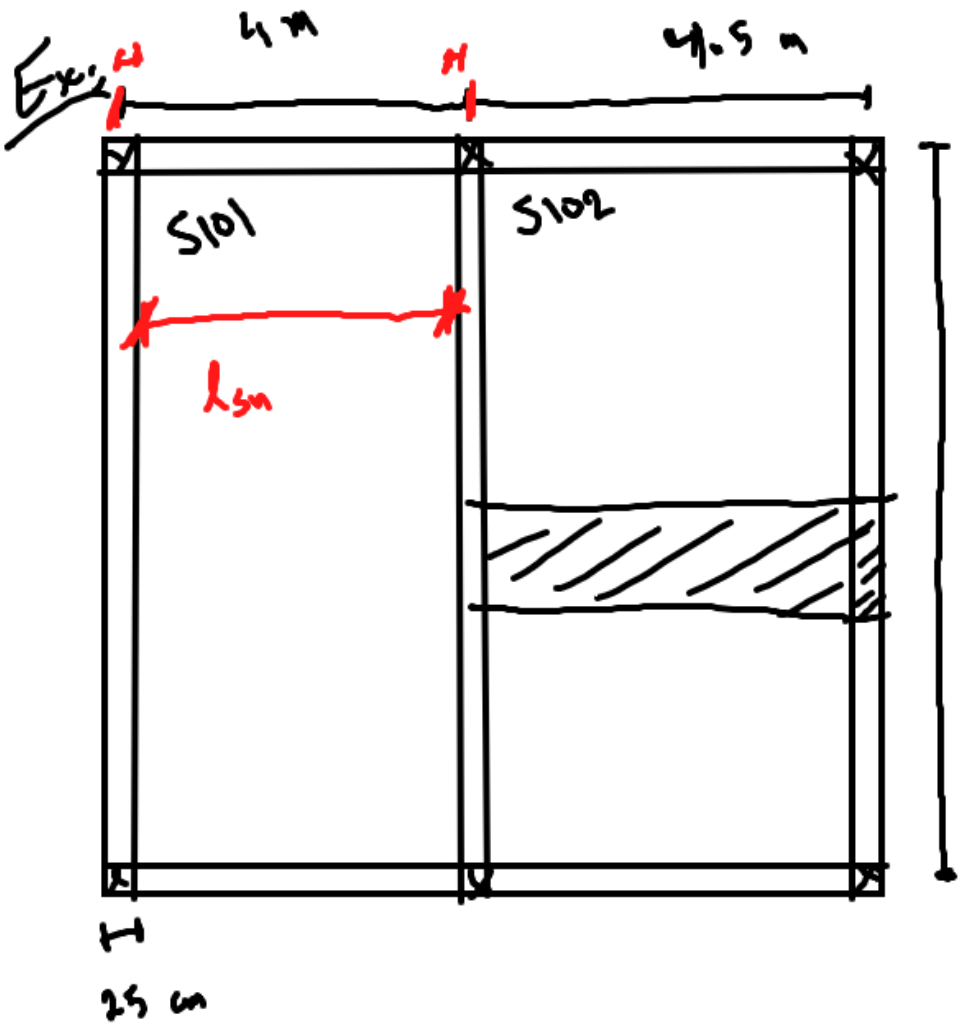




Solid ✓

- T.W.S: $m = \frac{l_l}{l_s} \leq 2$
- O.W.S: $m = \frac{l_l}{l_s} > 2$

- joist ✓
- Flat x



Givens:

① C20 , S220

$f_{ck} = 20\ MPa \rightarrow f_{cd} = \frac{f_{ck}}{1.5}$

$= \frac{20}{1.5}$

$= 13\ MPa$

$f_{yk} = 220\ MPa \rightarrow f_{yd} = \frac{f_{yk}}{1.15}$

$= \frac{220}{1.15}$

$= 191\ MPa$

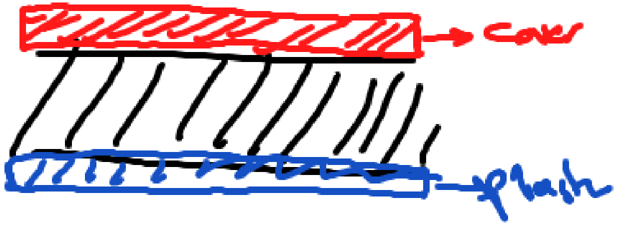
$f_{yd} = 191\ \frac{N}{mm^2} = \frac{191 \times 10^{-3} \times 10^{-1}}{1 \times (10^{-1})^2}$

$= 1.91\ t/cm^2$

Given:

(Dead loads) Beams: 25/50

Cover + plaster = 0.18 t/m²



live load Q = 0.2 t/m²

There are partial walls → Additional live load 0.15 t/m²

Required:

Design the slabs

أبعاد (إيجاد سماكة t)

تسليح (A_s →)

P_d → M_d ← → A_s

① S101:

$\frac{l_l}{l_s} = \frac{10}{4} = 2.5 > 2 \rightarrow$ O.W.S

S102:

$\frac{l_l}{l_s} = \frac{11}{4.5} = 2.2 > 2 \rightarrow$ O.W.S

② t (O.W.S) → simple : $t \geq \frac{l_{sn}}{25}$

→ continu : $t \geq \frac{l_{sn}}{30}$ ←

→ condition $t \geq \frac{l_{sn}}{\sim}$

* S101:

$t \geq \frac{l_{sn}}{30}$; $l_{sn} = l_s - 25$

$= 400 - 25$

$= 375$

$t \geq \frac{375}{30}$

$t \geq 12.5$ cm

* S102:

$t \geq \frac{l_{sn}}{30}$

$l_{sn} = 450 - 25$

$= 425$

$t \geq \frac{425}{30}$

$t \geq 14.2$ cm

$\therefore t = 15$ cm

③ loads: < G : Dead load
Q : Live load

$$P_2 = 1.4G + 1.6Q$$

G: → Self weight = $\gamma_c \cdot t = 2.4 \times 0.15 = 0.36$ t/m²

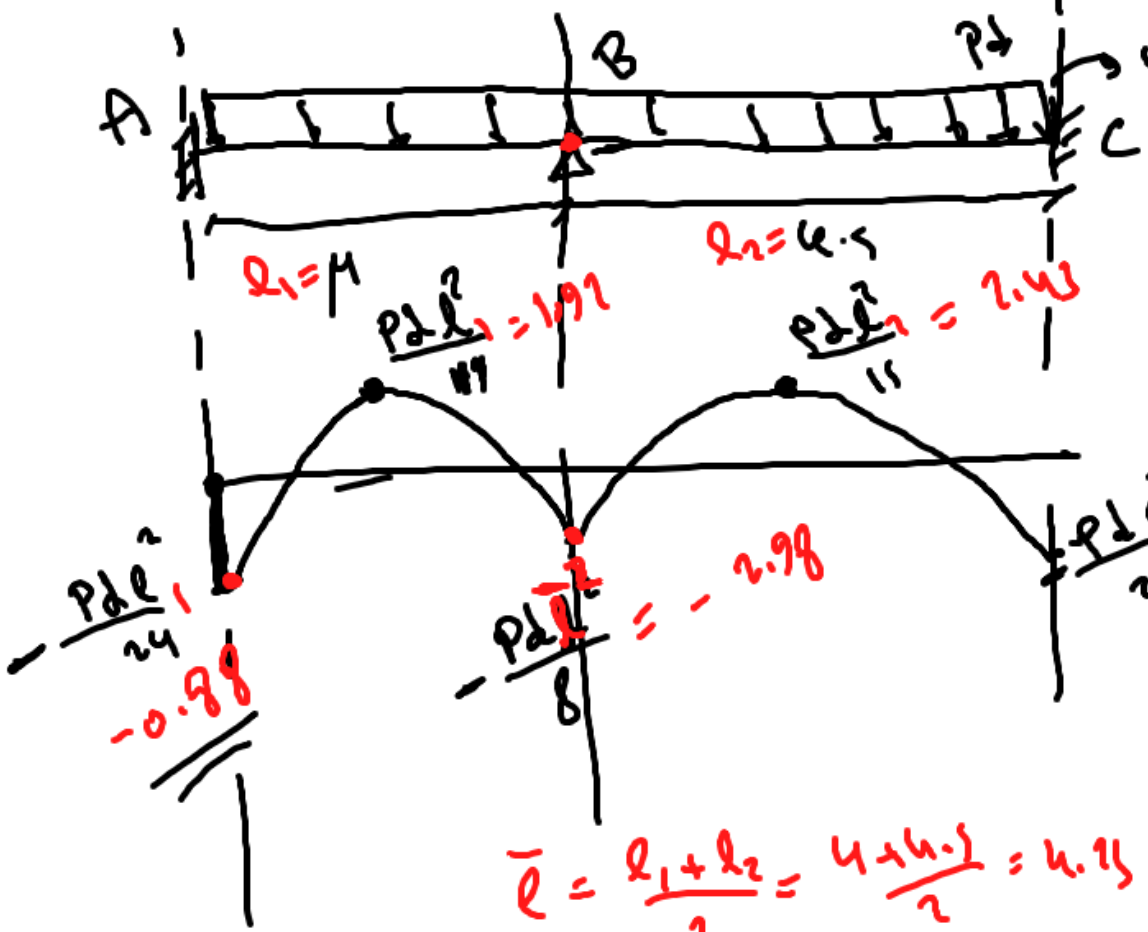
→ Cover+Plaster = 0.18 t/m²

$G = 0.36 + 0.18 = 0.54$ t/m²

$Q = 0.2 + 0.15 = 0.35$ t/m²

$P_2 = 1.4(0.54) + 1.6(0.35) = 1.32$ t/m² → $P_2 = 1.32 \times 1 = 1.32$ t/m

④ Momenti (S.L.U.) Empirical formulas:



$$\bar{l} = \frac{l_1 + l_2}{2} = \frac{4 + 4.1}{2} = 4.05$$

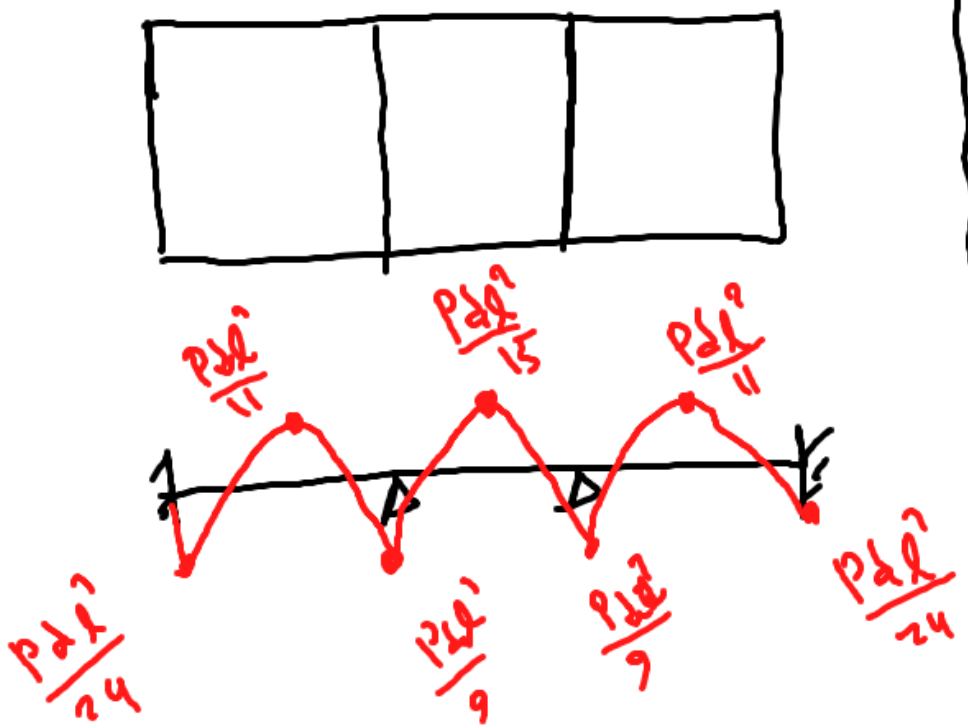
$$M_A = -\frac{Pd\,l^2}{24} = -\frac{1.32 \times 4^2}{24}$$

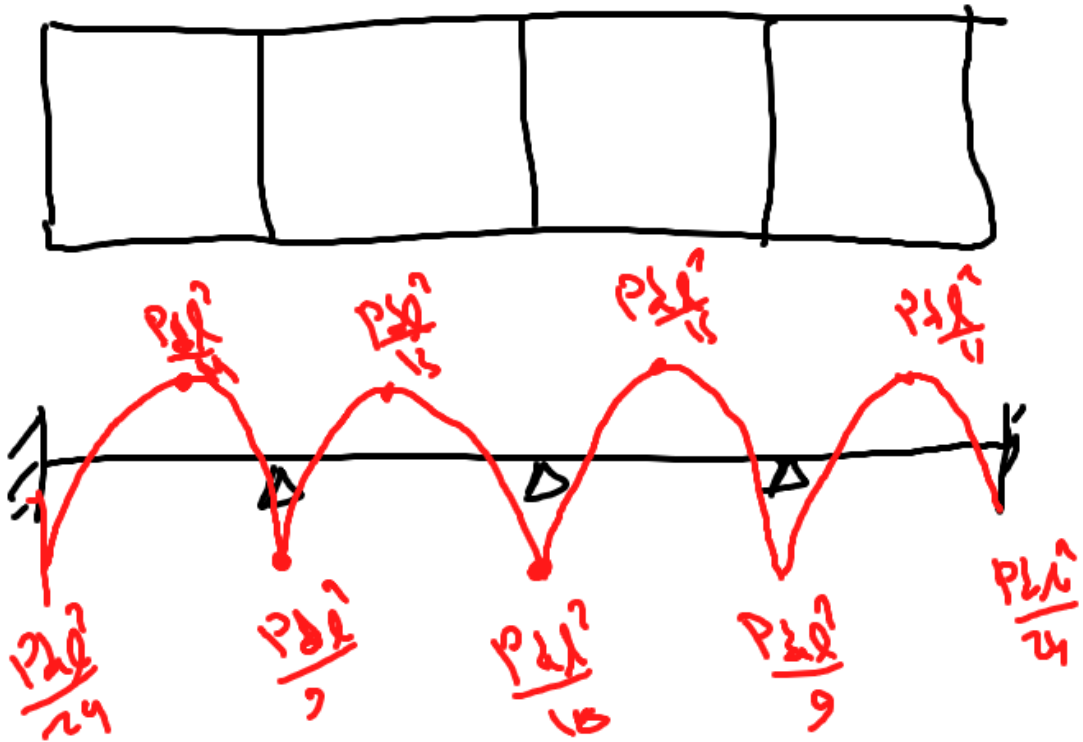
$$M_A = -0.88 \text{ t·m}$$

Check: ① $l_{min} \geq 0.8\, l_{max}$

ok $4 > \underbrace{0.8(4.1)}_{3.6}$

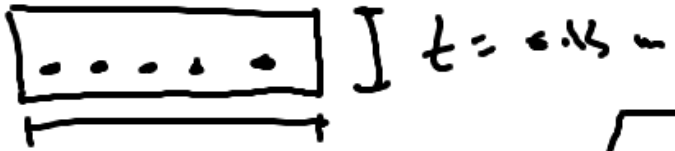
② $\frac{Q}{G} = \frac{0.35}{0.54} = 0.65 < 2$ V


$\frac{Pl^2}{11}$
$\frac{Pl^2}{16}$
$\frac{Pl^2}{11}$
$\frac{Pl^2}{24}$
$\frac{Pl^2}{9}$
$\frac{Pl^2}{6}$
$\frac{Pl^2}{24}$


$\frac{Pl^2}{11}$
$\frac{Pl^2}{16}$
$\frac{Pl^2}{11}$
$\frac{Pl^2}{24}$
$\frac{Pl^2}{9}$
$\frac{Pl^2}{10}$
$\frac{Pl^2}{6}$
$\frac{Pl^2}{24}$

⑤ Final Design:

● S101: Mid span:



$M_d = 1.92 \text{ t.m} = 192 \text{ t.cm}$ $b_w = 1$ m

C20 S220 $\Rightarrow K_R = 3.8$ cm²/t

$d = t - 1.5$ (c.w.)

$= 15 - 1.5$

$d = 13.5$ cm

$$K = \frac{b_w d^2}{M_d} = \frac{100 \times 13.5^2}{192} = 9.5 \text{ cm}^2/\text{t} > K_R$$

.. ok ..

$jd = 0.86\, d$ (rectang.)

$= 0.86 \times 13.5$

$= 11.61$ cm

$$A_{st} = \frac{M_d}{f_{yd} \cdot jd} = \frac{192}{1.91 \times 11.61} = 8.66 \text{ cm}^2$$

$$(A_{st})_{min} = \rho_{min} \cdot b_w \cdot d$$

$$= 0.003 \times 100 \times 13.5$$

$$= 4.05 \ cm^2$$

O.W.S → S220 → $\rho_{min} = 0.003$

→ S420 → $\rho_{min} = 0.002$

$A_{st} > (A_{st})_{min} \Rightarrow$ **$A_{st} = 8.66 \ cm^2$**

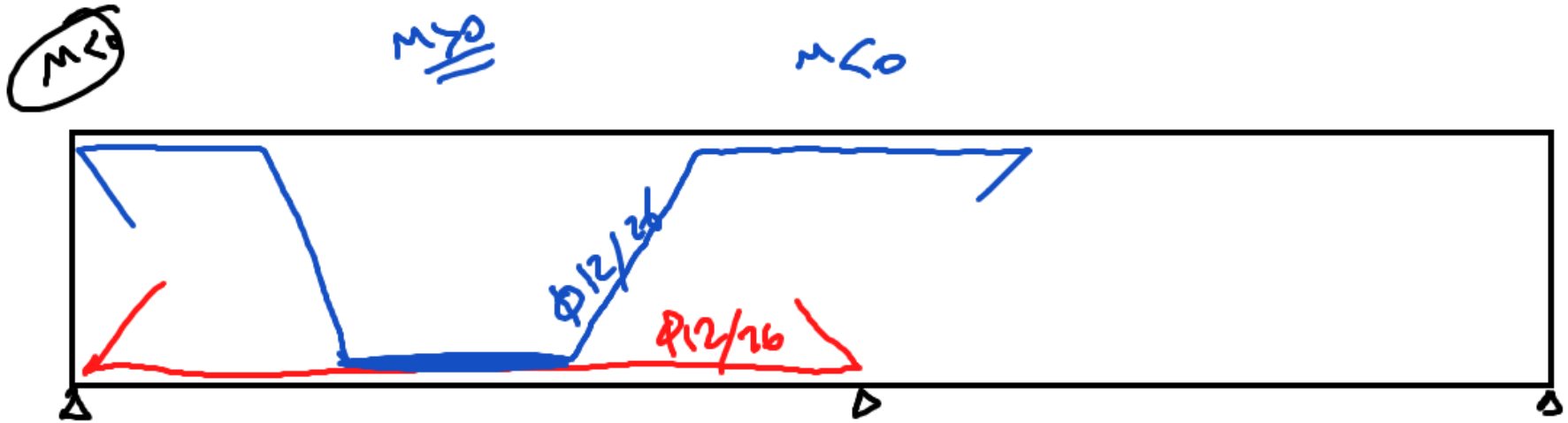
$\underline{\phi 12}$: $S = \frac{b_w}{A_{st_{req}}} \cdot A_\phi = \frac{100}{8.66} \times \frac{\pi 1.2^2}{4} = 13.06$

Use $\phi 12 / \underline{13} =$ Bt: $\phi 12/26$, St: $\phi 12/26$

$S = 13 < 20 \ cm$ ✓

$< 1.5t = 1.5(15) = 22.5$ ✓

ok



- Support A: (1m × 0.6m)

$M_d = 0.78\ t.m = 88\ t.cm$

$K = \frac{b_w d^2}{M_d} = \frac{100 \times 13.5^2}{88} = 207\ cm^2/t > K_R$ — OK

$A_{st} = \frac{M_d}{f_{yd}\, j\, d} = \frac{88}{1.91 \times 11.61} = 3.97\ cm^2 < (A_{st})_{min} \rightarrow$ Use $(A_{st})_{min}$

$(A_{st})_{req.} = 4.05 \text{ cm}^2$

$(A_{st})_{available} = \phi 12/26 \text{ Bt } S(01) = \frac{bw}{s} \times A\phi = \frac{100}{26} \times \frac{\pi \times 1.2^2}{4}$

$= 4.35 \text{ cm}^2$

$(A_{st})_{av} > (A_{st})_{req.} \Rightarrow$ No extra steel is needed

---

- temperature steel,

$(A_{st})_{temp} = \frac{A_{st}}{5} = \frac{8.66}{5} = 1.73 \text{ cm}^2 \rightarrow \phi 8 \rightarrow S = \frac{100}{1.73} \times \frac{\pi \times 0.8^2}{4}$

$= 29$

$\phi 8/29$

Check: $S = 29 < 30$ — ok

- **Shear Design:** $V_d \leq V_{cr}$

$$V_d = 1.15\, Pd\, \frac{l_{sn}}{2} = 1.15 \times 1.32 \times \frac{3.75}{2} = 2.85\ t$$

$$V_{cr} = 0.65\, f_{ctd}\, b_w\, d = (0.65) \times \left(10 \times 10^{-3}\ t/cm^2\right) \times (100\ cm) \times (13.5\ cm)$$

C20 → $f_{ctd} = 10 \times 10^{-3}$ t/cm²

$$= 8.78\ t$$

$V_{cr} > V_d$ — ok