

5th TASK: RC STAIRCASE

- DATA -

$$R = 4'4 \text{ m}$$

$$h_k = 3'9 \text{ m}$$

$$a = 5'6 \text{ m}$$

From Task 1: $h_s = 180 \text{ mm}$

→ Depth of floor structure: $h_f = 150 \text{ mm}$

→ Thickness of cladding of the stairs:

$$h_c = 30 \text{ mm}$$

- GEOMETRY -

- The ideal height of one step is 170 mm
 $3900 / 170 = 22'9 \rightarrow 24 \text{ steps (2 flights with 12 steps)}$

- Height of one step: $h = 3900 / 24 = 163 \text{ mm}$

- Width of one step: $b = 630 - 2h$

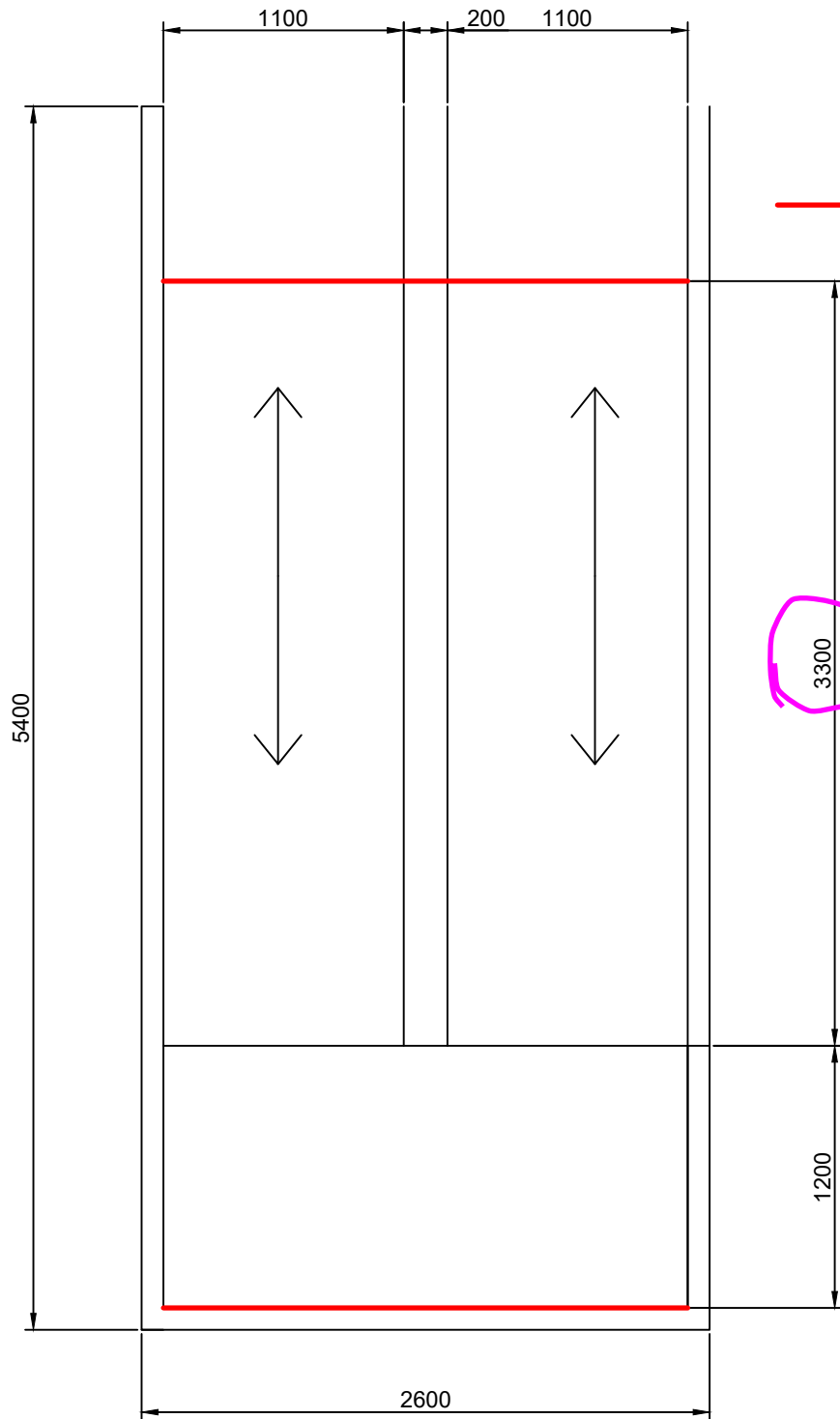
$$b = 630 - 2 \cdot 163$$

$$b = 304 \text{ mm}$$

DESIGN: staircase with $163 / 304 \text{ mm}$ steps, 2 flights, 12 steps in each flight.

- width of the flight = 1100 mm (minimum value)
- width of the gap between flights = 200 mm (common value)
- width of the landing = 1200 mm
- width of the staircase = $1100 \cdot 2 + 200 = 2400 \text{ mm}$ (At least)
- slope of the staircase: $\alpha = \arctg(163/304) = 28^\circ 2'$

Adjusting the values according to my geometry at the end, the dimensions are:



suppoorts

3300

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- PRELIMINARY CHECK OF THE DEPTH OF THE SLAB

- The staircase is considered as one-way slab with the span of 4500 mm. The slab will be simply supported \rightarrow the depth should be at least:

$$4500/25 = 180 \text{ mm}$$

- The depth of landings is the same as the depth of the main slab = 180 mm

- The depth of flights = 200 mm

$$\begin{array}{l} \rightarrow 180 \text{ mm} \geq 180 \text{ mm} \\ 200 \text{ mm} > 180 \text{ mm} \end{array} \quad \left. \vphantom{\begin{array}{l} \rightarrow 180 \text{ mm} \geq 180 \text{ mm} \\ 200 \text{ mm} > 180 \text{ mm} \end{array}} \right\} \text{OK}$$

PERPENDICULAR & HEAD CLEARANCE OF THE STAIRS

- Head clearance of the staircase should be more than:

$$1500 + 750 / \cos \alpha = 2351 \text{ mm and more than } 2100 \text{ mm}$$

\rightarrow Head clearance is:

$$h_1 = h_k - h_s - h_f - h = 3900 - 180 - 150 - 163$$

$$h_1 = 3407 \text{ mm } \checkmark$$

- Perpendicular clearance should be more:

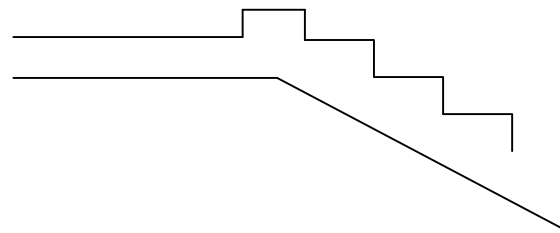
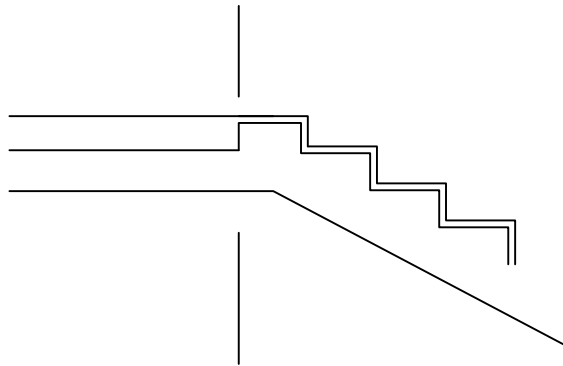
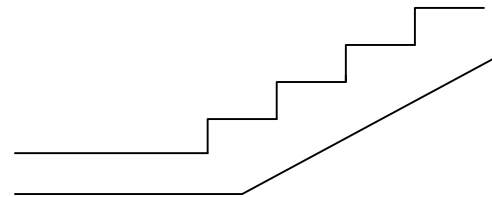
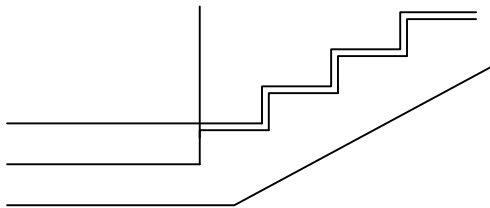
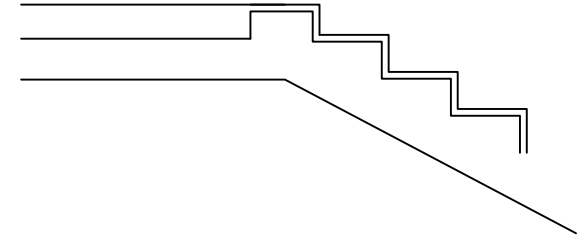
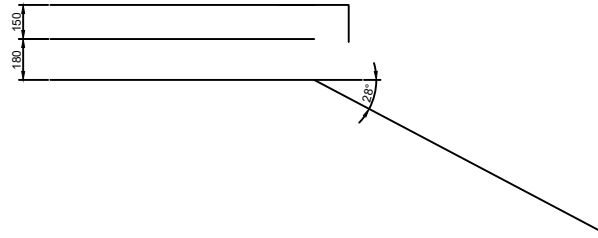
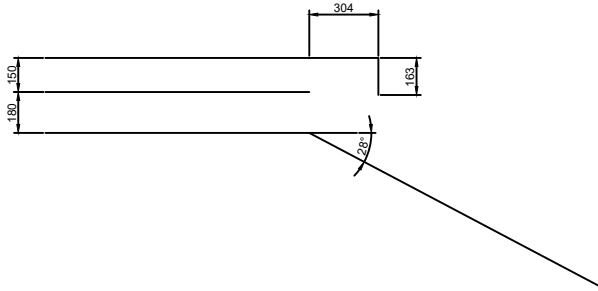
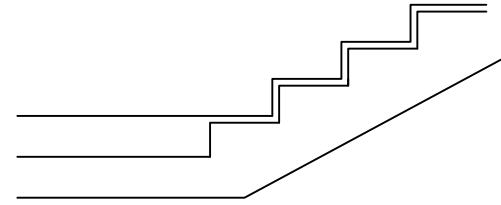
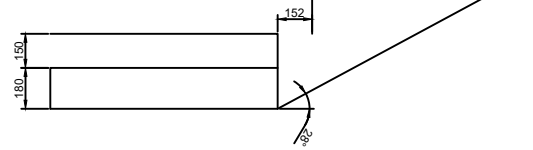
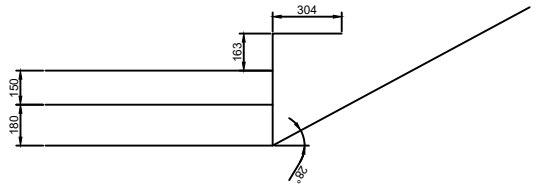
$$750 + 1500 \cdot \cos \alpha = 750 + 1500 \cdot \cos(28'2) = 2072 \text{ mm}$$

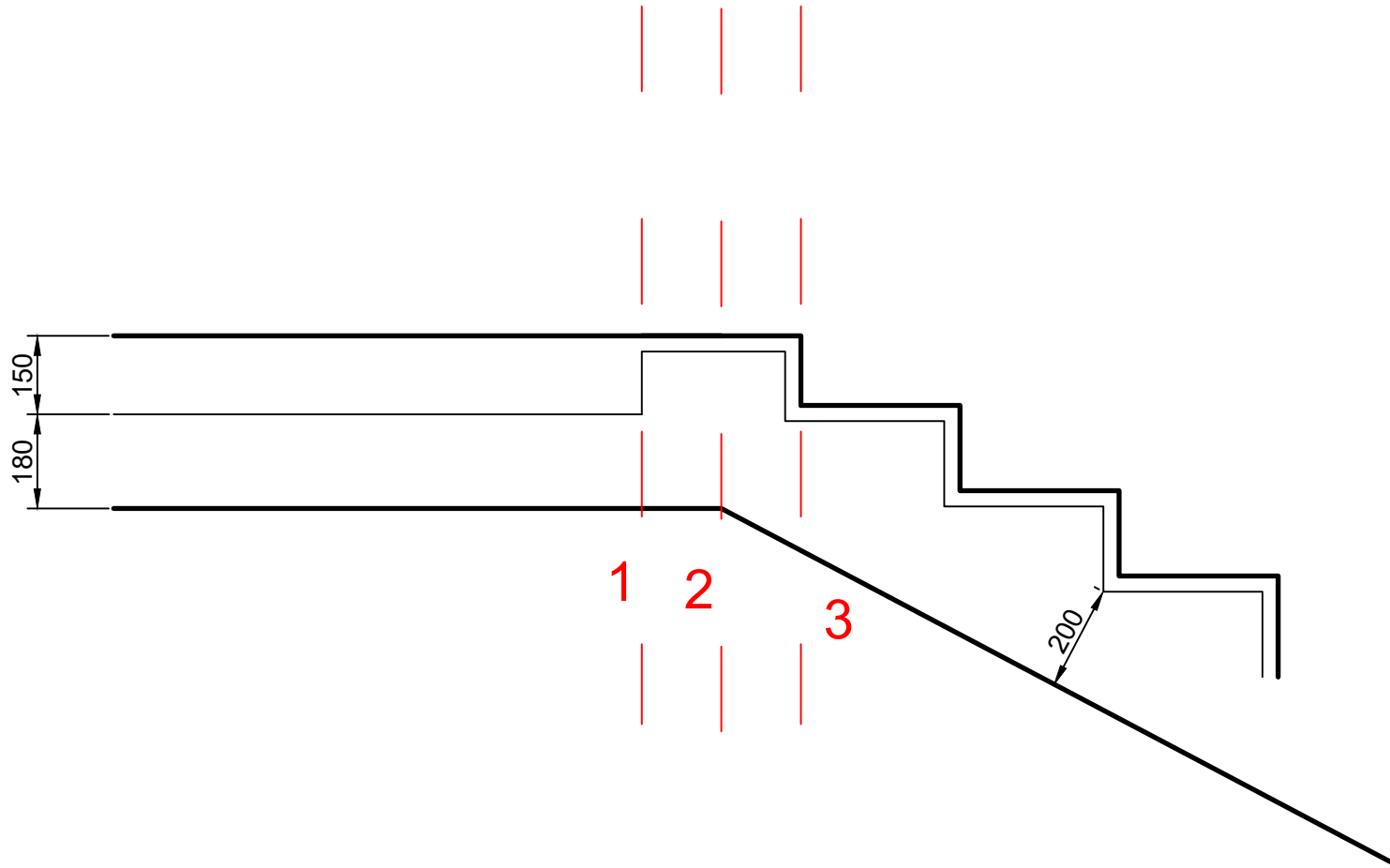
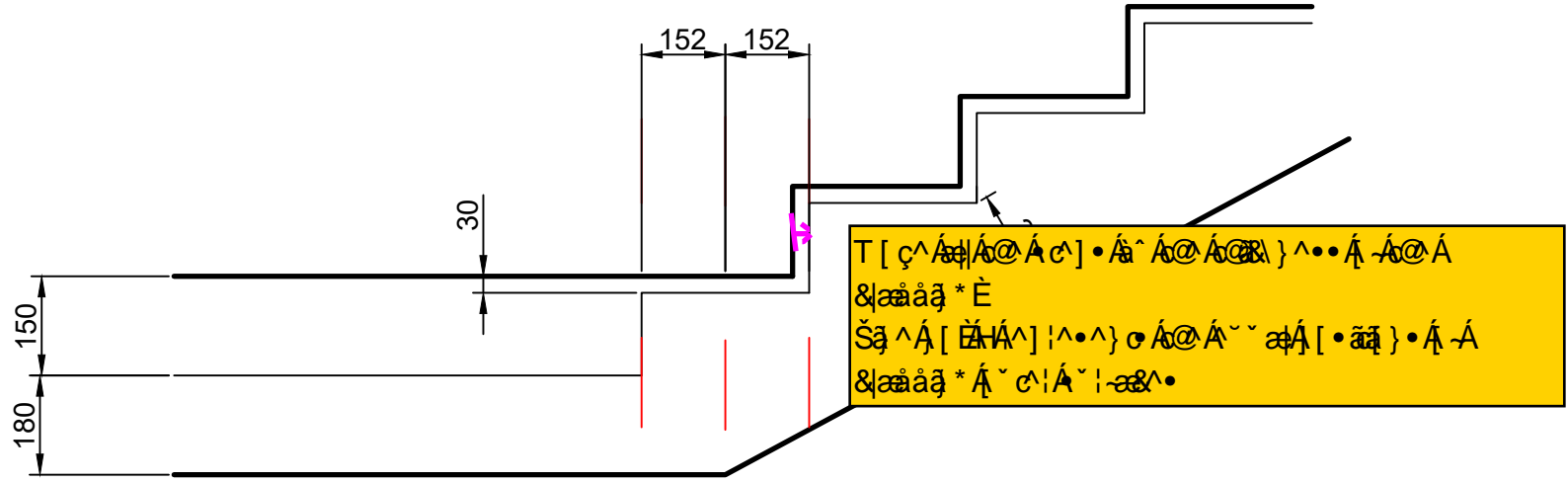
and more than 1900 mm

\rightarrow Perpendicular clearance: $h_2 = h_1 \cdot \cos \alpha$

$$h_2 = 3407 \cdot \cos(28'2)$$

$$h_2 = 3003 \text{ mm } \checkmark$$





- LOADS -

LANDING

Load	Charc. Value [kN/m ²]	γ_u	Desing value [kN/m ²]
Slab	$0.18 \cdot 25 = 4.5$	1.35	6.08
Floor	1	1.35	1.35
Live load	3.5	1.5	5.25
			$f_{dl} = 12.7 \text{ kN/m}^2$

FLIGHT

Load	C. value [kN/m ²]	γ_u	Desing. Value
Slab	$\frac{0.21}{\cos(28.2)} \cdot 25 = 5.67$	1.35	7.65
Cladding	$0.5 \cdot \frac{163+304}{304} = 0.52$	1.35	0.7
Steps	$\frac{0.163}{2} \cdot 25 = 2.04$	1.35	2.75
Live load	3.5	1.5	5.25
			$f_{df} = 16.4 \text{ kN/m}^2$

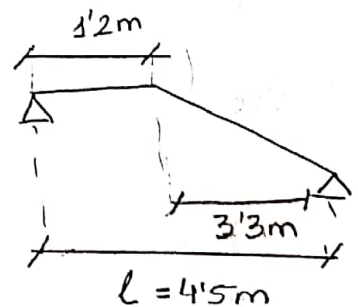
DESING BENDING MOMENT

Estimation →

$$M_{ed} = \frac{1}{12} \cdot f_{df} \cdot L^2$$

$$M_{ed} = \frac{1}{12} \cdot 16.4 \cdot 4.5^2$$

$$M_{ed} \approx 27.7 \text{ kN}$$



• Taking a $c = 20 \text{ mm}$
(TASK 1)

• And supposing
we are using rebars
of $\phi 8$

For a B500,
 $f_{yd} = 434.78 \text{ MPa}$

- DESIGN OF THE REINFORCEMENT -

The effective depth: $d = h - \frac{\phi}{2} - c$

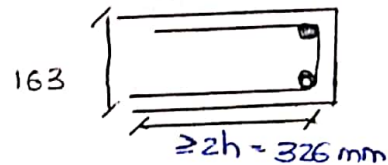
$$d = 163 - \frac{8}{2} - 20 = 139 \text{ mm}$$

So, the required area:

$$A_{s, \text{reqd}} = \frac{m \cdot e \cdot d}{0.9 \cdot d \cdot f_{yd}} = \frac{27.7}{0.9 \cdot 0.139 \cdot 434.78 \cdot 10^3} = 509.3 \text{ mm}^2$$

↳ 7 $\phi 10$ ($A_{s, \text{prov}} = 550 \text{ mm}^2$)

Edge reinforcement



Transverse reinforcement

$$A_{s, \text{tr}} \geq 0.25 \cdot A_{s, \text{main}}$$

$$S_{tr} \leq \min(3h; 400 \text{ mm})$$

$$A_{s, \text{tr}} \geq 0.25 \cdot 550 = 137.5 \text{ mm}^2$$

$$\downarrow$$
$$8 \phi 5 \text{ (} A_{s, \text{prov}} = 157 \text{ mm}^2 \text{)}$$

$$S_{tr} \leq \min(3 \cdot 163; 400) = 400 \text{ mm}$$

SECONDARY reinforcement of the upper surface

• The same as the transverse reinforcement:

8 $\phi 5$ with a spacing of 400 mm

End stirrups → Two stirrups.

- ① ISI UNIT
- ② TRAPEZ BOX
- ③ CORBEL ELEMENT

