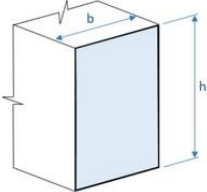
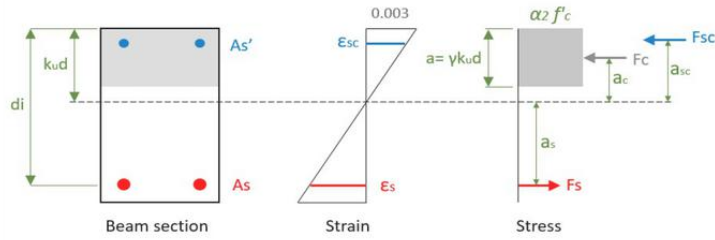


REFERENCES	CALCULATIONS	RESULTS						
<p>Code: AS 3600:2018(A1)</p>	<p>MEMBER #2 (SECTION POSITION 1250.0 mm) BEAM DESIGN REPORT</p> <p>Project details</p> <p>Your LOGO Here</p> <p>Project Name: Project ID: Company: Designer: Client: Project Notes: Project Units: Metric</p> <p>General member design information</p> <p>Dimensions:</p>  <p>Height $h = 199.9$ mm Width $b = 254$ mm Member length = 2500 mm</p> <p>Material properties: Concrete strength $f'_c = 25$ MPa Steel strength of longitudinal rebar $f_{sy} = 500$ MPa Steel strength of shear rebar $f_{syv} = 500$ MPa Limit crack width $w'_{max} = 0.3$ mm</p> <p>Design Factors and Settings: Reinforcement Class : N</p> <p>Load Combinations</p> <p>Ultimate Limit State: LC 1: ULS: 1. D (M = 0.34 kN-m, V = 0.00 kN) LC 2: ULS: 2. D + L (M = 0.24 kN-m, V = 0.93 kN) LC 3: ULS: 3. D + (S or Lr or R) (M = 0.34 kN-m, V = 0.00 kN) LC 4: ULS: 4. D + 0.75L + 0.75(S or Lr or R) (M = 0.27 kN-m, V = 0.70 kN) LC 5: ULS: 5a. D + 0.6W (M = 0.34 kN-m, V = 0.00 kN) LC 6: ULS: 5b. D + 0.7E (M = 0.34 kN-m, V = 0.00 kN) LC 7: ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R) (M = 0.27 kN-m, V = 0.70 kN) LC 8: ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S (M = 0.27 kN-m, V = 0.70 kN) LC 9: ULS: 7. 0.6D + 0.6W (M = 0.20 kN-m, V = 0.00 kN) LC 10: ULS: 8. 0.6D + 0.7E (M = 0.20 kN-m, V = 0.00 kN)</p> <p>Serviceability Limit State: LC 1: LC-1 (M = 0.34 kN-m)</p> <p>Accepted forces for section check: Positive moment strength case : (M = 0.34 kN-m) Positive moment service. case: (M = 0.34 kN-m) Negative moment strength case: (M = 0.00 kN-m) Negative moment service. case: (M = 0.00 kN-m) Shear strength case: M = (0.24 kN-m, V = 0.93 kN)</p> <p>DL - Dead Load LL - Live Load WL - Wind Load LrL - Roof Live Load RL - Rain Load SL - Snow Load EL - Earthquake Load</p>							
	<p>Flexure check (Positive bending moment case)</p> <p>Intermediate results of the optimization</p> <table border="1"> <thead> <tr> <th>Iteration</th> <th>Ratio</th> <th>Status</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>0.289</td> <td>OK</td> </tr> </tbody> </table>	Iteration	Ratio	Status	1	0.289	OK	
Iteration	Ratio	Status						
1	0.289	OK						

Results of iteration 1

BENDING MOMENT CAPACITY



Section input data:

Design yield strain of rebar $e_y = f_{sy}/E_s = 500/200000 = 0.00250$

Ultimate strain in concrete $e_{cu} = 0.003$

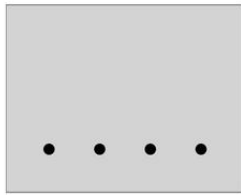
Distance to the outermost layer of tensile reinforcement $d_0 = 153.9$ mm

Given bending moment $M^* = 0.34$ kN-m

Section Rebar

Depth d_i (mm)	bar diameter (mm)	bar area A_{s_i} (mm ²)
153.9	12	113.10
153.9	12	113.10
153.9	12	113.10
153.9	12	113.10

Reinforced section view



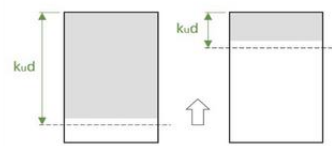
8.1.3(1), 8.1.3(2)

Rectangular compression block factors (8.1.3(1), 8.1.3(2))

$$\alpha_2 = 0.85 - 0.0015 \cdot \dot{f}_c = 0.85 - 0.0015 \cdot 25 = 0.81$$

$$\gamma = 0.97 - 0.0025 \cdot \dot{f}_c = 0.97 - 0.0025 \cdot 25 = 0.91$$

1. Calculation of neutral axis depth $k_u d$



Calculation is based on iterative process:

- Assume $k_u d$

- Calculate concrete force $F_c = \alpha_2 \cdot \dot{f}_c \cdot \int_{dA} \gamma \cdot k_u \cdot d$

- Calculate compression force in steel $F_{cs} = \sum A'_{s,i} \cdot f_{s,i}$

- Calculate tensioning force in steel $F_s = \sum A_{s,i} \cdot f_{s,i}$

- Check equilibrium $F_c + F_{cs} = F_s$

Reinforcement stresses $f_s = \{e_s E_s (e_s \leq e_y), e_y (e_s > e_y)\}$

Reinforcement strains above axis $e_s = e_{cu} \cdot (k_u \cdot d - d)/k_u \cdot d$

Reinforcement strains below axis $e_s = e_{cu} \cdot (d - k_u \cdot d)/k_u \cdot d$

Searching of neutral axis $k_u d$ (from 153.9 to 0 mm)

Iter.	$k_u d$ (mm)	$k_{uo} = a/d_0$	F_c (kN)	F_{cs} (kN)	$F_c + F_{cs}$ (kN)	F_s (kN)	Ratio
17	48.3	0.31	225.97	0.00	225.97	226.19	0.999

Final value of $k_u d$ is 48.26 mm and flexural tension reinforcement area is 452.39 mm²

Working depth of reinforcement $d = 153.90$ mm

Strength reduction factor for reinforcement Class N in bending without axial tension or compression (Table 2.2.2)

$$\phi = 1.24 - 13 \cdot k_{uo} / 12 = 1.24 - 13 \cdot 0.31 / 12 = 0.90$$

$$\phi > 0.85 \rightarrow \phi = 0.85$$

Check maximum allowable depth of the rectangular compression block (8.1.5)

$$a = \gamma \cdot k_u d = 0.91 \cdot 48.26 = 43.80 \text{ mm} \leq a_{max} = \gamma \cdot k_u \cdot d_0 = 0.91 \cdot 0.36 \cdot 153.9 = 50.28 \text{ mm}$$

2. Calculation moment resistance

$$\phi M_u = (F_c \cdot a_c + F_{cs} \cdot a_{cs} + F_s \cdot a_s) \cdot \phi = (5.96 + 0.00 + 23.89) \cdot 0.85 = 25.37 \text{ kN-m}$$

$$M^* = 0.34 \text{ kN-m} \leq \phi M_u = 25.37 \text{ kN-m} \text{ (Ratio: 0.013)}$$

8.1.6.1(1)

3. Minimum required strength in bending (M_{uo})_{min} (8.1.6.1(1))

$$f'_{ct,f} = 0.6 \sqrt{f'_c} = 0.6 \sqrt{25} = 3.00 \text{ MPa}$$

$$I_g = \frac{b \cdot h^3}{12} = \frac{254 \cdot 199.9^3}{12} = 169079460.31 \text{ mm}^4$$

$$Z = \frac{I_g}{y} = \frac{169079460.31}{99.95} = 1691640.42 \text{ mm}^3$$

$$M_{uo,min} = 1.2 \cdot Z \cdot f'_{ct,f} = 1.2 \cdot (1691640.42 \cdot 3.00) \cdot 10^{-6} = 6.09 \text{ kN-m}$$

$$M_{uo,min} = 6.09 \text{ kN-m} \leq \phi M_u = 25.37 \text{ kN-m} \text{ (Ratio: 0.240)}$$

8.1.6.1(2)

3. Minimum required flexural tension reinforcement in a beam section (8.1.6.1(2))

$$\alpha_b = 0.2$$

$$f'_{ct,f} = 0.6 \sqrt{f'_c} = 0.6 \sqrt{25} = 3.00 \text{ MPa}$$

$$A_{st,min} = \left[\alpha_b \cdot (h/d)^2 \cdot (f'_{ct,f} / f_{sy}) \right] \cdot b_w \cdot d = \left[0.20 \cdot (199.90/153.90)^2 \cdot (3.00/500.00) \right] \cdot 254.00 \cdot 153.90 \\ = 79.14 \text{ mm}^2$$

4. Maximum required flexural tension reinforcement in a beam section

$$A_{st,max} = 0.04 \cdot b \cdot d = 0.04 \cdot 254 \cdot 153.90 = 1563.62 \text{ mm}^2$$

5. Check of required flexural tension reinforcement in a beam section

$$A_{st} = 452.39 \text{ mm}^2 \leq A_{st,max} = 1563.62 \text{ mm}^2 \text{ (Ratio: 0.289)}$$

$$A_{st} = 452.39 \text{ mm}^2 \geq A_{st,min} = 79.14 \text{ mm}^2 \text{ (Ratio: 0.175)}$$

STATUS OK!
Ratio: 0.013

STATUS OK!
Ratio: 0.240

STATUS OK!
Ratio: 0.289

Week 10: Fluid Mechanics - Buoyancy and Archimedes' Principle

Question 1: Buoyancy and Archimedes' Principle

Volume	Mass	Density
1	1.00	1000

Question 2: Buoyancy



1. A rectangular block of height 10 cm and width 5 cm is partially submerged in a fluid of density 1000 kg/m³. The submerged part is 4 cm high. Calculate the buoyant force acting on the block.

2. A rectangular block of height 10 cm and width 5 cm is fully submerged in a fluid of density 1000 kg/m³. Calculate the buoyant force acting on the block.

Question 3: Buoyancy



3. A rectangular block of height 10 cm and width 5 cm is partially submerged in a fluid of density 1000 kg/m³. The submerged part is 4 cm high. Calculate the buoyant force acting on the block.

Volume	Mass	Density	Weight	Buoyant Force	Net Force
1	1.00	1000	9.81	3.92	-5.89

4. A rectangular block of height 10 cm and width 5 cm is partially submerged in a fluid of density 1000 kg/m³. The submerged part is 4 cm high. Calculate the buoyant force acting on the block.

$$F_b = \rho V g = 1000 \times 0.002 \times 9.81 = 3.92 \text{ N}$$

$$F_{net} = F_b - F_g = 3.92 - 9.81 = -5.89 \text{ N}$$

Question 4: Buoyancy

5. A rectangular block of height 10 cm and width 5 cm is fully submerged in a fluid of density 1000 kg/m³. Calculate the buoyant force acting on the block.

6. A rectangular block of height 10 cm and width 5 cm is fully submerged in a fluid of density 1000 kg/m³. Calculate the buoyant force acting on the block.

$$y_1 = 1000000 \cdot (1.05)^{10} = 1628894.63$$

$$y_2 = 1000000 \cdot (1.05)^{10} = 1628894.63$$

1000000

1000000

1000000

1000000

1000000

1000000

1000000

$$y_1 = 1000000 \cdot (1.05)^{10} = 1628894.63$$

1000000

$$y_2 = 1000000 \cdot (1.05)^{10} = 1628894.63$$

$$y_3 = 1000000 \cdot (1.05)^{10} = 1628894.63$$

1000000

$$y_4 = 1000000 \cdot (1.05)^{10} = 1628894.63$$

1000000

$$y_5 = 1000000$$

1000000

$$y_6 = 1000000 \cdot (1.05)^{10} = 1628894.63$$

$$y_7 = 1000000 \cdot (1.05)^{10} = 1628894.63$$

$$y_8 = 1000000$$

1000000

$$y_9 = 1000000 \cdot (1.05)^{10} = 1628894.63$$

1000000

1000000

$$y_{10} = 1000000 \cdot (1.05)^{10} = 1628894.63$$

1000000

$$y_{11} = 1000000 \cdot (1.05)^{10} = 1628894.63$$

1000000

$$y_{12} = 1000000 \cdot (1.05)^{10} = 1628894.63$$

1000000

$$y_{13} = 1000000 \cdot (1.05)^{10} = 1628894.63$$

$$y_{14} = 1000000 \cdot (1.05)^{10} = 1628894.63$$

QUESTION 1 (10 marks)

Let $f: \mathbb{R} \rightarrow \mathbb{R}$ be a function defined by

QUESTION 2 (10 marks)

Let $f: \mathbb{R} \rightarrow \mathbb{R}$ be a function defined by

QUESTION 3 (10 marks)

$$f(x) = \frac{x^2 + 1}{x^2 - 1} \quad \text{for } x \in \mathbb{R}, x \neq \pm 1$$

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QUESTION 4 (10 marks)

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QUESTION 5 (10 marks)

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Let $f: \mathbb{R} \rightarrow \mathbb{R}$ be a function defined by

$$f(x) = \frac{x^2 + 1}{x^2 - 1} \quad \text{for } x \in \mathbb{R}, x \neq \pm 1$$

QUESTION 6

QUESTION 7 (10 marks)

QUESTION 8 (10 marks)

Year	2018	2019
1	100	110

QUESTION 9 (10 marks)



Reaction 1: $A \rightarrow B$

Reaction 2: $B \rightarrow C$

Reaction 3: $C \rightarrow D$

Time (min)	[A] (M)	[B] (M)	[C] (M)	[D] (M)
0	1.00	0.00	0.00	0.00
10	0.75	0.25	0.00	0.00
20	0.50	0.50	0.00	0.00
30	0.25	0.75	0.00	0.00
40	0.00	1.00	0.00	0.00
50	0.00	0.75	0.25	0.00
60	0.00	0.50	0.50	0.00
70	0.00	0.25	0.75	0.00
80	0.00	0.00	1.00	0.00

Reaction 4: $D \rightarrow E$

Reaction 5: $E \rightarrow F$

Reaction 6: $F \rightarrow G$

Reaction 7: $G \rightarrow H$

Reaction 8: $H \rightarrow I$

$$A \rightarrow B \rightarrow C \rightarrow D \rightarrow E \rightarrow F \rightarrow G \rightarrow H \rightarrow I$$

Reaction 9: $I \rightarrow J$

$$A \rightarrow B \rightarrow C \rightarrow D \rightarrow E \rightarrow F \rightarrow G \rightarrow H \rightarrow I \rightarrow J$$

Reaction 10: $J \rightarrow K$

110

Reaction 11: $K \rightarrow L$

$$A \rightarrow B \rightarrow C \rightarrow D \rightarrow E \rightarrow F \rightarrow G \rightarrow H \rightarrow I \rightarrow J \rightarrow K \rightarrow L$$

$$A \rightarrow B \rightarrow C \rightarrow D \rightarrow E \rightarrow F \rightarrow G \rightarrow H \rightarrow I \rightarrow J \rightarrow K \rightarrow L$$

$$A \rightarrow B \rightarrow C \rightarrow D \rightarrow E \rightarrow F \rightarrow G \rightarrow H \rightarrow I \rightarrow J \rightarrow K \rightarrow L$$

$$A \rightarrow B \rightarrow C \rightarrow D \rightarrow E \rightarrow F \rightarrow G \rightarrow H \rightarrow I \rightarrow J \rightarrow K \rightarrow L$$

$$A \rightarrow B \rightarrow C \rightarrow D \rightarrow E \rightarrow F \rightarrow G \rightarrow H \rightarrow I \rightarrow J \rightarrow K \rightarrow L$$

Reaction 12: $L \rightarrow M$

$$A \rightarrow B \rightarrow C \rightarrow D \rightarrow E \rightarrow F \rightarrow G \rightarrow H \rightarrow I \rightarrow J \rightarrow K \rightarrow L \rightarrow M$$

Reaction 13: $M \rightarrow N$

$$A \rightarrow B \rightarrow C \rightarrow D \rightarrow E \rightarrow F \rightarrow G \rightarrow H \rightarrow I \rightarrow J \rightarrow K \rightarrow L \rightarrow M \rightarrow N$$

$$A \rightarrow B \rightarrow C \rightarrow D \rightarrow E \rightarrow F \rightarrow G \rightarrow H \rightarrow I \rightarrow J \rightarrow K \rightarrow L \rightarrow M \rightarrow N$$

Reaction 14: $N \rightarrow O$

$$A \rightarrow B \rightarrow C \rightarrow D \rightarrow E \rightarrow F \rightarrow G \rightarrow H \rightarrow I \rightarrow J \rightarrow K \rightarrow L \rightarrow M \rightarrow N \rightarrow O$$

$$A \rightarrow B \rightarrow C \rightarrow D \rightarrow E \rightarrow F \rightarrow G \rightarrow H \rightarrow I \rightarrow J \rightarrow K \rightarrow L \rightarrow M \rightarrow N \rightarrow O$$



Rectangular prism with 4 dots on front face

000000

Front view: 4 dots on front face

Top view: 4 dots on front face

View	Dot	Color
1	1000	00

Back view: 4 dots on front face



Rectangular prism with 4 dots on front face

000000

000000

Top view: 4 dots on front face

View	Dot	Color
1	1000	00

Back view: 4 dots on front face

Side view: 4 dots on front face



000000

Rectangular prism with 4 dots on front face

Top view: 4 dots on front face

Back view: 4 dots on front face

Side view: 4 dots on front face

Front view: 4 dots on front face

Left view: 4 dots on front face

Right view: 4 dots on front face

Bottom view: 4 dots on front face

Top view: 4 dots on front face

Back view: 4 dots on front face

QUESTION NO. 10 (10 MARKS)

QUESTION NO. 10 (10 MARKS)

QUESTION

QUESTION NO. 10 (10 MARKS)

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QUESTION NO. 10 (10 MARKS)

QUESTION	ANSWER	MARKS
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QUESTION	ANSWER	MARKS
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