YUE ZHI YENG A17KA0202 SKAB 3313 - 01 RCD 01

5/3/2020

Beam ABC shown in Figure 2(a) carries a uniformly distributed load, w kN/m over a span of 10m. The bending moment diagram of the beam and its maximum value at span A-B and support B is shown in Figure 2(b). The cross section and reinforcement arrangements of the beam for span A-B and support B is shown in Figure 2(c) and 2(d), respectively. The concrete cube compressive strength, f_{ck} of the beam is 30 N/mm². The effective depth to the tension reinforcement, d: 390 mm. Determine the following:

a. Draw the strain and stress distribution diagram of the section at span A-B and support B at ultimate limit state and show all the important values.

b. Calculate the neutral axis, x of the beam at span A-B and support B.

c. Determine and describe the mode of failure of the beam

d. Determine the allowable uniformly distributed load, w kN/m for the beam to withstand based on the two different reinforcement arrangements.

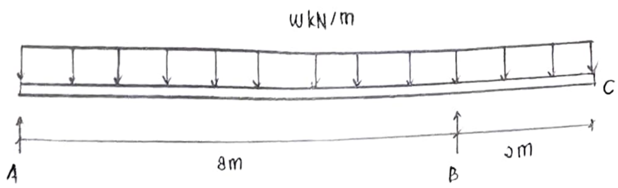

Figure 2(a) : Loading

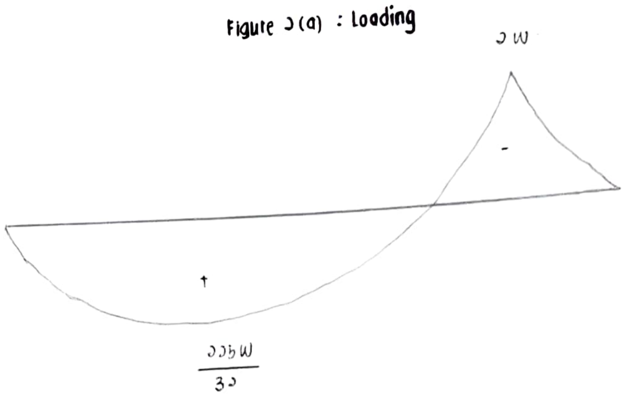

Figure 2(b) : Bending Moment Diagram

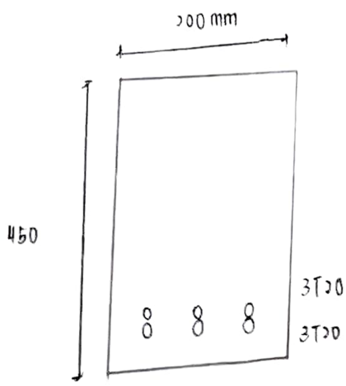

Figure 2(c) : span A-B

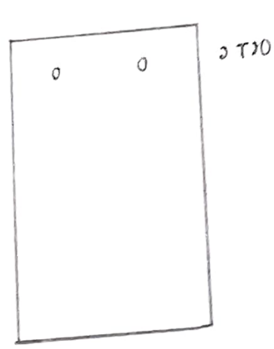

Figure 2(d) : support B

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6/3/2020

Beam ABC shown in figure 2(a) carries a uniformly distributed load, w kN/m over a span of 10m. The bending moment diagram of the beam and its maximum value at span A-B and support B is shown in Figure 2(b). The cross section and reinforcement arrangements of the beam for span A-B and support B is shown in figure 2(c) and 2(d) respectively. The concrete cube compressive strength, f_{ck} of the beam is 30 N/mm². The effective depth to the tension reinforcement, d = 390 mm. Determine the following:

a. Draw the strain and stress distribution diagram of the section at span A-B and support B at ultimate limit state and show all the important values.

b. Calculate the neutral axis, x of the beam at span A-B and support B.

c. Determine and describe the mode of failure of the beam

d. Determine the allowable uniformly distributed load, w kN/m for the beam to withstand based on the two different reinforcement arrangements.

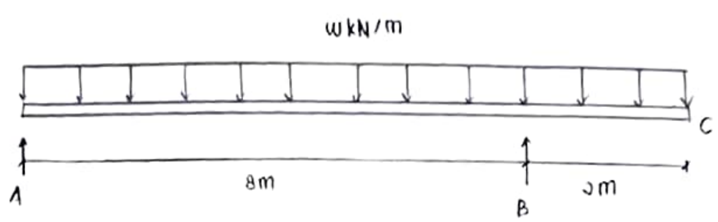


Figure 2(a) : loading

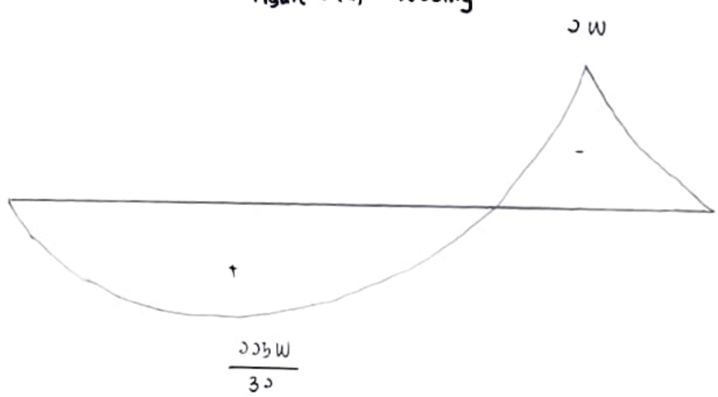


Figure 2(b) : Bending Moment Diagram

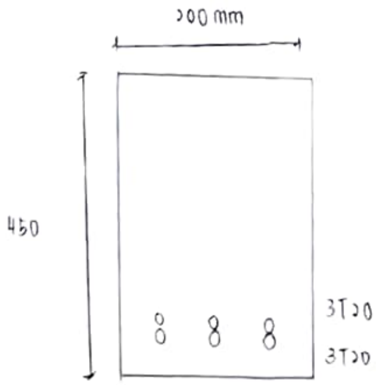


Figure 2(c) : span A-B

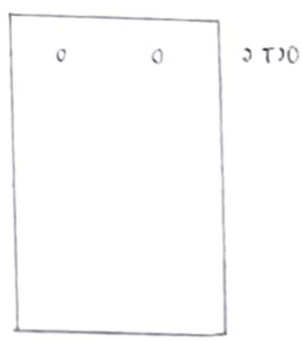
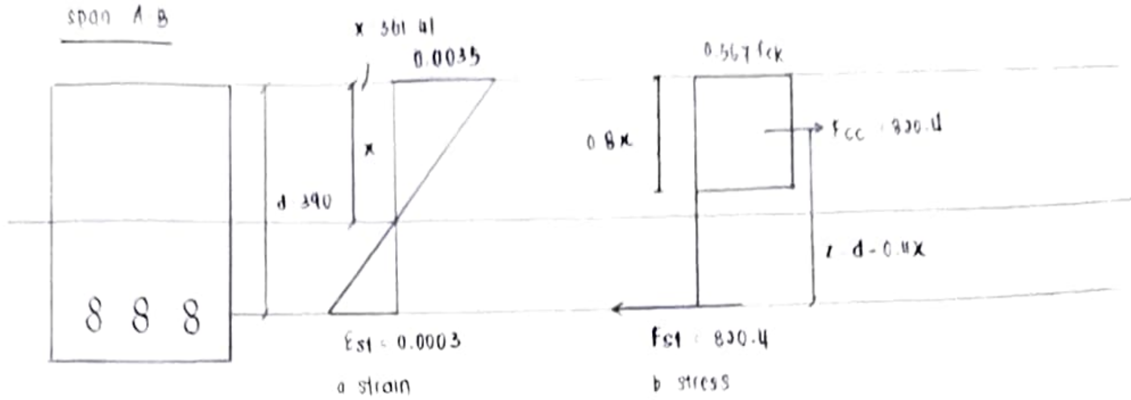


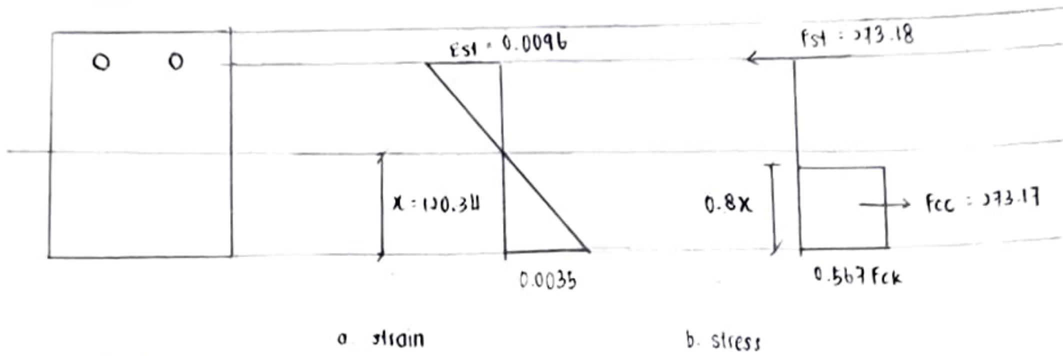
Figure 2(d) : support B

span A B

a.



support B



b. span A - B

c. Tension = compression

$F_{st} = F_{sc} + F_{cc}$

$0.87\, f_{yk}\, A_s = F_{cc}\, f_{ck}\, bx$

$0.87 (500)(1886) = 0.454 (25)(200) x$

$x = 361.41$ mm

$F_{cc} = 0.454 (25)(200)(361.41)$

$= 820.4$ kN

$F_{st} = 820.41$ kN

$$\frac{\varepsilon_{st}}{390 - x} = \frac{0.0035}{x}$$

$\varepsilon_{st} = 0.00028$ ∴ over reinforced

support B

Tension = compression

$F_{st} = F_{sc} + F_{cc}$

$0.87 (500)(628) = 0.454 (25)(200) x$

$x = 120.34$ mm

$F_{st} = 273.18$ kN

$F_{cc} = 273.17$ kN

$$\frac{\varepsilon_{st}}{390 - x} = \frac{0.0035}{x}$$

$\varepsilon_{st} = 0.0078$

∴ underreinforced

$M_{AB} = f_{st} \, (d - 0.4x)$

$= 0.87(500)(1886)(390 - 0.4 \times 361.41)$

$= 201.36 \text{ kNm}$

$$\frac{22.5w}{32} = 201.36 \text{ kNm}$$

$w = 28.64 \text{ kN/m}$

$M_B = 0.87(500)(628)(390 - 0.4 \times 120.34)$

93.39 kNm

$2w = 93.39 \text{ kNm}$

$w = 46.70 \text{ kN/m}$

Allowable uniformly distributed load, $w = 28.64 \text{ kN/m}$