



**higher education  
& training**

Department:  
Higher Education and Training  
**REPUBLIC OF SOUTH AFRICA**

# **MARKING GUIDELINE**

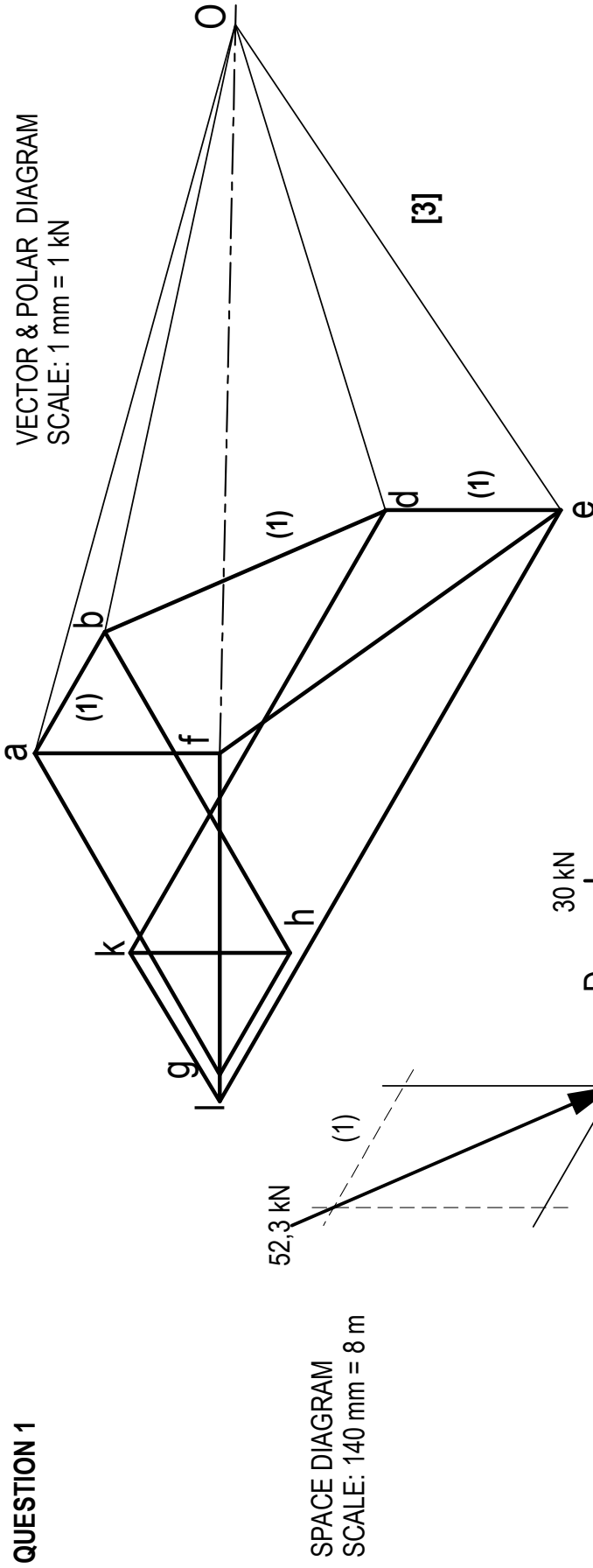
**NATIONAL CERTIFICATE**

**BUILDING AND STRUCTURAL CONSTRUCTION N5**

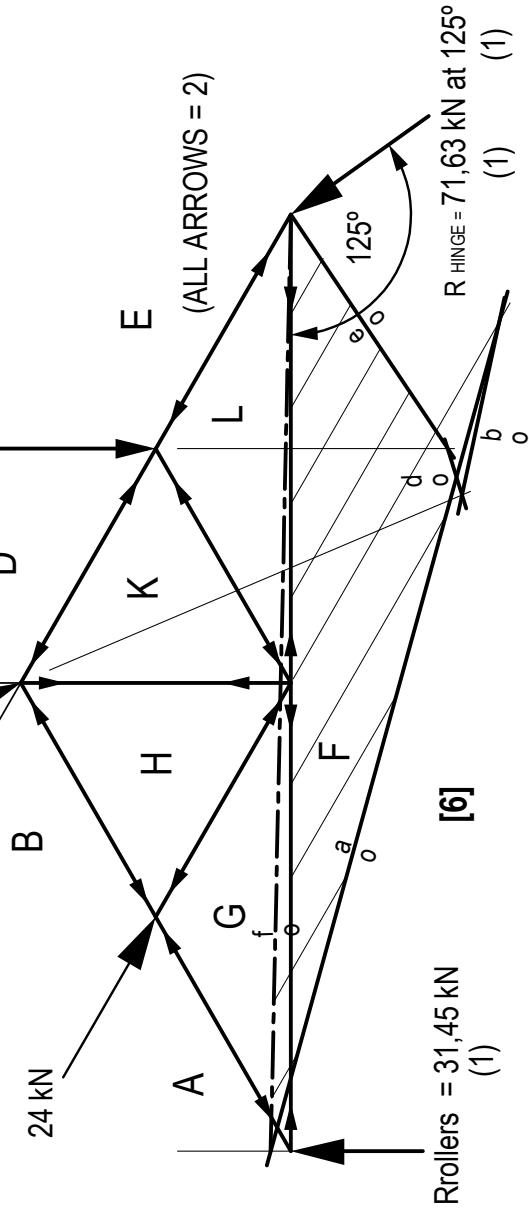
**17 August 2023**

**This marking guideline consists of 10 pages.**

QUESTION 1



| Member | Type  | Magnitude |     |
|--------|-------|-----------|-----|
| AG     | Strut | 63 kN     | (1) |
| BH     | Strut | 63 kN     | (1) |
| DK     | Strut | 87 kN     | (1) |
| EL     | Strut | 117 kN    | (1) |
| LK     | Strut | 29.5 kN   | (1) |
| KH     | Tie   | 27.5 kN   | (1) |
| GH     | Strut | 24 kN     | (1) |
| GF     | Tie   | 55 kN     | (1) |
| LF     | Tie   | 59 kN     | (1) |
|        |       | [9]       | [9] |



[9] + [3] + [6] = 18 Marks

**QUESTION 2****2.1 The load at 'A'**Force = stress  $\times$  area

$$= 220 \times 4 \times 12 \times 8 \checkmark$$

Force = 84,48 kN  $\checkmark$  (force and unit)**The load at 'B'**Force = stress  $\times$  area

$$= 220 \times 2 \times 16 \times 8 \checkmark$$

Force = 56,32 kN  $\checkmark$  (force and unit)Therefore, the safest load between the two is 56,32 kN.  $\checkmark$ 

(5)

**2.2 The shear stress at the safest side (B)**

$$\text{Shear stress} = \frac{\text{load}}{\text{area}}$$

$$= \frac{56,32 \times 10^3 \times 4}{\pi \times 16^2 \times 2} \checkmark$$

$$\text{Shear stress} = \frac{225280}{1608,5}$$

Shear stress = 140 MPa  $\checkmark \checkmark$  (force and unit)

(3)

**2.3 The tearing stress at the safest side (B)**

$$\text{Tearing stress} = \frac{\text{load}}{\text{area}}$$

$$= \frac{\text{load}}{(B \times T) - n(d \times t)}$$

$$\text{Tearing stress} = \frac{56,32 \times 10^3}{(75 \times 8) - 1(18 \times 8)} \checkmark$$

Tearing stress = 123,5 MPa  $\checkmark \checkmark$  (force and unit)

(3)

**[11]**

**QUESTION 3****3.1 Calculate areas:**

$$\text{Area 1: } 20 \times 20 = 400$$

$$\text{Area 2: } 50 \times 40 = 2\,000$$

$$\text{Area 3: } \frac{1}{2} 50 \times 43 = 1\,075$$

$$= 3\,475$$

**Minus**

$$\text{Area 4: } \pi \frac{20^2}{4} = -314,159$$

$$\text{Total area} = 3\,160,84 \checkmark$$

**Calculate neutral axis from A-B**

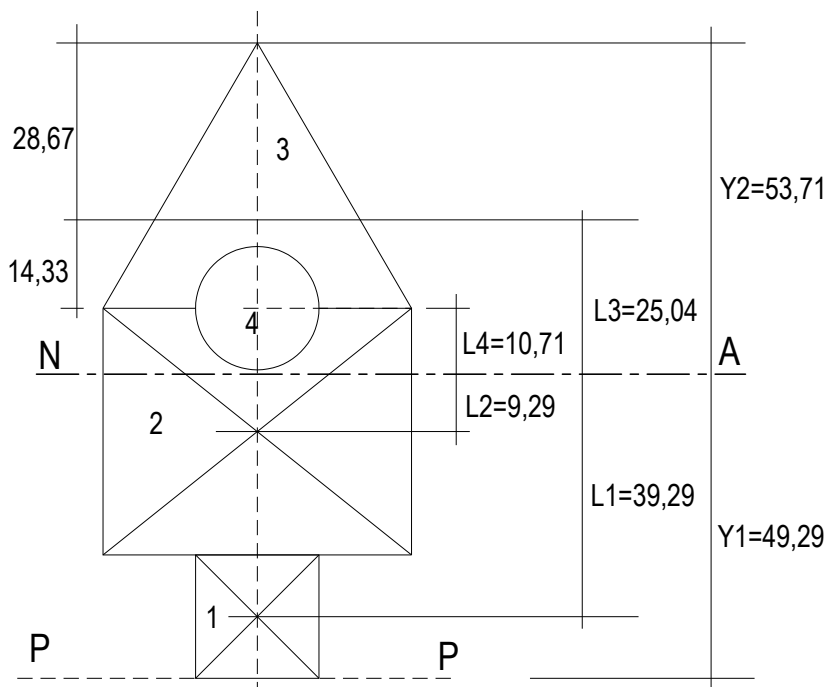
$$3\,160,84 \times Y_1 = (20 \times 20 \times 10) + (2\,000 \times 40) + (\frac{1}{2} 50 \times 43 \times 84,33) - (314,16 \times 60) \checkmark$$

$$Y_1 = \frac{4000 + 80\,000 + 904,75 - 18\,849,56}{3\,160,84} \checkmark$$

$$Y_1 = \frac{155\,805,19}{3\,160,84}$$

$$Y_1 = 49,290 \text{ mm} \checkmark$$

(4)



|    |                                                       |         |    |                            |         |
|----|-------------------------------------------------------|---------|----|----------------------------|---------|
| NA | 103 - 49,29(Y <sub>1</sub> ) = 53,71(Y <sub>2</sub> ) |         |    |                            |         |
| L1 | 49,29 - 20/2                                          | = 39,29 | L1 | 103 - 53,71 - 49,29 - 20/2 | = 32,29 |
| L2 | 49,29 - 20 - 40/2                                     | = 9,29  | L2 | 43 + 40/2 - 53,72          | = 9,29  |
| L3 | 20 + 40 + 14,33 - 49,29                               | = 25,04 | L3 | 53,71 - (2/3 × 43 = 28,67) | = 25,04 |

|    |                 |         |    |            |         |
|----|-----------------|---------|----|------------|---------|
| L4 | 20 + 40 – 49,29 | = 10,71 | L4 | 53,71 – 43 | = 10,71 |
|----|-----------------|---------|----|------------|---------|

### 3.2 Calculate second moment of area

$$I_{xx \text{ total}} = \left( \frac{bd^3}{12} + AL^2 \right) + \left( \frac{bd^3}{12} + AL^2 \right) + \left( \frac{\pi d^4}{64} + AL^2 \right) + \left( \frac{bd^3}{36} + AL^2 \right)$$

$$I_{xx 1} = \left( \frac{20 \times 20^3}{12} + 20 \times 20 \times 39,29^2 \right) = (13333,33 + 617481,64) = 630814,97 \text{ mm}^4 \checkmark \checkmark$$

$$I_{xx 2} = \left( \frac{50 \times 40^3}{12} + 50 \times 40 \times 9,29^2 \right) = (266666,67 + 172608,2) = 439274,87 \text{ mm}^4 \checkmark \checkmark$$

$$I_{xx 3} = \left( \frac{50 \times 43^3}{36} + \frac{1}{2} \times 50 \times 43 \times 25,04^2 \right) = (110426,39 + 647026,72) = 784453,11 \text{ mm}^4 \checkmark \checkmark$$

1 854 542,95

mm<sup>4</sup>

Minus

$$I_{xx 4} = \left( \frac{\pi \times 20^4}{64} + \frac{\pi 20^2}{4} \times 10,71^2 \right) = (7853,982 + 36035,36) = -43889,34 \text{ mm}^4 \checkmark \checkmark$$

$$I_{yy \text{ TOTAL}} = \underline{1\,810\,653,61 \text{ mm}^4}$$

✓

(9)

### 3.3 Calculate the profile modulus about the x-x axis

$$Z = \frac{I}{Y}$$

$$Z = \frac{1810653,61 \text{ mm}^4}{49,29 \text{ mm}} \checkmark$$

$$Z = 36734,71 \text{ mm}^3 \quad 36,73 \times 10^{-6} \text{ m}^3 \checkmark \quad (2)$$

### 3.4 A suitable I-section taper flange to replace the given section

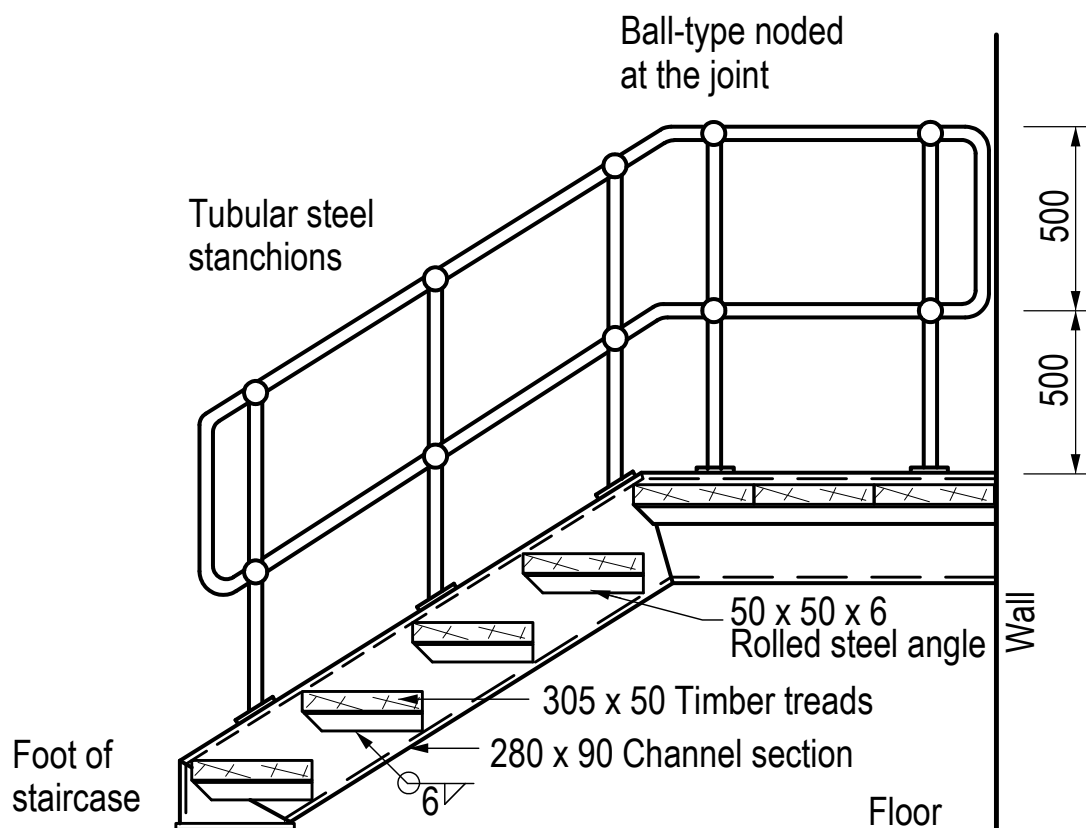
$$Z_e = 36,73 \times 10^{-6} \text{ m}^3$$

$$102 \times 64 \times 9,65 \text{ kg/m I-section taper flange } \checkmark$$

(1)  
[16]

**QUESTION 4**

4.1



| QUESTION 4      |   |    |   |
|-----------------|---|----|---|
| MARK ALLOCATION |   |    |   |
| CORRECTNESS:    |   | 10 |   |
| Rise corr       | 1 |    |   |
| Treads corr     | 1 |    |   |
| Treads overlap  | 2 |    |   |
| Channels        | 2 |    |   |
| Angle cleats    | 2 |    |   |
| Landing         | 2 |    |   |
|                 |   |    |   |
| Accuracy        |   |    | 2 |
| Labels & Dims   |   |    | 2 |
| Weld symbols    |   |    | 1 |
| Total           |   | 15 |   |

(15)

- 4.2      4.2.1      Waist  
             4.2.2      Stairwell  
             4.2.3      Flight  
             4.2.4      Tread  
             4.2.5      Rise

(5 × 1)      (5)  
**[20]**

**QUESTION 5**

5.1      Calculate moments about RL:

$$(RR \times 10) + (50 \times 2) = (20 \times 3) + (15 \times 7 \times 6,5) + (10 \times 7) \checkmark$$

$$RR = \frac{(-100+60+680,5+70)}{10}$$

$$RR = 71,25 \text{ kN} \checkmark$$

(2)

Calculate moments about RR:

$$(RL \times 10) = (50 \times 12) + (20 \times 7) + (15 \times 7 \times 3,5) + (10 \times 3) \checkmark$$

$$(600+140+367,5+30)$$

$$RL = \frac{1107,5}{10} \checkmark$$

(2)

$$RL = 113,75 \text{ kN} \checkmark$$

5.2      SF A: -50 kN

- 50 kN

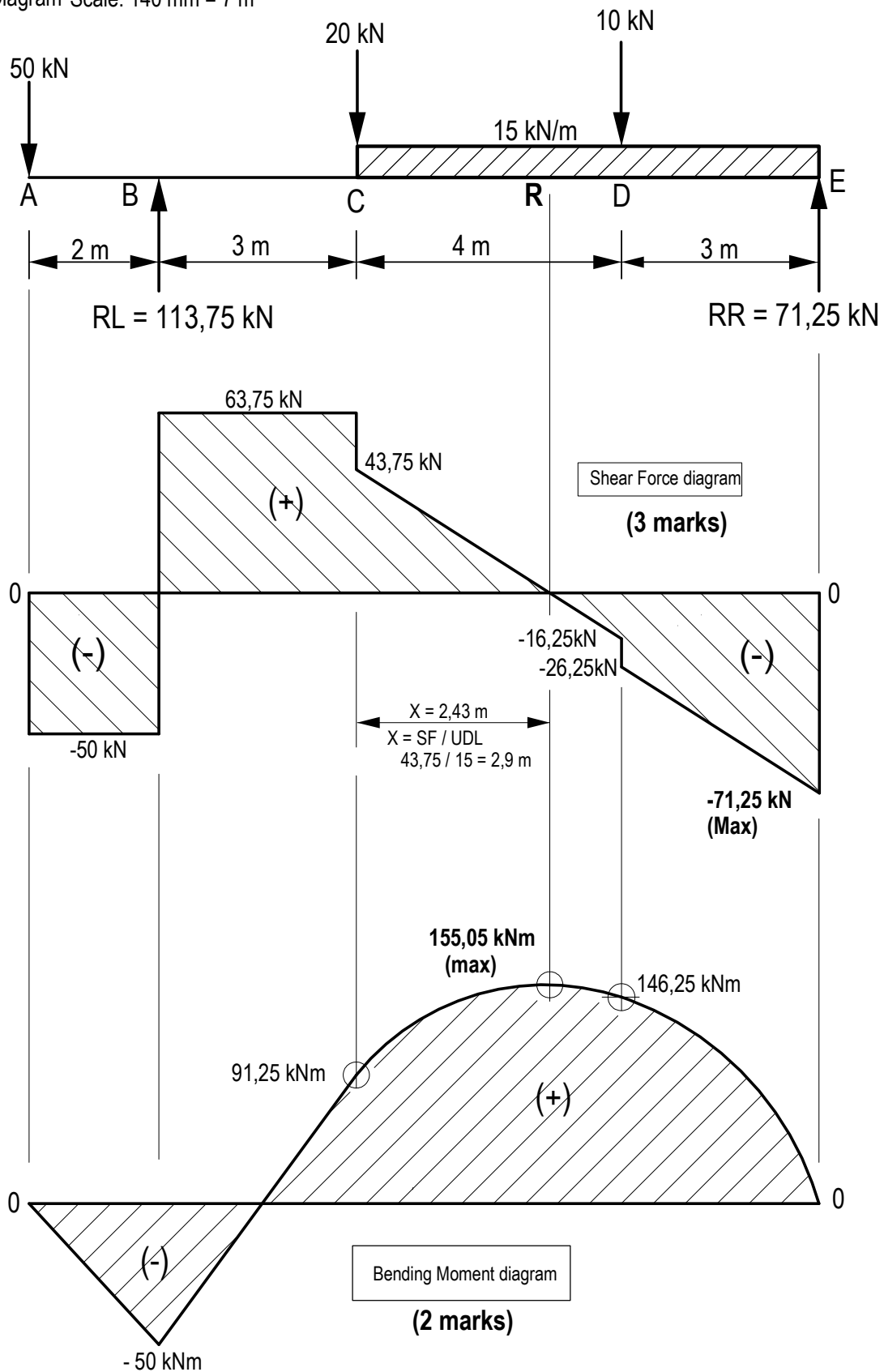
## BUILDING AND STRUCTURAL CONSTRUCTION N5

|       |                                          |                  |     |
|-------|------------------------------------------|------------------|-----|
| SF B: | $-50 + 113,75$ (max)                     | 63,75 kN (max) ✓ |     |
| SF C: | $-50 + 113,75 - 20$                      | 43,57 kN         |     |
| SF C: | $-50 + 113,75 - 20 - (15 \times 4)$      | - 16,25 kN ✓     |     |
| SF D: | $-50 + 113,75 - 20 - (15 \times 4) - 10$ | - 26,25 kN ✓     | (3) |
| SF E: | $-50 + 113,75 - 20 - (15 \times 4) - 10$ |                  |     |
|       | (Mark any 2 correct answers)             |                  |     |
|       | (Shear force max = 1 mark)               |                  |     |

(3 marks for correct shear force diagram) (3)

|     |                                                                                     |                   |     |
|-----|-------------------------------------------------------------------------------------|-------------------|-----|
| 5.3 | BM B: $-(50 \times 2) =$                                                            | -100 kNm✓         |     |
|     | BM C: $-(50 \times 5) + (113,75 \times 3) =$                                        | -91,25 kNm✓       |     |
|     | BM D: $-(50 \times 9) + (113,75 \times 7) - (20 \times 4) + (15 \times 4 \times 2)$ | 146,25 kNm✓       |     |
|     | <b>BM R: <math>(113,75 \times 5,9) - (50 \times 7,9) - (20 \times 2,9)</math></b>   | 155,05 kNm (max)✓ | (4) |
|     |                                                                                     |                   | (2) |
|     | (2 marks for correct bending moment diagram)                                        |                   |     |

Space Diagram Scale: 140 mm = 7 m



5.4 
$$Z_e = \frac{BM \max}{\text{stress}} = \frac{155,05 \times 10^6}{180} = 861\,388,89 \text{ mm}^3 \checkmark$$

$$Z_e = 861,4 \times 10^{-6} \text{ m}^3 \checkmark$$

Select: 305 x 152 x 65,5 kg/m I-section taper flange ( $Z_e = 864,0 \times 10^{-6}$ )  $\checkmark$

(3)

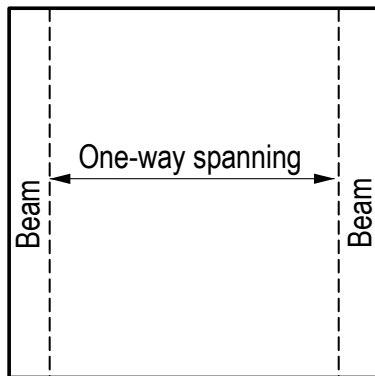
Shear stress = 
$$\frac{SF \max}{D \times t} = \frac{63,75 \times 10^3}{305 \times 10,2} = 20,492 \text{ MPa} \checkmark$$

$$Z_e = 20,492 < 100 \text{ MPa} \checkmark$$

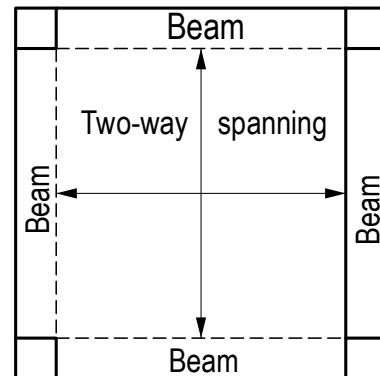
(2)

**[21]****QUESTION 6**

6.1 6.1.1



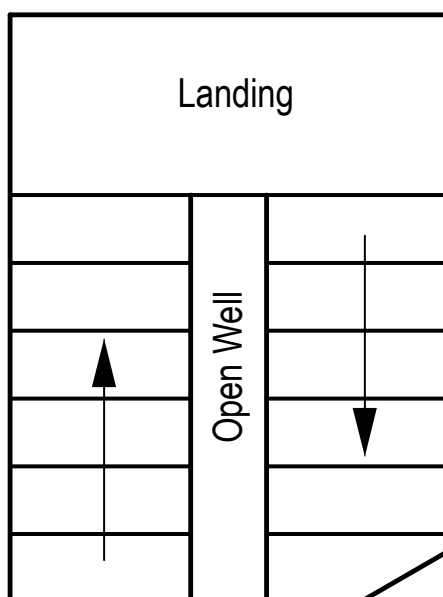
6.1.2



| Question 6.1        |   |
|---------------------|---|
| Beams layout corr   | 1 |
| Spanning directions | 1 |
| Total 2x2 =4        | 2 |

(4)

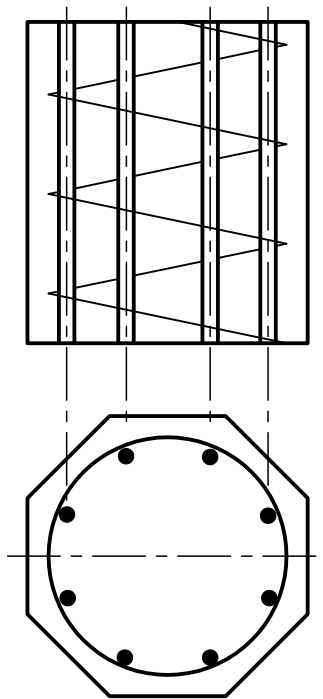
6.2



| Question 6.2         |   |
|----------------------|---|
| Half turn stair corr | 1 |
| Open well corr       | 1 |
| Total                | 2 |

(2)

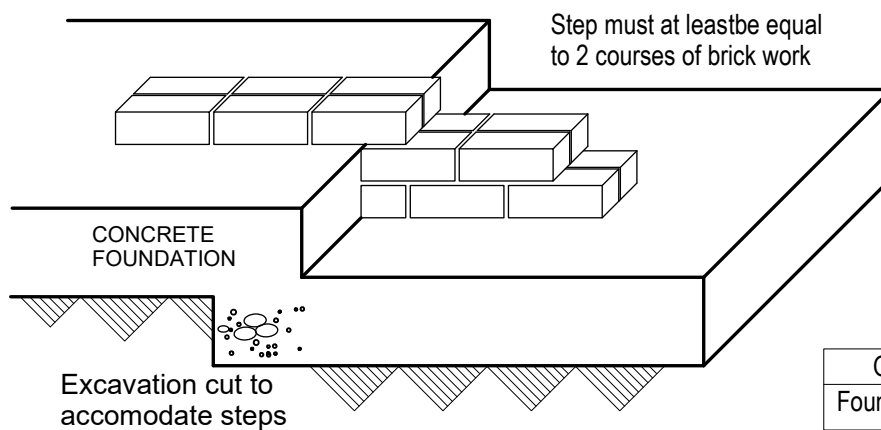
6.3



| Question 6.3        |   |
|---------------------|---|
| Octagon corr        | 1 |
| Side sizes corr     | 1 |
| Main steel corr     | 2 |
| Helical binder corr | 2 |
| Total               | 6 |

(6)

6.4



| Question 6.4     |   |
|------------------|---|
| Foundation corr. | 2 |

(2)

[14]

**TOTAL: 100**