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

T150(E)(A2)T

**NATIONAL CERTIFICATE**

**BUILDING AND STRUCTURAL CONSTRUCTION N6**

(8060026)

**2 April 2019 (X-Paper)  
09:00–13:00**

**OPEN-BOOK EXAMINATION**

**REQUIREMENTS: Hot-rolled structural steel sections (red book) (BOE8/6)**

**Calculators, personal notes and textbooks may be used.**

**This question paper consists of 6 pages and 3 schedules.**

**DEPARTMENT OF HIGHER EDUCATION AND TRAINING**  
**REPUBLIC OF SOUTH AFRICA**  
NATIONAL CERTIFICATE  
BUILDING AND STRUCTURAL CONSTRUCTION N6  
TIME: 4 HOURS  
MARKS: 100

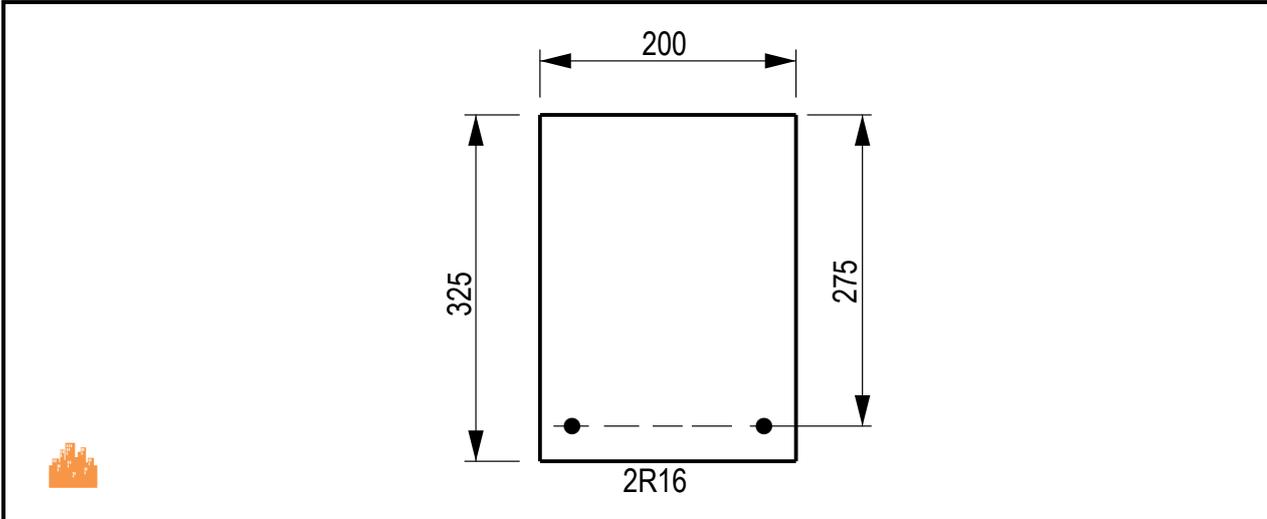
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**INSTRUCTIONS AND INFORMATION**

1. Answer ALL the questions.
  2. Read ALL the questions carefully.
  3. Number the answers according to the numbering system used in this question paper.
  4. Start each question on a NEW page.
  5. Draw a line across the page at the end of each answer.
  6. ALL calculations must conform to the relevant SABS/SANS Codes of Practice.
  7. Indicate ALL relevant code/clause references.
  8. Complement answers with neat sketches.
  9. Use the attached SCHEDULES A, B and C to assist with answers.
  10. Write neatly and legibly.
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**QUESTION 1**

FIGURE 1 shows a simply supported reinforced concrete beam where the span is limited to 4,50 metres.



**FIGURE 1**

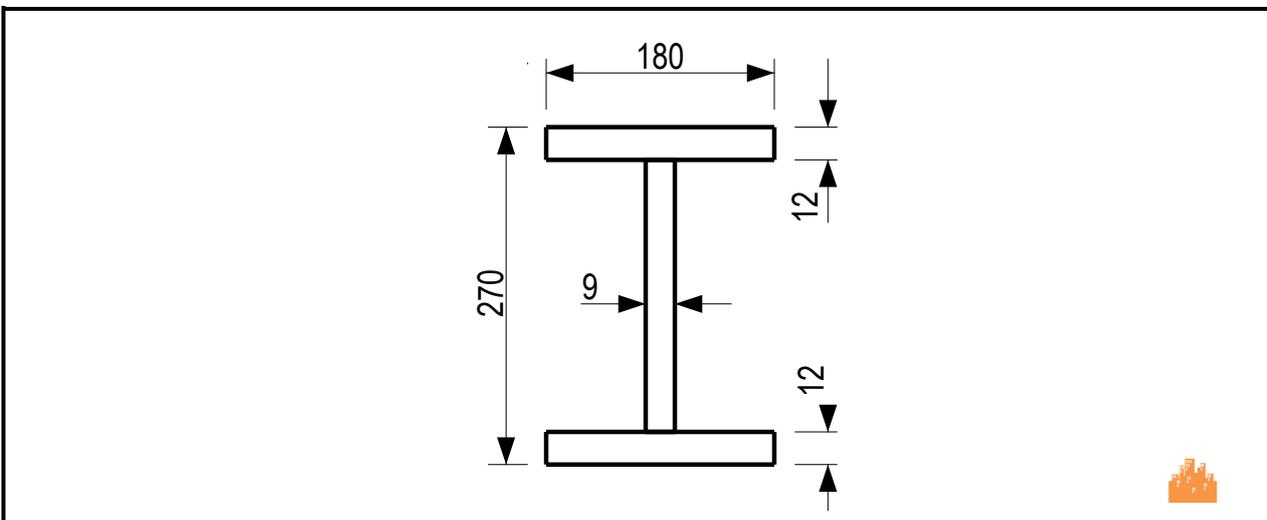
Calculate the maximum distributed load per metre run if the density of the concrete is 2 400 kg/m<sup>3</sup>. The beam is reinforced with a mild-steel reinforcement and cast with 20 MPa concrete. Consider the self-weight of the reinforced concrete beam in the calculations.



[15]

**QUESTION 2**

FIGURE 2 shows a horizontal sectional view of THREE plates, built-up to form a steel column. The effective height of the column will be 4,65 metres.



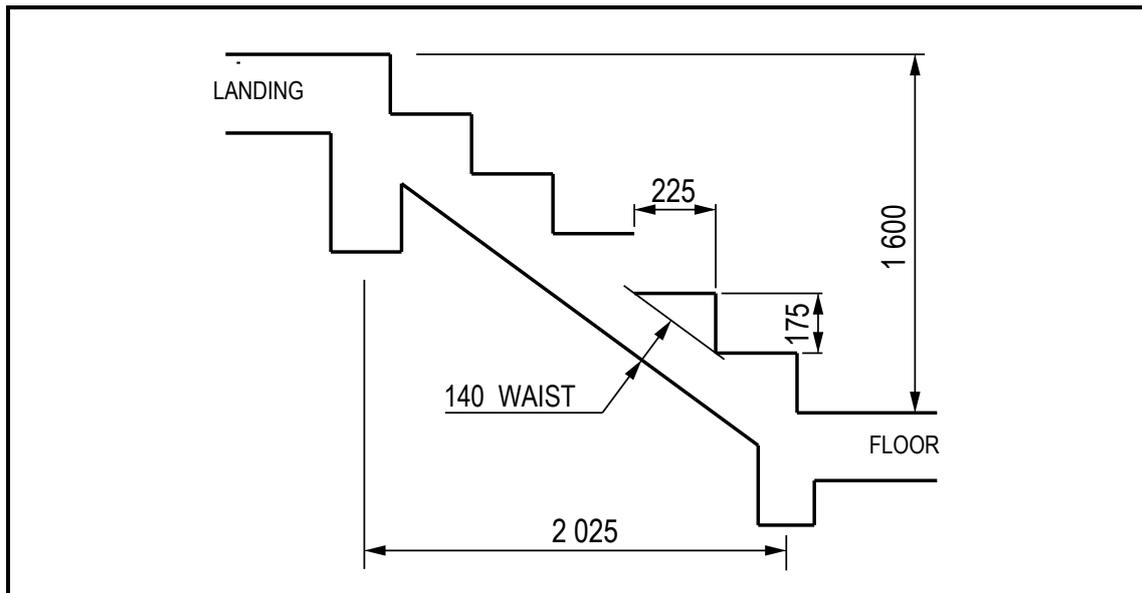
**FIGURE 2**

Calculate:

- 2.1 The cross-sectional area of the steel section (2)
- 2.2 The second moment of area about the x-x axis (4)
- 2.3 The second moment of area about the y-y axis (3)
- 2.4 The minimum second moment of area (1)
- 2.5 The minimum radius of gyration (2)
- 2.6 The slenderness ratio  (2)
- 2.7 The maximum axial load the column can support (1)
- [15]**

### QUESTION 3

FIGURE 3 shows a vertical section through a simply supported, reinforced concrete staircase. The staircase is 1,35 metres wide and supported at both ends. The staircase must be able to withstand an imposed load of 4,5 kN/m<sup>2</sup> and will be cast monolithically. The density of the concrete is 2 425 kg/m<sup>3</sup>. Use grade 20 concrete with mild-steel reinforcement. Indicate ALL relevant code references.



**FIGURE 3**

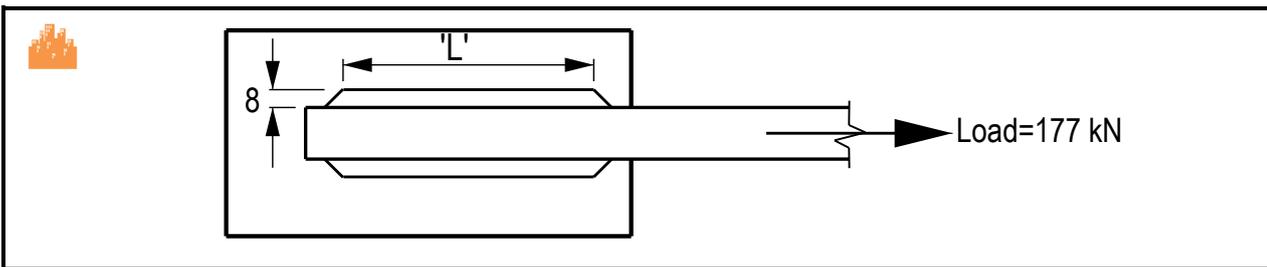
Calculate:

- 3.1 The total design dead and imposed loads (8)
- 3.2 The maximum bending moment  (3)

- 3.3 The value of the constant K (3)
  - 3.4 The distance of the lever arm (3)
  - 3.5 The size and spacing of suitable tension reinforcement (3)
  - 3.6 The size and spacing of suitable secondary reinforcement (3)
- [23]**

**QUESTION 4**

FIGURE 4 shows a fillet welding joint with a leg size of 8 mm. The maximum stress of the weld is 130 MPa.



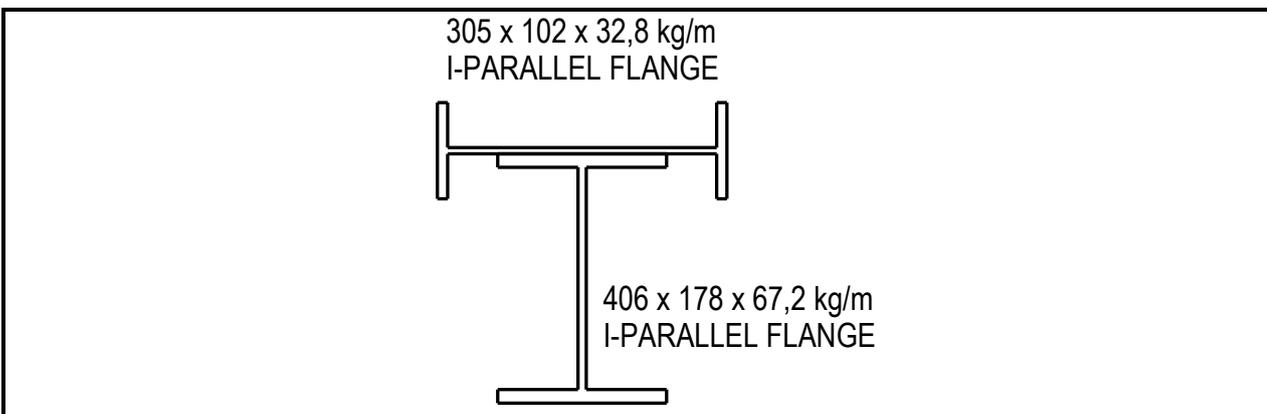
**FIGURE 4**

Calculate the minimum length of the fillet welding joint.

**[6]**

**QUESTION 5**

FIGURE 5 shows a simply supported compound beam consisting of a 406 x 178 x 67,2 kg/m I-section parallel-flange steel beam supporting a 305 x 102 x 32,8 kg/m I-section parallel-flange steel beam. The steel beam has a span of 12 metres.



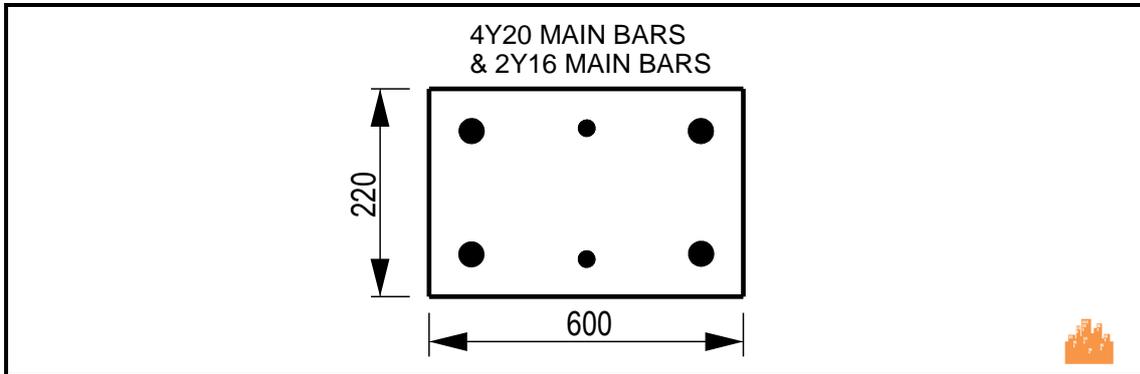
**FIGURE 5**

Include the self-weight of the beam and calculate the maximum point load the beam will carry at mid-span. Use a bending stress of 162 MPa.

**[20]**

**QUESTION 6**

6.1 FIGURE 6 shows a rectangular reinforced concrete column. The column is reinforced with 4Y20 and 2Y16 main bars. The characteristic strength of the concrete is limited to 30 MPa. Use a safe bearing upward soil pressure of 220 kN/m<sup>2</sup>.



**FIGURE 6**

Calculate:

- 6.1.1 The nett area of the concrete (4)
  - 6.1.2 The axial load the column can withstand (4)
  - 6.1.3 The required diameter and spacing of the binders (2)
- 6.2 Calculate the minimum area of a square isolated pad foundation for the RC column mentioned in QUESTION 6.1. Use a safe bearing upward soil pressure of 220 kN/m<sup>2</sup>.

The column must also resist the following loads:

Imposed load:	600 kN	
Mass of foundation concrete:	85 kN	(4)

**[14]**

**QUESTION 7**

7.1 Select TWO ferrous and TWO nonferrous metals used in the construction of steel buildings from the list below.

lead; cast iron; tin; zinc; carbon steel;  
 aluminium; structural steel; copper

(2 + 2) (4)

7.2 Name the apparatus used to perform a slump test for fresh concrete. (3)

**[7]**

**TOTAL: 100**

## SCHEDULE A

CROSS-SECTIONAL AREA OF REINFORCEMENT RODS FOR BEAMS AND COLUMNS											
Number of rods	Rod diameter (mm)										
	Ø6	Ø8	Ø10	Ø12	Ø16	Ø20	Ø25	Ø32	Ø40	Ø50	
1	28,3	50,3	78,5	113,1	201,1	314,2	490,9	804,2	1 256,6	1 963,5	
2	57	101	157	226	402	628	982	1 608	2 513	3 927	
3	85	151	236	339	603	943	1 473	2 413	3 770	5 891	
4	113	201	314	452	804	1 257	1 964	3 217	5 026	7 854	
5	141	251	393	566	1 006	1 571	2 455	4 021	6 283	9 818	
6	170	302	471	679	1 207	1 885	2 945	4 825	7 540	11 781	
7	198	352	550	792	1 408	2 199	3 436	5 629	8 796	13 745	
8	226	402	628	905	1 609	2 514	3 927	6 434	10 053	15 708	
9	255	453	707	1 018	1 810	2 828	4 418	7 238	11 309	17 672	
10	283	503	785	1 131	2 011	3 142	4 909	8 042	12 566	19 635	
11	311	553	864	1 244	2 212	3 456	5 400	8 846	13 823	21 599	
12	339	603	942	1 357	2 413	3 770	5 891	9 650	15 079	23 562	
	Typical secondary reinforcement			Typical main reinforcement							

**SCHEDULE B**

<b>CROSS-SECTIONAL AREA OF REINFORCEMENT RODS PER METRE WIDTH FOR SLABS AND STAIRCASES</b>										
<b>Spacing of rods centre to centre</b>	<b>Rod diameter (mm)</b>									
	<b>Ø6</b>	<b>Ø8</b>	<b>Ø10</b>	<b>Ø12</b>	<b>Ø16</b>	<b>Ø20</b>	<b>Ø25</b>	<b>Ø32</b>	<b>Ø40</b>	<b>Ø50</b>
50	566	1 005	1 571	2 262	4 021	6 283	9 817	16 085	25 133	39 270
75	377	670	1 048	1 508	2 681	4 189	6 545	10 723	16 755	26 180
100	283	503	785	1 131	2 011	3 142	4 909	8 042	12 566	19 635
125	226	402	628	905	1 608	2 513	3 927	6 434	10 053	15 708
150	188	335	524	754	1 340	2 094	3 272	5 362	8 378	13 090
175	162	387	449	646	1 149	1 795	2 805	4 596	7 181	11 220
200	141	251	393	565	1 005	1 571	2 454	4 021	6 283	9 817
250	113	201	314	452	804	1 257	1 963	3 217	5 027	7 854
300	94	168	262	377	670	1 047	1 636	2 681	4 189	6 545
350	81	144	224	323	574	898	1 402	2 298	3 590	5 610
400	71	125	196	283	503	786	1 227	2 011	3 142	4 909
500	57	101	157	226	402	620	982	1 608	2 513	3 927
	<b>Typical secondary reinforcement</b>				<b>Typical main reinforcement</b>					

## SCHEDULE C

ISOMETRIC BLACK HEXAGON BOLTS AND NUTS									
Normal size and thread diameter	DIMENSION IN MILLIMETRE							Tensile stress area in mm <sup>2</sup>	Minimum distance between centres
	Pitch of thread coarse pitch series	Maximum width of head and nut		Maximum height of head		Maximum thickness of nut			
		Across flats	Across corners	Black	Face on underside	Black	Face one side		
M 6	1	10,00	11,5	4,375	4,25	5,375	5	20,1	15
M 8	1,25	13,00	15,0	5,875	5,74	6,875	6,5	36,6	20
M 10	1,5	17,00	19,6	7,45	7,29	8,45	8,	58,0	25
M 12	1,75	19,00	21,9	8,45	8,29	10,45	10	84,3	30
M 16	2	24,00	27,7	10,45	10,29	13,45	13	157	40
M 20	2,5	30,00	34,6	13,90	13,35	16,55	16	245	50
M 22	2,5	32,00	36,9	14,90	14,35	18,55	18	303	55
M 24	3	35,00	41,6	15,90	15,35	19,65	19	353	60
M 27	3	41,00	47,3	17,90	17,35	22,65	22	459	67,5
M 30	3,5	46,00	53,1	20,05	19,42	24,65	24	561	75
M 33	3,5	50,00	57,7	22,05	21,42	26,65	26	694	82,5
M 36	4	55,00	63,5	25,05	23,42	29,65	29	817	90
M 39	4	60,00	69,3	26,05	25,42	31,80	31	976	97,5
M 42	4,5	65,00	75,1	27,05	26,42	34,80	34	1 120	105
M 45	4,5	70,00	80,8	29,05	28,42	36,80	36	1 300	112,5
M 48	5,0	75,00	86,6	31,05	30,42	38,80	38	1 470	120
M 52	5,0	80,00	92,4	34,25	33,42	42,80	42	1 760	130
M 56	5,5	85,00	98,1	36,25	35,50	45,80	45	2 030	140