higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

BUILDING AND STRUCTURAL CONSTRUCTION N6

(8060026)

29 July 2021 (X-paper)
09:00–13:00

OPEN-BOOK EXAMINATION

REQUIREMENTS: Hot-rolled structural steel sections (BOE 8/6) (Red Book)

Candidates may use drawing instruments, nonprogrammable calculators, their personal notes and textbooks.

This question paper consists of 5 pages, a diagram sheet of 2 pages and 3 schedules.

080Q1G2129

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
BUILDING AND STRUCTURAL CONSTRUCTION N6
TIME: 4 HOURS
MARKS: 100

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 the relevant code/clause references.
8. Complement your answers with neat sketches.
9. Use the attached SCHEDULES A, B and C to assist with your answers.
10. Work neatly.

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QUESTION 1

FIGURE 1 on the DIAGRAM SHEET (attached) shows a compound steel beam required to lift goods from a truck and into a building. The steel beam consists of a channel section welded to the bottom of a structural steel section.

Calculate the following:

1.1 The second moment of area (10)

1.2 The maximum bending moment (2)

1.3 The maximum load that the beam can support at 'W'. Use a bending stress of 170 MPa. (4)

The density of structural steel is 7 855 kg/m^3. Include the self-weight of the beam. **[16]**

QUESTION 2

FIGURE 2 on the DIAGRAM SHEET (attached) shows the load diagram and sectional view of a simply supported reinforced concrete beam.

Calculate the required tension reinforcement using the following specifications:

Width of beam:	295 mm
Span:	6,78 m
Density of concrete:	2 400 kg/m^3
Characteristic strength for concrete:	20 MPa
Characteristic strength for steel:	450 MPa

Check whether the minimum and maximum reinforcement requirements are within the parameters of Table 23 (SANS 10 100(2 000) Part 1. **[20]**

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QUESTION 3

Calculate suitable tension and secondary reinforcement for the reinforced concrete staircase shown in FIGURE 3 on the DIAGRAM SHEET (attached).The staircase is supported at both ends and subjected to a 10,5-kN/m^2 imposed load. The width of the stairway is 1,35 m.

The stairway will be monolithically cast using Grade 25 concrete with mild steel reinforcement. The density of the concrete is 2 425 kg/m^3.

Calculate the following:

3.1 The total design dead and imposed loads

3.2 The maximum bending moment

3.3 The value of the constant 'K'

3.4 The size and spacing of suitable tension reinforcement

3.5 The size and spacing of suitable secondary reinforcement

All the relevant code references must be indicated. **[20]**

QUESTION 4

4.1 A flat 162 mm wide tie bar is welded to a flat plate by means of two 10-mm end fillets. Both the end welds have 25-mm return side fillets.

Use a stress of 130 MPa to determine the capacity of the load on the joint. (6)

4.2 Calculate the number of Grade 4.6 M10 bolts required to join an angle cleat to a gusset plate. The maximum shear is 100 MPa. (4)

[10]

QUESTION 5

An 11 m long steel beam must be constructed over two steel columns to form an opening for a frameless window. FIGURE 4 on the DIAGRAM SHEET (attached) shows the required loads that the simply supported beam must support.

Do the following:

5.1 Determine the magnitude of the reactions at RR and RL.

5.2 Select a suitable I-parallel flange steel beam to support the given loads.

5.3 Do the necessary calculations to confirm whether the chosen beam is adequate to support its own weight as well as the given loads.

[15]

QUESTION 6

6.1 Explain how you would ensure adequate moisture content during the process of curing the concrete of a concrete column or wall. (2)

6.2 Name TWO methods of producing steel. (2)

[4]

QUESTION 7

FIGURE 5 on the DIAGRAM SHEET (attached) shows a simply supported, reinforced concrete T-beam over an effective span of 8,50 m. The dead load, including the self-weight and finishes, is 11,20 kN/m² with an imposed dead load of 4,35 kN/m^2. Use Grade 25 concrete with high-yield tensile steel reinforcement to calculate the following:

7.1 The lever arm (Z)

7.2 The position of the neutral axis

7.3 The total design load

7.4 The maximum moment of resistance

7.5 Suitable tension reinforcement for the T-beam

All the relevant code references must be indicated. **[15]**

TOTAL: 100

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DIAGRAM SHEET

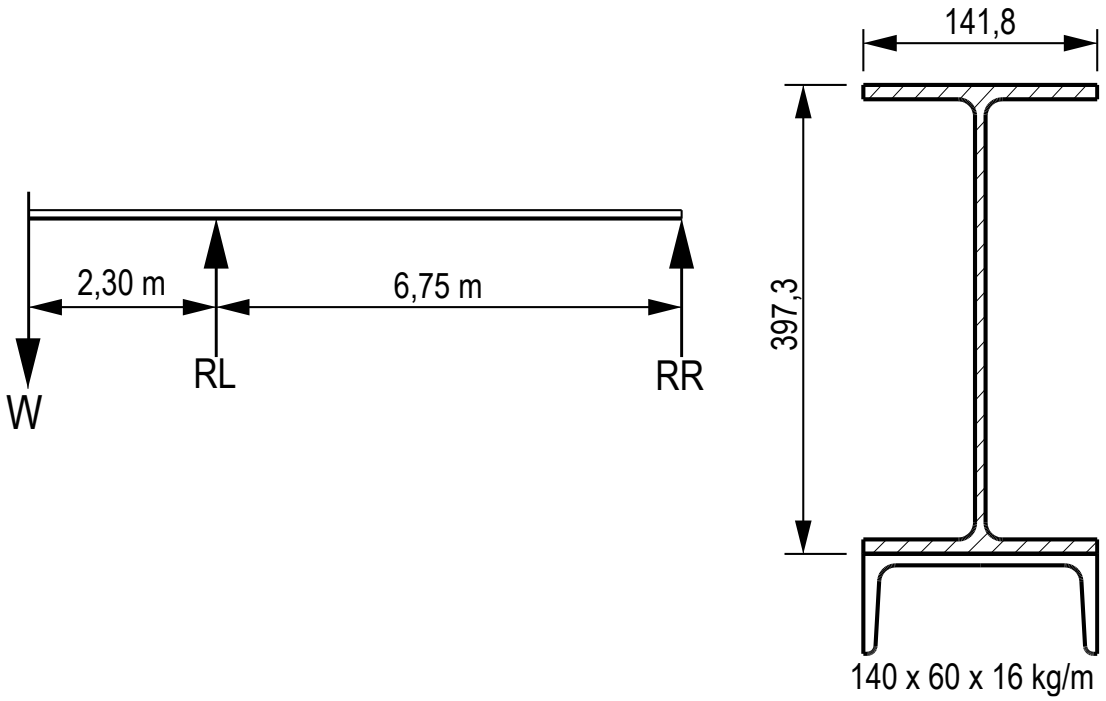

FIGURE 1

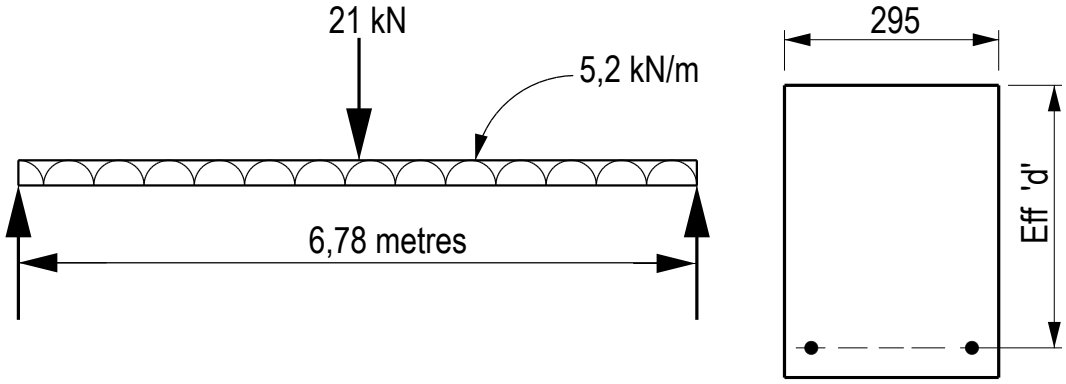

FIGURE 2

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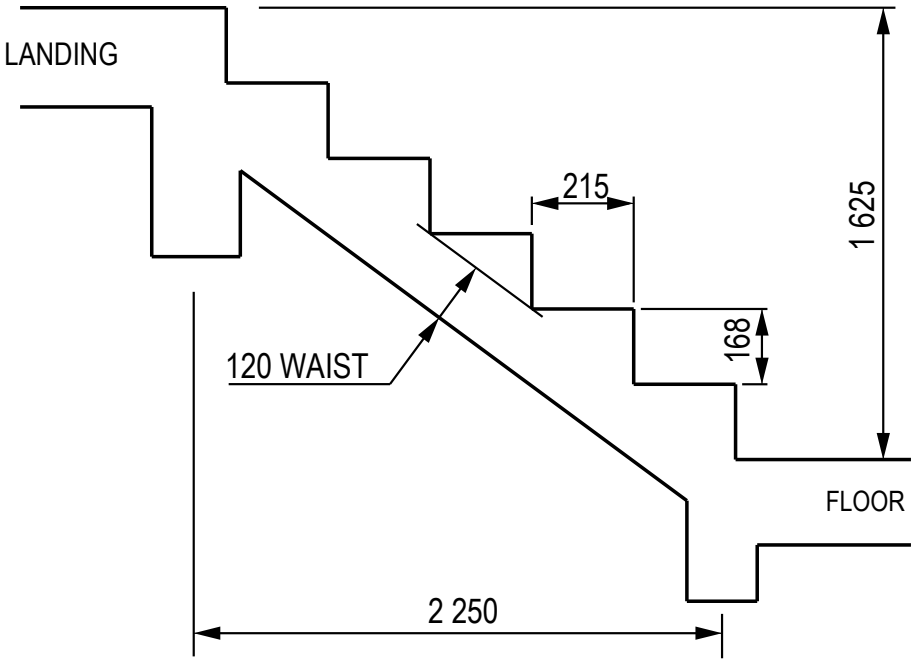

FIGURE 3

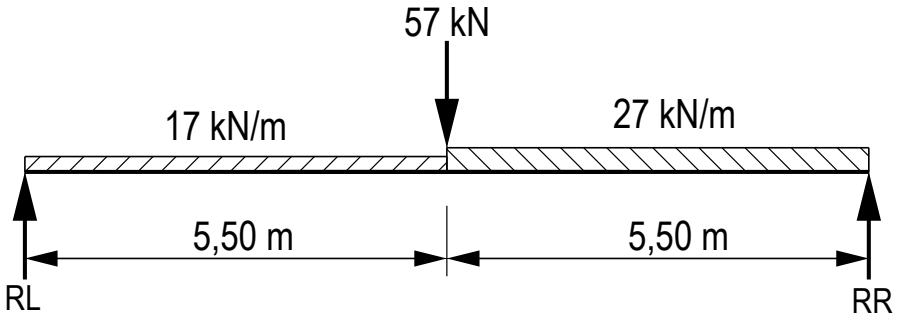

FIGURE 4

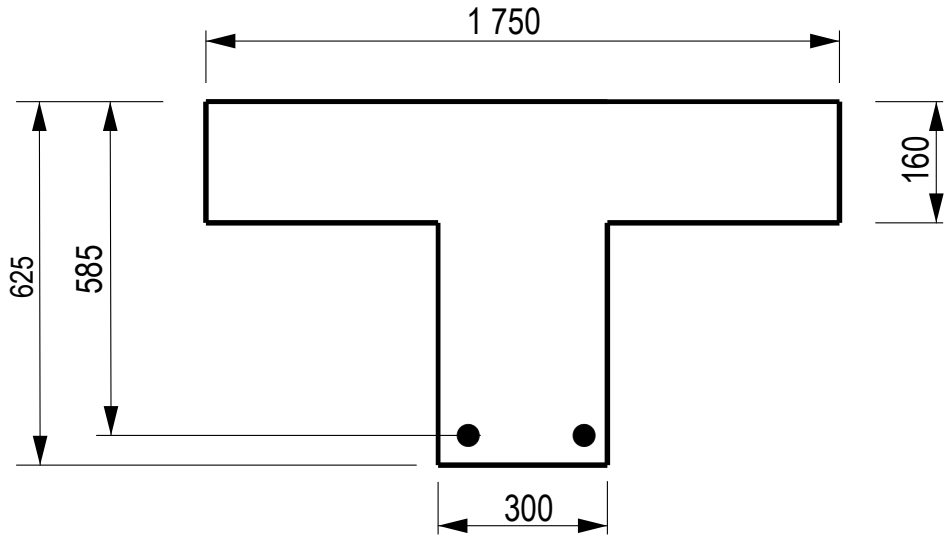

FIGURE 5

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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						

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SCHEDULE B

CROSS-SECTIONAL AREA OF REINFORCEMENT RODS PER METRE WIDTH FOR SLABS AND STAIRCASES										
Spacing of rods centre to centre	Rod diameter (mm)									
	Ø6	Ø8	Ø10	Ø12	Ø16	Ø20	Ø25	Ø32	Ø40	Ø50
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
	Typical secondary reinforcement				Typical main reinforcement					

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SCHEDULE C

ISOMETRIC BLACK HEXAGON BOLTS AND NUTS									
Normal size and thread diameter	DIMENSION IN MILLIMETRES								
	Pitch of thread coarse pitch series	Maximum width of head and nut		Maximum height of head		Maximum thickness of nut		Tensile stress area in mm²	Minimum distance between centres
		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

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