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Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

BUILDING AND STRUCTURAL CONSTRUCTION N6

(8060026)

24 November 2024 (X-paper)
09:00–13:00

OPEN-BOOK EXAMINATION

REQUIREMENTS: BOE 8/6 HOT-ROLLED Structural Steel Sections (Red Book)

Candidates may use their own notes and their textbooks. Drawing instruments and nonprogrammable calculators may be used.

This question paper consists of 6 pages, 1 diagram sheet and 3 schedules.

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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 Code of Practices.
7. Indicate all the relevant codes or 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 DIAGRAM SHEET 1 (attached) shows a compound beam consisting of ONE steel plate welded to the top flange of a 203 × 102 × 25,3 kg/m I-section taper flange steel beam. A channel section completes the sectional view of the compound.

The compound beam will span over a distance of 8,5 metres (8 500 mm) and is simply supported on two reinforced concrete columns.

Use a bending stress of 170 MPa and calculate the uniformly distributed load (UDL) that the beam will safely support.

The self-weight of the compound beam must not be included in the calculations. **[20]**

QUESTION 2

Calculate suitable tension and secondary reinforcement for the reinforced concrete staircase shown in FIGURE 2, DIAGRAM SHEET 1 (attached). The staircase is supported at both ends and subjected to an imposed load of 12,5 kN/m^2. The width of the stairway is 1,15 metres (1 150 mm).

The stairway is cast monolithically with Grade 20 concrete and mild-steel reinforcement. The density of the concrete is 2 400 kg/m^3. **[20]**

QUESTION 3

3.1 A short, axially loaded, reinforced-concrete, round column with a diameter of 425 mm has to support an ultimate load of 2 250 kN. Use Grade 30 concrete with high-yield tensile steel main bars and mild-steel helical binder.

Calculate the following:

3.1.1 The required number and diameter of the longitudinal bars.

3.1.2 The maximum and minimum percentage of the steel reinforcement.

3.1.3 The diameter and pitch of the helical binder.

(12)

3.2 Calculate the maximum lengths of the sides of a square, isolated pad foundation for the reinforced-concrete column in QUESTION 3.1 above.

The following loads must be included in the calculations:

Dead load:	950 kN
Imposed load:	Refer to QUESTION 3.1 (Round column)
Mass of foundation:	95 kN
Safe bearing pressure:	220 kN/m^2

(4)
[16]

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QUESTION 4

FIGURE 3 shows a 100 × 100 × 8 mm Grade 43 rolled-steel angle that must be secured to a 8 mm thick gusset plate by using M20 class 8,8 ordinary bolts.

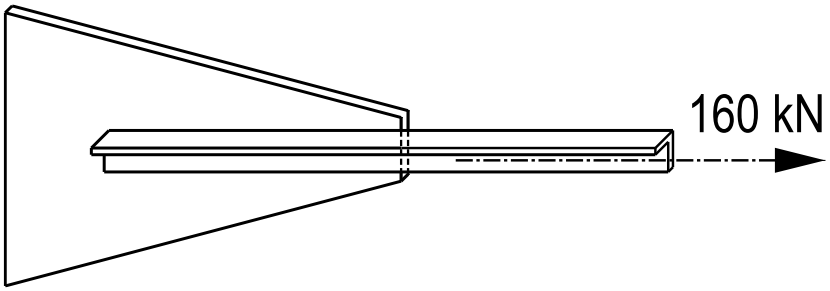


FIGURE 3

The maximum tensile force in the tie is 160 kN.

Determine if the angle will withstand the tensile force if:

4.1 The angle is welded to the gusset plate.

4.2 The angle is bolted to the gusset plate.

4.3 Calculate the number of M20 bolts required to secure the angle to the gusset plate.

[18]

QUESTION 5

A simply supported reinforced-concrete beam with a span of 6,750 metres (6 750 mm) is cast over a motor garage door.

Calculate the maximum distributed load per metre run if the density of the concrete is 2 425 kg/m³.

The beam is reinforced with Grade 250 MPa steel.

Use 25 MPa concrete.

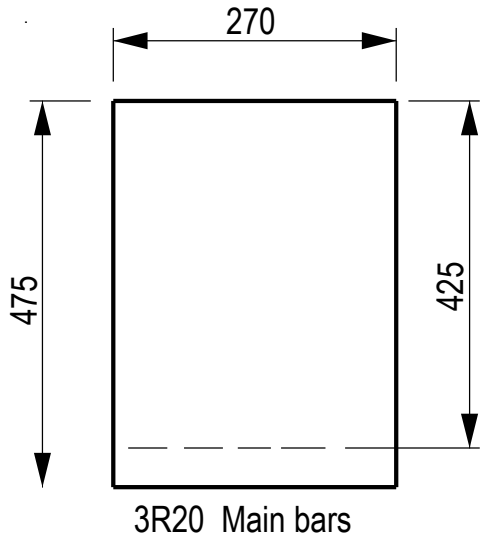


FIGURE 4

The self-weight of the beam must be included in your calculations. **[15]**

QUESTION 6

FIGURE 5 shows a 280 × 95 × 41,8 kg/m structural-steel channel that must be able to carry a 118 kN point load at mid-span.

Calculate the maximum effective span for the 280 × 95 × 41,8 kg/m structural-steel channel.

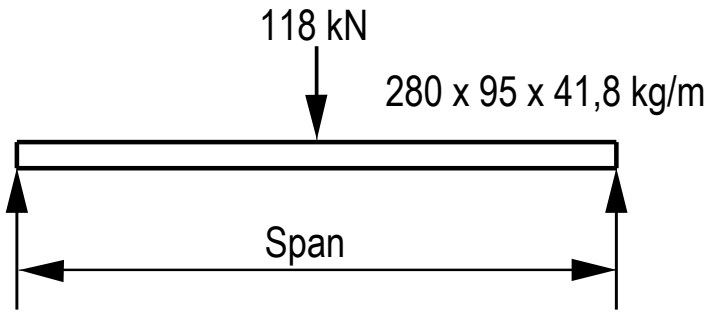


FIGURE 5

The self-weight of the beam must be included in your calculations.

Use a bending stress of 155 MPa. **[8]**

QUESTION 7

7.1 Name TWO of the main materials used to manufacture steel. (2)

7.2 Briefly explain the characteristics of the fine aggregate that is used make cement plaster, floor screed or concrete. (2)
[4]

TOTAL: 100

DIAGRAM SHEET 1

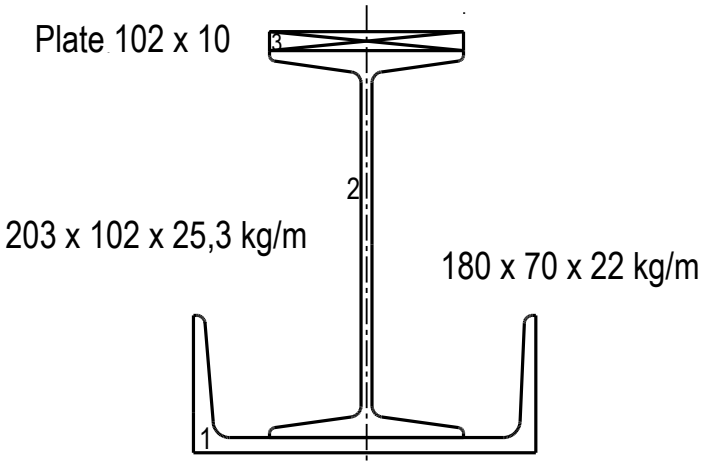


FIGURE 1

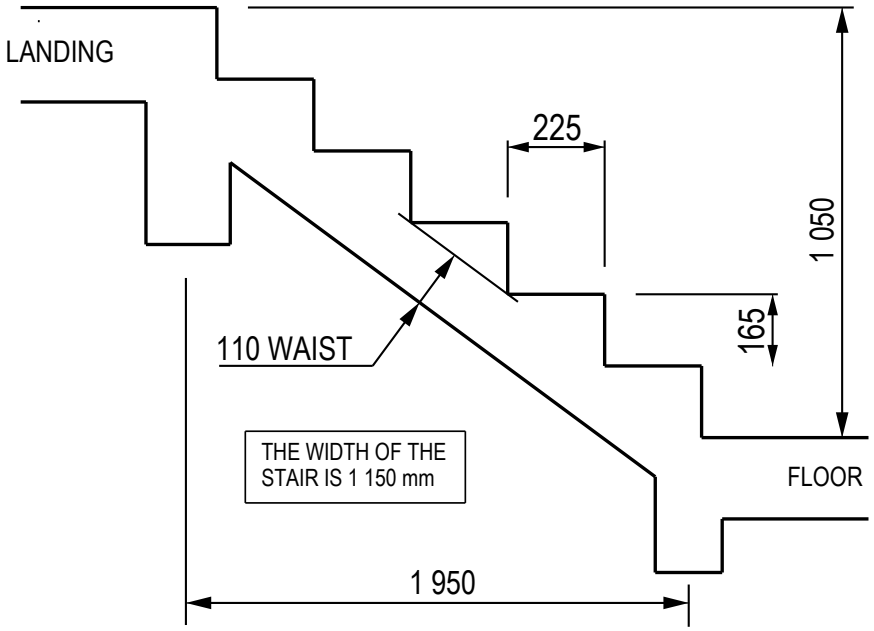


FIGURE 2

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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 MILLIMETRE								
	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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