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Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

BUILDING AND STRUCTURAL CONSTRUCTION N6

(8060026)

3 April 2020 (X-paper)
09:00–13:00

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

OPEN-BOOK EXAMINATION

Personal notes and textbooks may be used.

This question paper consists of 6 pages and 3 schedules.

074Q1A2003

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 after 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.

QUESTION 1

A simply supported reinforced concrete beam has an effective span of 5 000 mm. The width of the beam is 220 mm. The RC beam must support a 16 kN midspan point load and a 7 kN/m uniformly distributed load over the entire span.

Use the following information to determine the required reinforcement to withstand the loads:

- Grade 25 MPa concrete with mild-steel reinforcement
- Density of the concrete = 2 400 kg/m³
- Consider self-weight of the reinforced concrete beam in the calculations.
- Check if the reinforcement is within the parameters of Table 23. **[20]**

QUESTION 2

A short, axially loaded, round reinforced concrete column with a diameter of 850 mm must support an ultimate load of 8 500 kN. Use Grade 30 concrete with high-yield tensile steel main reinforcement and mild-steel binder.

Calculate:

2.1 The required number and diameter of the longitudinal bars (7)

2.2 The maximum and minimum percentage of the steel reinforcement (4)

2.3 The diameter and pitch of the helical binder (4)
[15]

QUESTION 3

3.1 Explain how concrete is cured during the initial stages of hardening. (1)

3.2 Explain the effects of the water:cement ratio in a concrete mix. (2)

3.3 Name THREE main materials used to manufacture steel. (3)
[6]

QUESTION 4

FIGURE 1 shows two steel plates supporting a 220 × 80 × 29,4 kg/m channel to form a compound tension member over two walls. The span is 5,50 m. The density of structural steel is 7 850 kg/m³. The maximum bending stress must not exceed 160 MPa.

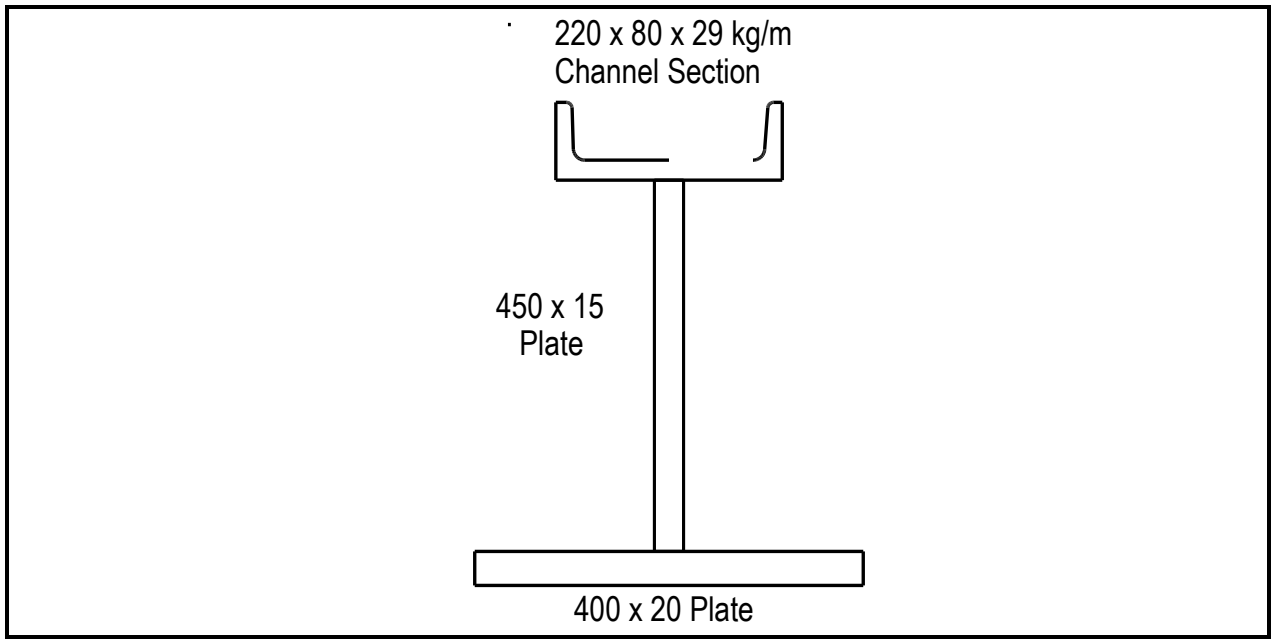

FIGURE 1

Include the self-weight of the beam and calculate:

4.1 The position of the neutral axis (7)

4.2 The second moment of area (moment of inertia) about the neutral axis (10)

4.3 The uniformly distributed load that the beam can safely support (3)

[20]

QUESTION 5

FIGURE 2 shows an extended part at the foot of a steel truss.

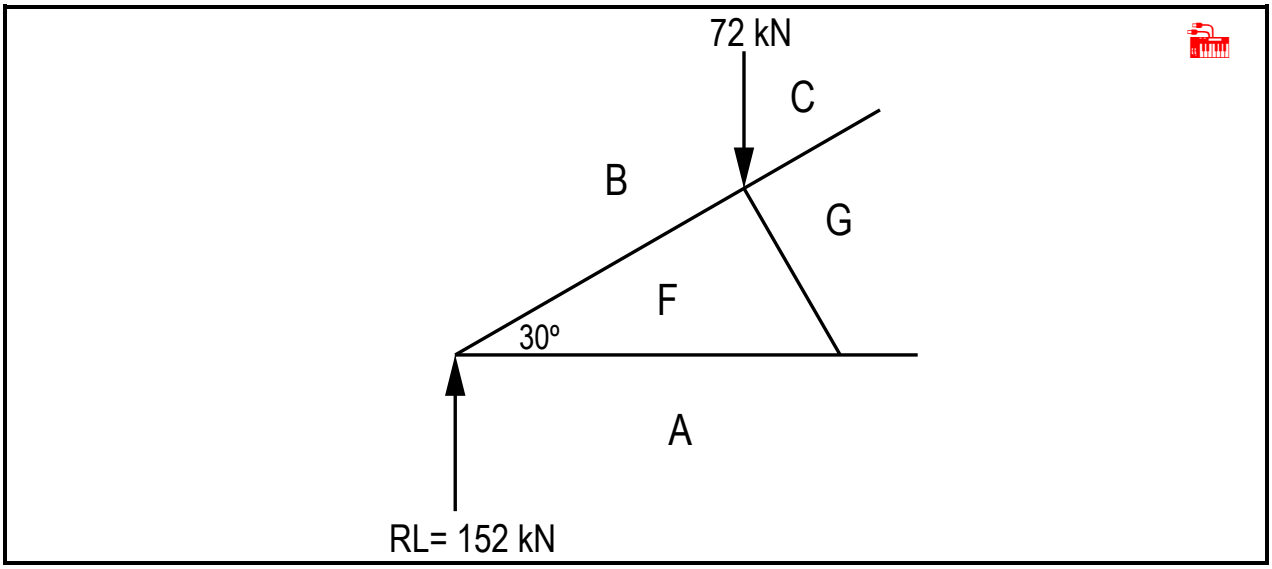

FIGURE 2

Calculate the magnitude of the following forces and distinguish between tension and compression in the parts marked:

5.1 BF and FA (9)

5.2 CG and FG (5)

[14]

QUESTION 6

FIGURE 3 shows a fully dimensioned T-beam with a span of 5,0 m.

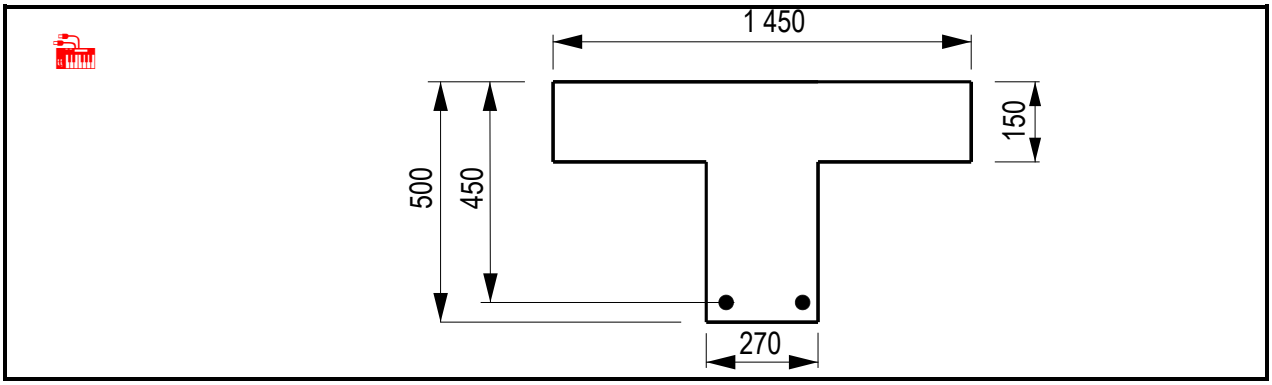

FIGURE 3

Use Grade 25 concrete with mild-steel reinforcement to calculate suitable tension reinforcement for the T-beam. The beam will support a dead load of 8,25 kN/m^2 and an imposed load of 6 kN/m^2.

Calculate:

6.1 The lever arm distance (3)

6.2 The position of the neutral axis (3)

6.3 The total design load (3)

6.4 The bending moment maximum (2)

6.5 The required tension reinforcement using the formula:

$$AS = m + 0,1\ fcubwd(0,45 – hf)/0,87fy(d – 0,5hf)$$ (5)

[16]

QUESTION 7

A 254 × 254 × 73 kg/m H-section parallel flange steel column was used to support a load of 1 200 kN. The actual height of the column is 3,30 m and was effectively held in position at both ends, but restrained at one end.

Do the necessary calculations and state if the column was suitable under the given conditions. **[9]**

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

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					

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	1000	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