higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

BUILDING AND STRUCTURAL CONSTRUCTION N6

(8060026)

8 April 2021 (X-paper)
09:00–13:00

Calculators and drawing instruments may be used.

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

074Q1A2108

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 Practice.
7. Indicate all the relevant code/clause references.
8. Use the attached SCHEDULES A, B and C to assist with the answers.
9. Write neatly and legibly.

QUESTION 1

FIGURE 5 on the DIAGRAM SHEET (attached) shows a vertical section through a simply supported, reinforced concrete staircase. The staircase is 1,45 m wide and is supported at both ends. The staircase must be able to withstand an imposed load of 2,5 kN/m² and will be cast monolithically. Use Grade 20 concrete with mild steel reinforcement. The density of the concrete is 2 400 kg/m³.

Calculate:

1.1 The total design, dead and imposed loads (8)

1.2 The maximum bending moment (3)

1.3 The value of the constant 'K' (6)

1.4 The size and spacing of suitable tension reinforcement (3)

1.5 The size and spacing of suitable secondary reinforcement (3)

NOTE: All the relevant code references must be indicated. **[23]**

QUESTION 2

FIGURE 6 on the DIAGRAM SHEET (attached) shows a sectional view of THREE plates, built up to form a steel column. The height of the column is 5,75 m and will be held effectively in position and restrained against rotation at both ends.

Calculate:

2.1 The cross-sectional area of the steel section (3)

2.2 The second moment of area about the x-x axis (3)

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 (4)

2.6 The maximum axial load the column can support (1)

[15]

QUESTION 3

FIGURE 1 shows a simply supported, reinforced concrete L-beam. The dead load of the L-beam is 5,5 kN/m^2 with an additional imposed load of 2,75 kN/m^2. The L-beam will be spanned effectively over a distance of 7,0 m.

Use clause 4.3.1.5 to calculate the width ('X') of the L-beam.

Calculate suitable tension reinforcement for the L-beam. The neutral axis is within the flange. Mild steel reinforcement with Grade 25 concrete will be used to construct the L-beam.

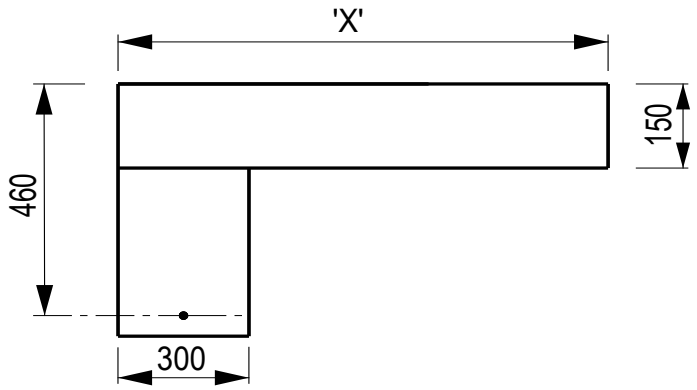

FIGURE 1 **[11]**

QUESTION 4

4.1 FIGURE 2 shows a rectangular reinforced concrete column. The column is reinforced with 6Y25 and has a rainwater pipe with a diameter of 75 mm, cast in the concrete.

Use Grade 30 MPa concrete with high-yield tensile steel reinforcement for the main bars and mild reinforcement for the binders.

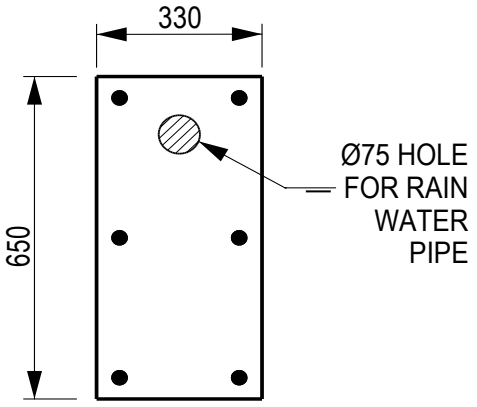

FIGURE 2

Calculate:

4.1.1 The nett area of the concrete (4)

4.1.2 The axial load the column can withstand (4)

4.1.3 The required diameter and spacing of the binders (2)

4.2 Calculate the minimum area of a square isolated pad foundation for the reinforced concrete column mentioned in QUESTION 4.1. Use a safe bearing upward soil pressure of 210 kN/m².

The column must also resist the following loads:

Imposed load: 750 kN.
Mass of foundation concrete: 95 kN (4)

[14]

QUESTION 5

FIGURE 3 shows a compound beam consisting of a 203 × 203 × 53,5 kg/m H-section parallel flange steel beam, supporting a 180 × 150 × 4 mm rectangular hollow section over a span of 6,5 m. Assume a self-weight for the compound beam to be 1,25 kN/m. The maximum bending stress must not exceed 148 MPa. The density of structural steel is 7 860 kg/m³.

Make a neat sketch and calculate the maximum uniformly distributed load that the structural steel connection can support.

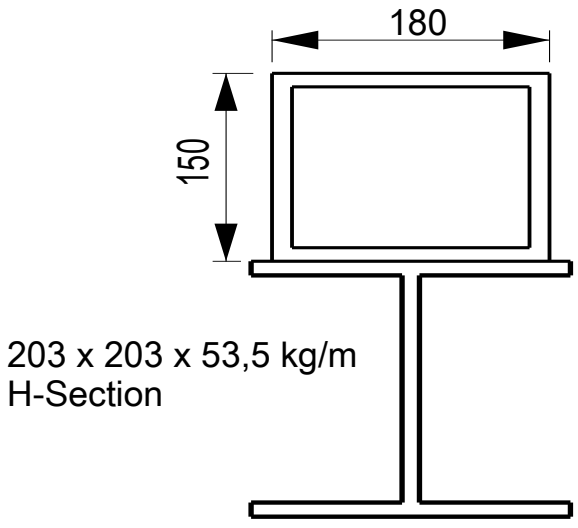

FIGURE 3 **[20]**

QUESTION 6

FIGURE 4 shows a typical connection at one of the nodes of a steel roof truss. The parts marked 'B' and 'W' are single discontinuous rolled steel angles fixed to an 8 mm thick gusset plate.

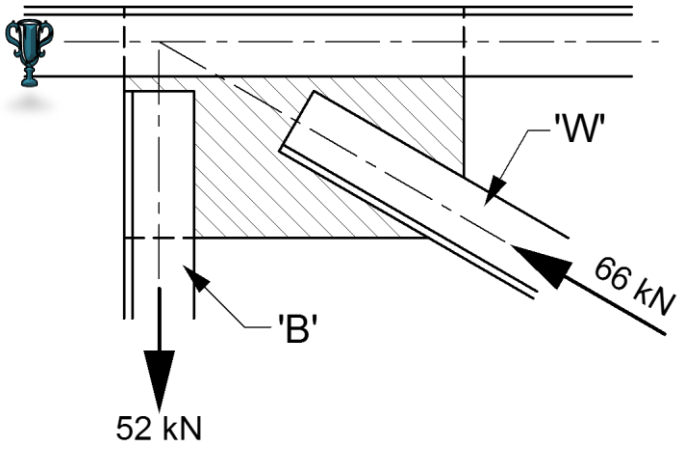

FIGURE 4

6.1 The part marked 'B' is bolted to the gusset plate with Grade 4,6 M16 bolts. The thread of the bolts will be in the shearing plane.

Determine the number of bolts required to safely secure the rolled steel angle to the gusset plate. (5)

6.2 The part marked 'W' must be welded to the gusset plate by using a 5 mm fillet weld.

Calculate the minimum length of the required weld. (5)

[10]

QUESTION 7

A 533 x 102 x 92,5 kg/m structural steel beam is required to support a point load of 150 kN at its centre point. The bending stress is 159 MPa.

Calculate the maximum effective span of the steel beam to carry the point load as well as the self-weight of the beam. **[7]**

TOTAL: 100

DIAGRAM SHEET

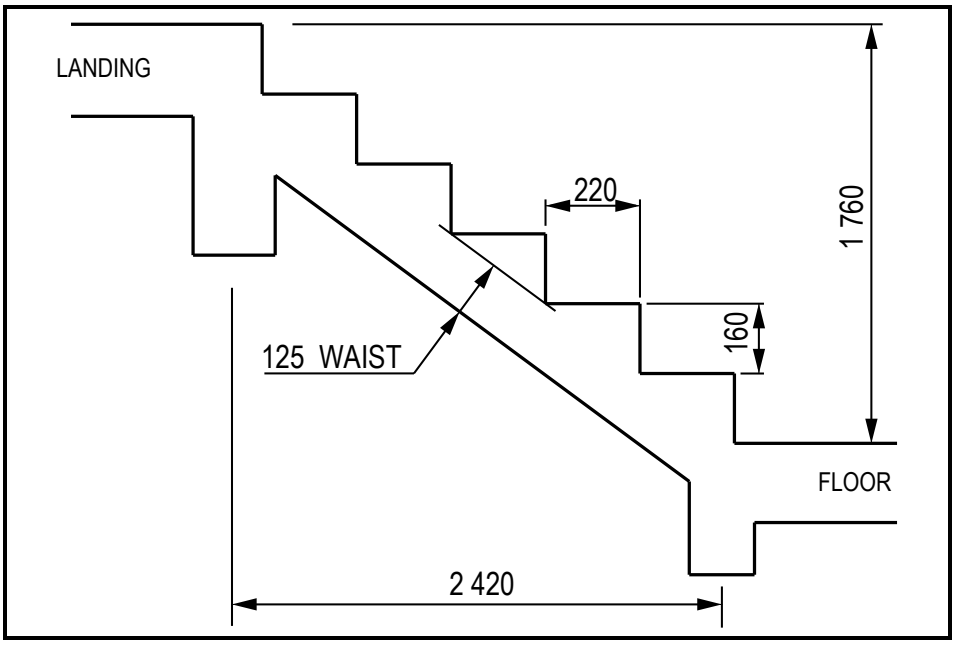

FIGURE 5

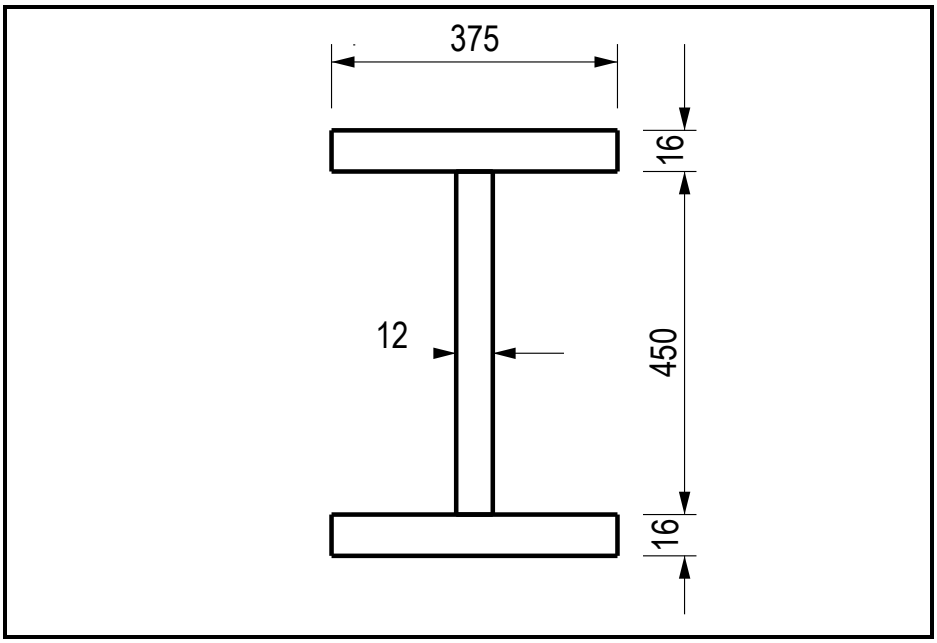

FIGURE 6

SCHEDULE A

CROSS-SECTIONAL AREA OF REINFORCEMENT RODS FOR BEAMS AND COLUMNS										
No. 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 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