higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T200(E)(N22)T
NOVEMBER 2010

NATIONAL CERTIFICATE

BUILDING AND STRUCTURAL CONSTRUCTION N6

(8060026)

22 November (X-Paper)
09:00 – 13:00

OPEN-BOOK EXAMINATION

REQUIREMENTS: Standard hot rolled structural steel section tables (BOE 8/2)

Calculators may be used.
The candidates may use personal notes and text books.

This question paper consists of 5 pages, schedules A and B and 2 diagram sheets.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
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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. ALL the work must be according to the latest building regulations.
4. ALL the calculations must be shown.
5. Show ALL the code references.
6. Use the enclosed SCHEDULES A and B to assist in your calculations.
7. Number the answers correctly according to the numbering system used in this question paper.
8. 100 marks: 100%
9. Write neatly and legibly.

QUESTION 1

A one-directional, simply supported, reinforced concrete slab supports an evenly distributed imposed load of 9,7 kN/m^2. The following specifications are known:

Effective span:		6 400 mm
Effective depth:		340 mm
Total depth:		390 mm
Grade concrete:		25
Reinforcement:	Main:	High-yield steel bars
	Secondary:	Mild steel bars
Density of reinforced concrete:		2 400 kg/m^3

Calculate the minimum required main and secondary reinforcement. **[16]**

QUESTION 2

FIGURE 1 on DIAGRAM SHEET 1, attached, shows a vertical section through a 1 m wide simply supported staircase. The imposed load is 17 kN/m^2 and the density of reinforced concrete is 2 400 kg/m^3. Use grade 25 concrete. ALL dimensions are given in millimetres.

2.1 Calculate the ultimate design load. (8)

2.2 Determine if compression reinforcement is required. (4)

2.3 Calculate the lever arm length. (4)

2.4 Determine the following:

2.4.1 The size and spacing of suitable main reinforcement of high yield steel (2)

2.4.2 The size and spacing of suitable secondary reinforcement of mild steel (2)

[20]

PTO

QUESTION 3

FIGURE 2 on DIAGRAM SHEET 1, attached, shows a cross section through a 3,75 m high steel column. The column is effectively held in position at both ends and restrained against rotation at ONE end only. ALL dimensions are given in millimetres. Determine if the column can safely support a load of 3 700 kN.

Calculate the following:

3.1 The effective length of the column (1)

3.2 The second moment of area (moment of inertia) (3)

3.3 The radius of gyration (3)

3.4 The maximum allowable stress in the column (2)

3.5 The maximum allowable force the column can support (3)
[12]

QUESTION 4

A short, axially loaded concrete column, 950 mm in diameter, must support an ultimate design load of 3 210 kN safely. Grade 30 concrete with high-yield steel reinforcement is used.

4.1 Related to the above-mentioned column, determine the following according to SABS 0100-1: 1992 directions and state where it can be found in the code:

4.1.1 The minimum area of compression reinforcement required in the column (3)

4.1.2 The minimum area of secondary reinforcement required in the column (2)

4.1.3 The minimum number of longitudinal bars required in the column (2)

4.1.4 The maximum area of compression reinforcement allowed in the column (1)

4.2 Determine the minimum required longitudinal reinforcement to support the load safely. (4)
[12]

QUESTION 5

FIGURE 3 on DIAGRAM SHEET 2, attached, shows TWO eccentrically loaded beam connections. Are the forces acting on each bolt of both connections equal? Motivate the answer.

The dimensions in the figure are given in millimetres. **[13]**

PTO

QUESTION 6

A single-discontinuous angle-iron profile strut of a steel roof truss is fixed, at both ends to a gusset, by means of bolts and must support a compressive force of 140 kN safely.

Select a suitable equal-leg angle for the strut, if the total effective length of the strut is 3 200 m. **[8]**

QUESTION 7

A simply supported steel beam, with an effective span of 6 750 m supports the following loads:

7.1 A distributed load of 53 kN/m, from the left hand support to mid span

7.2 A point load of 75 kN at mid-span

Make the necessary calculations and select a suitable I-section with parallel flanges to support the given loads. The maximum bending stress must NOT exceed 195 MPa. **[9]**

QUESTION 8

FIGURE 4 on DIAGRAM SHEET 2, attached, shows a cross-sectional view through a reinforced concrete T-beam. Calculate the ultimate moment of resistance for the beam in FIGURE 4, if grade 25 concrete and high-yield steel reinforcement is used. Use EIGHT ϕ20 mm rods. ALL the measurements are given in millimeters.

NOTE: Assume that the neutral axis is in the flange. **[10]**

TOTAL: 100

CROSS SECTIONAL AREA OF REINFORCING RODS
SCHEDULE A

Quantity of rods	Rod Diameter (mm)									
	ϕ 6	ϕ 8	ϕ 10	ϕ 12	ϕ 16	ϕ 20	ϕ 25	ϕ 32	ϕ 40	ϕ 50
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

CROSS SECTIONAL AREA OF REINFORCING RODS PER METER WIDTH OF FLOOR SLAB

Spacing of rods, Centre to centre	Rod Diameter (mm)									
	ϕ 6	ϕ 8	ϕ 10	ϕ 12	ϕ 16	ϕ 20	ϕ 25	ϕ 32	ϕ 40	ϕ 50
50	565	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 (floor slabs)						

ISOMETRIC BLACKHEXAGON BOLTS AND NUTS
SCHEDULE B

Nominal Size and thread Diameter	DIMENSIONS IN MILLIMETER								
	Pitch of thread coarse pitch series	Max. width of head and nut		Max height of head		Max. thickness of nut		Tensile stress area in mm^2	Minimum distance between centers
		Across flats	Across corners	Black	Faced on underside	Black Swart	Faced 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	13,55	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	24,05	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	33,50	42,80	42	1 760	130
M 56	5,5	85,00	98,1	36,25	35,50	45,80	45	2 030	140

DIAGRAM SHEET 1

BUILDING AND STRUCTURAL CONSTRUCTION N6
BOU EN STRUKTUUR KONSTRUKSIE N 6

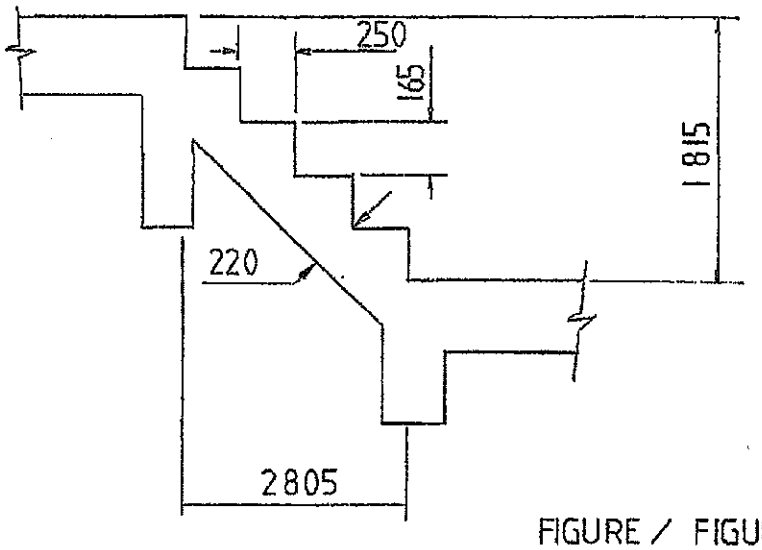

FIGURE / FIGUUR 1

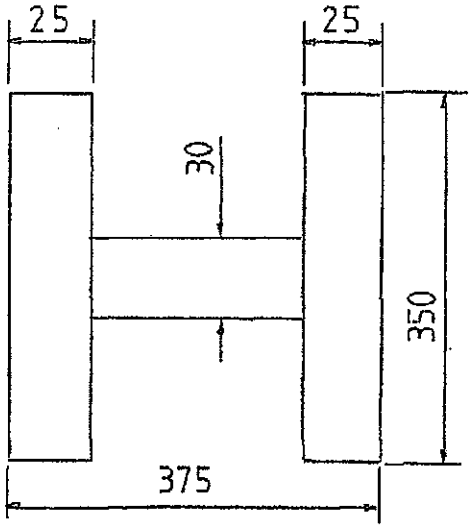

FIGURE / FIGUUR 2

DIAGRAM SHEET 2

BUILDING AND STRUCTURAL CONSTRUCTION N6
BOU EN STRUKTUUR KONSTRUKSIE N 6

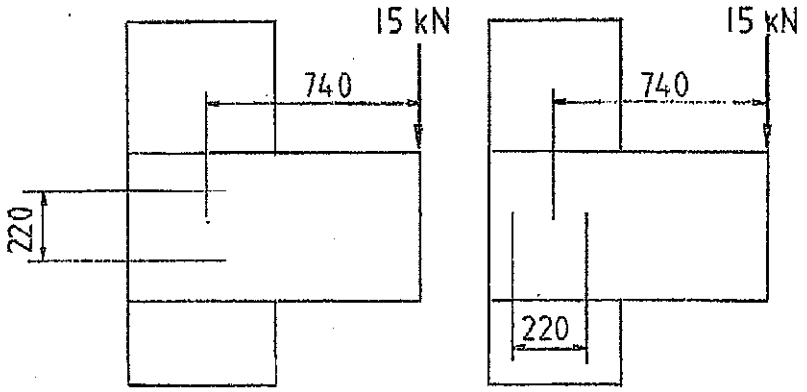

FIGURE / FIGUUR 3

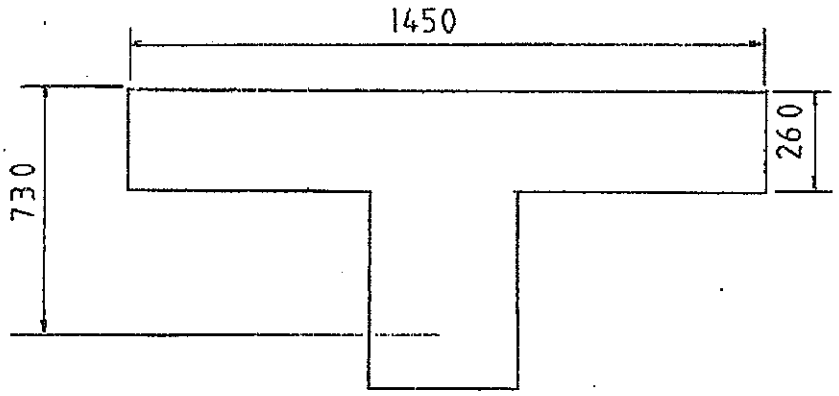

FIGURE / FIGUUR 4