higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

BUILDING AND STRUCTURAL CONSTRUCTION N6

(8060026)

22 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 personal notes and textbooks.
Drawing instruments and non-programmable scientific calculators may be used.
No past question papers and/or marking guidelines will be allowed in the examination room(s).

This question paper consists of 6 pages, 1 diagram sheet, 3 schedules and 2 addenda.

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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. Draw a line across the page at the end of each answer.
5. All calculations must conform to the relevant SABS/SANS codes of practice.
6. Indicate all the relevant code/clause references.
7. Complement your answers with neat sketches.
8. Use SCHEDULES A, B and C (attached) to assist with your answers.
9. Use only a black or blue pen.
10. Write neatly and legibly.

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QUESTION 1

A 356 × 171 × 56,7 kg/m I-section parallel flange steel beam is placed over TWO supports to form a simply supported beam.

Calculate the maximum point load that the beam can support at its central point when the effective span of the beam is 12 metres (12 000 mm).

Use a bending stress of 164 MPa and consider the self-weight of the beam. **[6]**

QUESTION 2

FIGURE 1 shows a 12-metre long plated I-section parallel flange steel beam to be used as a girder beam, supporting a roof structure.

Calculate the maximum uniformly distributed load that the girder can support when the effective span of the beam is 12 metres (12 000 mm).

Use a bending stress of 164 MPa and consider the self-weight of the beam.

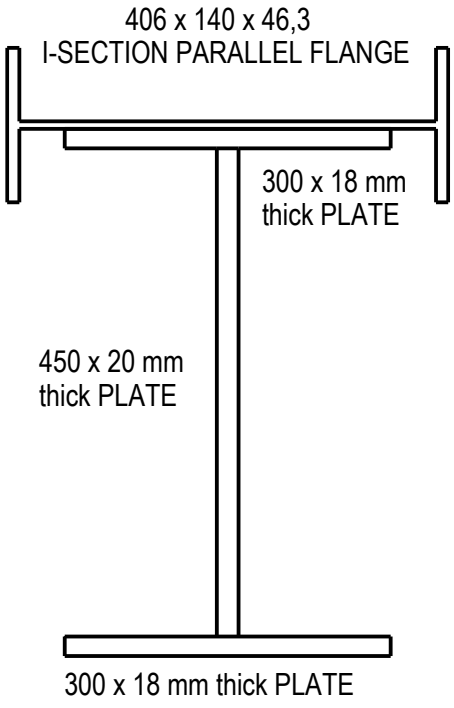

FIGURE 1

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

The maximum bending stress must not exceed 162 MPa. The density of structural steel is 7 870 kg/m^3. **[24]**

QUESTION 3

FIGURE 2 shows a cross sectional view of a rectangular reinforced concrete column required to support an ultimate load of 2 200 kN. The column will require EIGHT high-yield longitudinal tension bars and binders.

Calculate the following:

3.1 The minimum and maximum main reinforcement required. (6)

3.2 The sizes of the required longitudinal compression reinforcement and binders for the short axially-loaded reinforced concrete column.

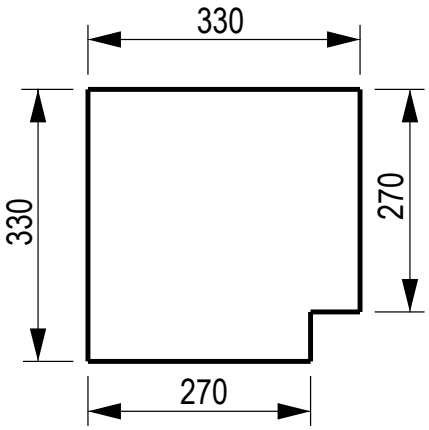

FIGURE 2

The concrete strength of the column is 25 MPa. (6)

[12]

QUESTION 4

FIGURE 3, DIAGRAM SHEET 1 (attached) shows a loaded steel truss.

4.1 Calculate the reactions at RL and RR.

4.2 Calculate the forces at 'R' and distinguish between *tension* and *compression* for the parts marked 'AH' and 'HG'.

4.3 Calculate the forces at 'S' and distinguish between *tension* and *compression* for the parts marked 'BJ' and 'HJ'.

4.4 Calculate the forces at 'T' and distinguish between *tension* and *compression* for the parts marked 'JK' and 'CK'.

All calculations must be neatly presented with all relevant codes and reference numbers.

[26]

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QUESTION 5

FIGURE 4, DIAGRAM SHEET 1 (attached) shows a simply supported beam of 535 mm deep and 300 mm wide with an effective span of 9,00 metres that supports the following loads:

- A uniformly distributed load of 11 kN/m
- A point load of 96 kN TWO metres from the left support

Use Grade 25 MPa concrete and high yield tensile reinforcement with a characteristic value of 450 MPa. The density of the concrete is 2 410 kg/m³.

Answer the following:

5.1 Calculate the design load. (3)

5.2 Calculate the reactions RL and RR of the beam. (4)

5.3 Draw a neat sketch of the shear force diagram. (3)

5.4 Calculate and draw a neat sketch of the bending moment. (2)

5.5 Calculate the value of K to determine if compression reinforcement is required. (7)
If required, then calculate suitable compression reinforcement.
NOTE: USE 25 mm concrete cover

Include the self-weight of the reinforced concrete beam in the calculations.

[19]

QUESTION 6

6.1 Name ONE method that can be used to ensure adequate moisture content during the curing process of a flat concrete slab. (1)

6.2 Curing is said to prevent plastic shrinkage cracking.

Explain what *plastic shrinkage cracking* is. (1)

6.3 Name TWO of the main materials that are used to manufacture steel. (2)

[4]

QUESTION 7

FIGURE 5 shows a longitudinal sectional view of a reinforced rectangular concrete beam of 5,0 m (5 000 mm) long and a cross sectional view supporting the reinforced concrete column.

DO NOT copy these drawings, but complete the bending schedule for TWO of the same structural elements on ADDENDUM 2 (attached). The cover for all the reinforcement is 25 mm. The length of the right-angled bend is 100 mm. Allow 100 mm for the overlap of the binders (50 mm overlap at each side of the joint). Refer to ADDENDUM 1 for a summary of the shape codes. Once completed, enter you STUDENT NUMBERS in the spaces provided and submit ADDENDUM 2 with the ANSWER BOOK.

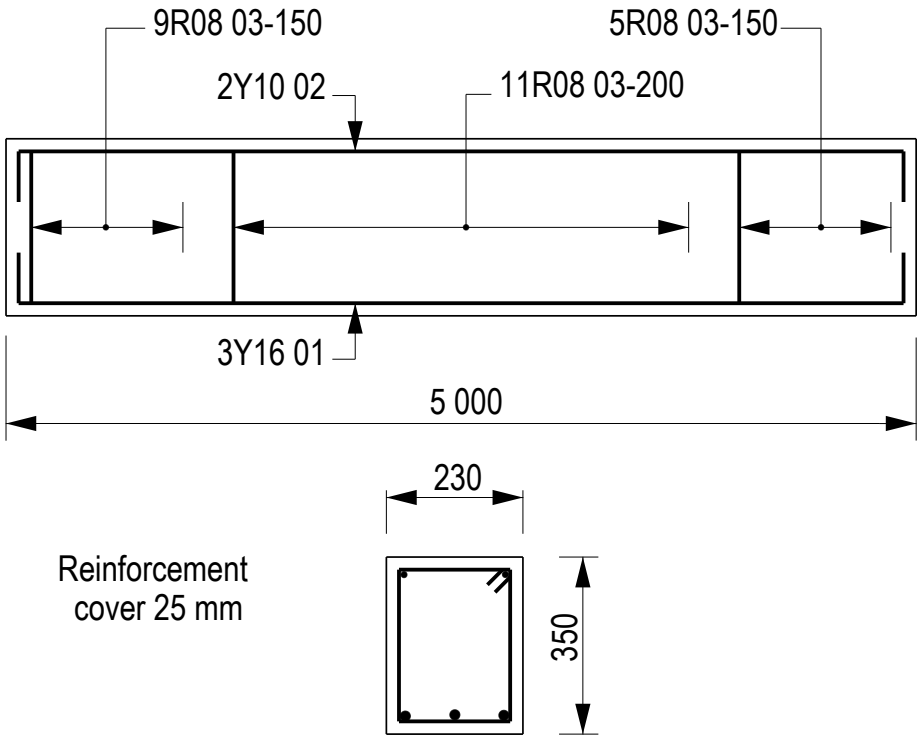

FIGURE 5

[9]

TOTAL: 100

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DIAGRAM SHEET 1

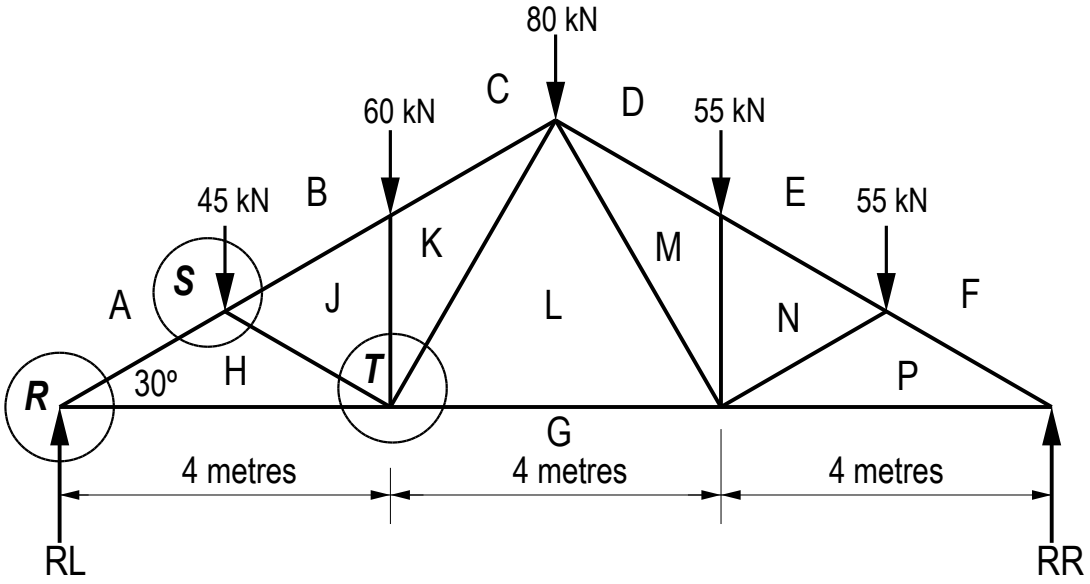

FIGURE 3

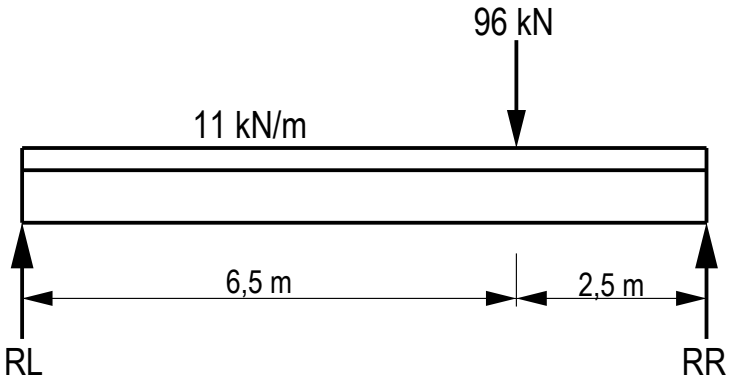

FIGURE 4

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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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ADDENDUM 1 **SANS 282 Summary of shape codes**

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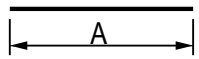

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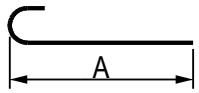

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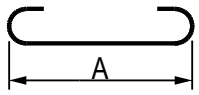

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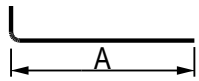

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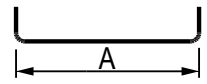

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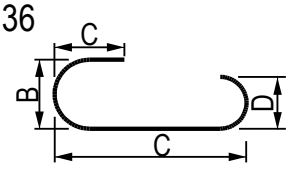

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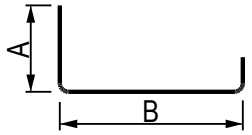

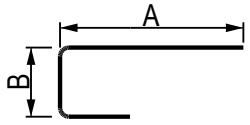

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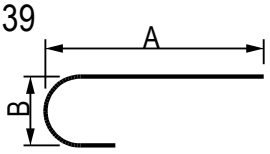

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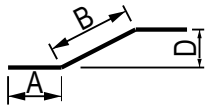

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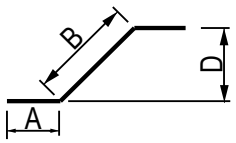

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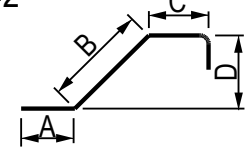

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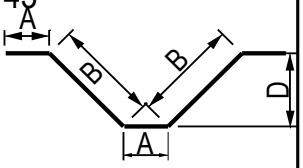

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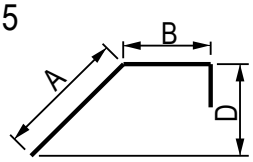

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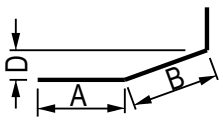

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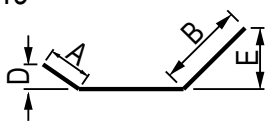

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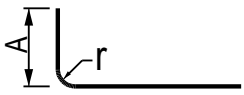

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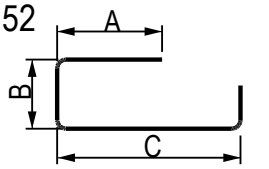

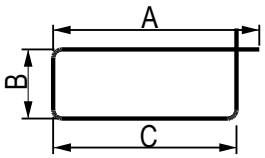

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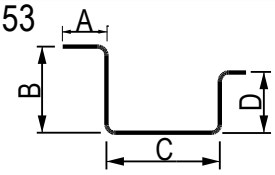

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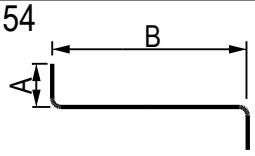

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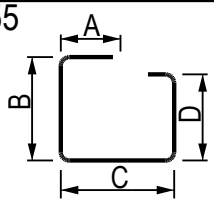

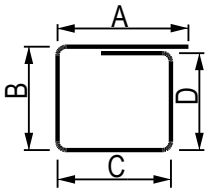

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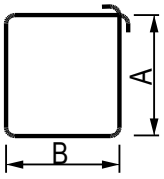

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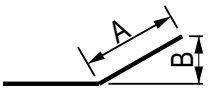

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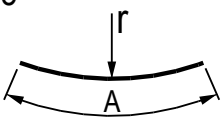

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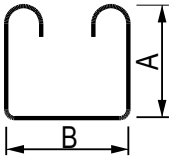

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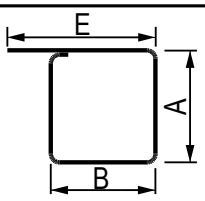

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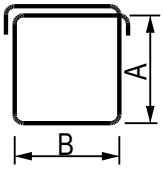

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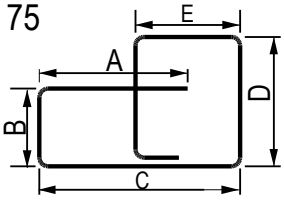

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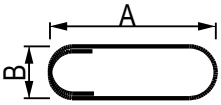

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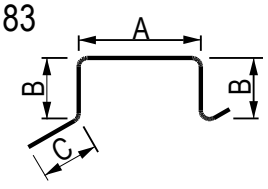

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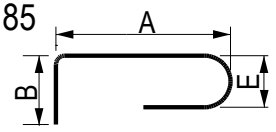
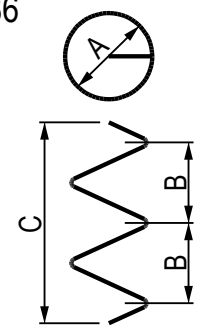


86


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ADDENDUM 2

(This page must be handed in with the ANSWER BOOK, even if you did not answer this question)

STUDENT NUMBER:													

1	2	3	4	5	6	7	8	9	10	11	12
Member	Reinforcement					Bending dimensions for shape codes (SANS 282)					
Mark; size & no. of	Mark	Type and size	No. in each	Total no.	Length (mm)	Shape code	A	B	C	D	E or R
Rectangular beam 2 of											
Marks											

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