higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

CIVIL AND STRUCTURAL STEEL WORK DETAILING

(First paper)

NQF LEVEL 4

(12050674)

12 November 2024 (X-paper)
09:00–11:00

REQUIREMENTS: **A3 drawing sheet**
Standard hot-rolled structural steel sections (BOE 8/1)

Calculators and drawing instruments may be used.

This question paper consists of 4 pages, 1 formula sheet and 1 addendum.

055Q1N2412

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NATIONAL CERTIFICATE (VOCATIONAL)
CIVIL AND STRUCTURAL STEEL WORK DETAILING
(First paper)
NQF LEVEL 4
TIME: 2 HOURS
MARKS: 75

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 section on a new page.
5. Use only a blue or black pen.
6. Write neatly and legibly.

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QUESTION 1: CALCULATIONS FOR CIVIL AND STRUCTURAL STEEL WORK

1.1 a Horizontal beam is loaded as shown in Figure 1 below:

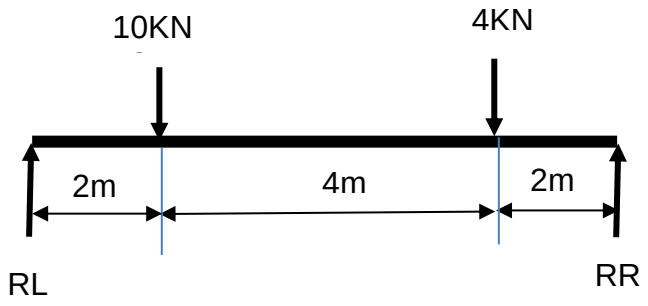

FIGURE 1

1.1.1 Determine the reactions RL and RR as shown. (6)

1.1.2 Check the answers by balancing upward and downward forces. (4)

1.2 Choose a description from COLUMN B that matches an item in COLUMN A. Write only the letter (A–J) next to the question number (1.2.1 to 1.2.10) in the ANSWER BOOK.

COLUMN A		COLUMN B	
1.2.1	force	A	F_n
1.2.2	moment	B	F_s
1.2.3	stress	C	F_c
1.2.4	tensile force	D	M
1.2.5	web thickness	E	F
1.2.6	flange thickness	F	F_t
1.2.7	web height	G	σ
1.2.8	shear force	H	t_w
1.2.9	compressive force	I	t_f
1.2.10	axial force	J	h_w

(10 × 1) (10)

[20]

QUESTION 2

2.1 The ADDENDUM (attached) shows the properties of I-sections and H-sections. Use the formula sheet (attached) to determine the elastic modulus of the following sections:

2.2.1 457 × 191 × 98 I-Section

2.2.2 254 × 254 × 73 H-Section

2.2.3 152 × 152 × 37 H-Section

2.2.4 305 × 305 × 158 H-Section

2.2.5 533 × 210 × 101 I-Section

(5 × 2) (10)

2.2 Make a neat sketch of a cantilever retaining wall. (4)

2.3 Draw a typical truss and indicate the following connections: ridge, shoe-to-eave, and internal joint. (6)

2.4 Explain the difference between angle cleats and gusset plates. (4)

2.5 Calculate the amount of steel required for a square column with length of 400 mm if the strength of the concrete is 35 Mpa, and that of steel is 350 Mpa. X is 187,84 mm. (6)

[30]

QUESTION 3

3.1 Steel structures are always classified into different classes. List and describe at least THREE such classes classifications based on construction method. (6)

3.2 Explain how the self-weight of a beam is determined. (2)

3.3 With reference to cantilever retaining walls, describe what the level differential means. (2)

3.4 List the FOUR components that are essential to indicate when drawing multi-level buildings. (4)

3.5 State the function of pile caps and indicate the maximum number of piles that a single pile cap can accommodate. (2)

3.6 Draw the true shear, shear slump and the collapse slump and label each. (9)

[25]

TOTAL: 75

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(12050674)

CIVIL AND STRUCTURAL STEEL WORK DETAILING L4

FORMULA SHEET

$F = ma$

$W = mg$

$M_B = F_A d_{AB}$

$\sum Fy = 0$

$\sum Fx = 0$

$\sum M = 0$

$\sigma = \frac{F}{A}$

$F_C = F_S$

$M = F_S \times$ perpendicular distance

$M = F_C \times$ perpendicular distance

$ax^2 + bx + c = 0$

$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$UDL = Y_{CON} \times$ cross-sectional area

$F_C = 0{,}45\sigma cb(0{,}9x)$

$F_C = 0{,}45\sigma bh$

$F_S = 0{,}87\sigma y A_{st}$

$F_S = 0{,}73\sigma y A_{sc}$

$N = F_C + F_S$

$Q_B A - N - Y_S(1)(A) - Y_C(h)(A) = 0$

$A = \frac{N}{QB - YS(1) - YC(h)}$

$Q_U = \frac{UDL}{A}$

$M_r = \emptyset Z_{Pl} f_y$

$M_r = \emptyset Z_e f_y$

Self-weight of a beam $= m \times a$

$\lambda = \frac{KL}{r}\sqrt{\frac{fy}{\pi^2 E}}$

$C_r = \emptyset A f_y (1 + \lambda^{2,68})^{-1/1,34}$

$T_r = \emptyset A fy$

$F_{AE}\cos\theta + F_{AC} = 0$

$F_{AE} = -\frac{100}{\sin 30}$

$F_{AB}\sin\theta - F_{BE} = 0$

Maximum compressive force $= M_{MAX}/h$

Maximum tensile force $= F_{SMAX}/\cos\emptyset$

$F_R = F_1 + F_2 + F_3$

$0{,}405\sigma_C bx = 0{,}87\sigma_y A_{st}$

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ADDENDUM

Table 3.2: Properties of I-sections and H-sections (continued)

I-section (Beams)	m (kg/m)	h (mm)	b (mm)	t_w (mm)	t_f (mm)	h_w (mm)	A (10^3mm^2)	Z_e (10^3mm^3)	Z_{pl} (10^3mm^3)	r (mm)
457x191x89	89.3	463.6	192.0	10.6	17.7	408	11.4	1770	2020	42.8
457x191x98	98.3	467.6	192.8	11.4	19.6	408	12.5	1960	2230	43.3
533x210x82	82.2	528.3	208.7	9.6	13.2	476	10.5	1800	2060	43.8
533x21092	92.1	533.1	209.3	10.2	15.6	476	11.8	2080	2370	45.0
533x210x101	101	536.7	210.1	10.9	17.4	476	12.9	2300	2620	45.7
533x210x109	109	539.5	210.7	11.6	18.8	476	13.9	2480	2830	46.0
533x210x122	122	544.6	211.9	12.8	21.3	477	15.6	2800	3200	46.6
H-section (Columns)	**m (kg/m)**	**h (mm)**	**b (mm)**	**t_w (mm)**	**t_f (mm)**	**h_w (mm)**	**A (10^3mm^2)**	**Z_e (10^3mm^3)**	**Z_{pl} (10^3mm^3)**	**r (mm)**
152x152x23	23.0	152.4	152.4	6.1	6.8	124	2.97	165	184	36.8
152x152x30	30.0	157.5	152.9	6.6	9.4	123	3.84	222	248	38.2
152x152x37	37.0	161.8	154.4	8.1	11.5	124	4.73	274	309	38.7
203x203x46	46.1	203.2	203.2	7.3	11	161	5.88	449	497	51.2
203x203x52	52.0	206.2	203.9	8	12.5	161	6.64	510	567	51.6
203x203x60	60.0	209.6	205.2	9.3	14.2	161	7.60	582	654	51.9
203x203x71	71.0	215.9	206.2	10.3	17.3	161	9.09	707	801	52.8
203x203x86	86.1	222.3	208.8	13	20.5	161	11.0	851	978	53.2
254x254x73	73.1	254.2	254.0	8.6	14.2	200	9.29	896	990	64.6
254x254x89	88.9	250.4	255.9	10.5	17.3	200	11.4	1100	1230	65.2
254x254x107	107	266.7	258.3	13	20.5	200	13.7	1310	1480	65.7
254x254x132	132	276.4	261.0	15.6	25.1	201	16.8	1620	1860	66.6
254x254x167	167	289.1	264.5	19.2	31.7	200	21.2	2070	2420	67.9
305x305x97	96.9	307.8	304.8	9.9	15.4	247	12.3	1440	1590	76.8
305x305x118	118	314.5	306.8	11.9	18.7	247	15.0	1760	1950	77.6
305x305x137	137	320.5	308.7	13.8	21.7	247	17.4	2040	2290	78.2
305x305x158	158	327.2	310.6	15.7	25	247	20.1	2360	2670	78.9

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