higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

# NATIONAL CERTIFICATE: MULTIDISCIPLINARY DRAWING OFFICE PRACTICE

# STRUCTURAL STEEL DETAILING

(8090225)

**28 July 2021 (X-paper)**
**09:00–13:00**

**REQUIREMENTS: A2, A3 and A4 drawing sheets**
**Hot-rolled structural steel tables (BOE 8/2)**

**Drawing instruments, nonprogrammable calculators and computer software may be used.**

**This question paper consists of 5 pages, 2 diagram sheets and 2 information sheets.**

078Q1G2128

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# DEPARTMENT OF HIGHER EDUCATION AND TRAINING
# REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE: MULTIDISCIPLINARY DRAWING OFFICE PRACTICE
STRUCTURAL STEEL DETAILING
TIME: 4 HOURS
MARKS: 100

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**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. Before any drawing work is done on the computer, a border must be retrieved from the symbols directory and displayed on the screen.
5. Each question must be answered on a separate AA3 or A4 drawing sheet.
6. Plot the answers on ONE side of the drawing paper only.
7. Computers may be used as drawing aids.
8. All candidate information must be plotted in the title block.
9. Standard structural steel symbols may be obtained from the symbols directory.
10. Candidates must plot their own answers under suitable supervision.
11. Work neatly.

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## QUESTION 1: INTRODUCTION

Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (1.1–1.10) on the DRAWING SHEET:

1.1 A holding-down bolt is a steel bolt cast into a concrete foundation securing a column to the foundation through the column base plate.

1.2 A high-strength frictional-grip bolt is a strong structural bolt used to transfer tensile force.

1.3 A column is a vertical steel member that generally transfers loads to a support foundation.

1.4 A cleat is usually a short length of angle or channel section that is welded or bolted to a steel member enabling it to be fastened to another member.

1.5 A truss is a triangulated structural steel member made up of several individual parts welded or bolted together.

1.6 A gusset is a piece of plate welded or bolted at an intersection of two steel members to facilitate a connection between the two.

1.7 The shaft of a bolt is called the rod.

1.8 A plate girder is constructed by welding steel plates together to form a stronger beam.

1.9 A column is a horizontal member supporting floors, roofs and cranes in buildings.

1.10 A column cap plate is fixed to the top of a column section.

(10 × 1) **[10]**

## QUESTION 2: BEAMS

FIGURE 1 on DIAGRAM SHEET 1 (attached) shows a view of a steel structure.

Make, to scale 1:10, fully detailed drawings of the beams marked B1 and B3 and supply enough information for the manufacturing of the beams in a workshop. All plates are 10 mm thick and bolts are M20.

Show each of the following:

- Column centres
- Lengths and sizes of beams
- Dimensions of beams over end plates
- Dimensions for drilling of bolt holes
- View with dimensions of end plates
- Item marks, number of beams required and diameter of bolt holes
- Top of beams

Use discretion for information not given. **[30]**

## QUESTION 3: COLUMNS

Make fully detailed drawings to scale 1:10 of the columns marked C1 and C2 in FIGURE 1 on DIAGRAM SHEET 1 (attached). Supply enough information for the manufacturing of the columns in a workshop. All plates are 10 mm thick and bolts are M20.

Show each of the following:

- Lengths and sizes of columns
- Dimensions of columns over cap and base plates
- Dimensions for drilling of bolt holes
- View with dimensions of cap and base plates

Use discretion for information not given. **[25]**

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## QUESTION 4: LATTICED GIRDER

FIGURE 2 on DIAGRAM SHEET 2 (attached) shows a line diagram of a welded latticed girder.

Specifications:

- Top and bottom booms: rolled steel angle profiles 120 × 120 × 12
- Internal members: rolled steel angle profiles 90 × 90 × 10
- All gusset plates: 10 mm thick

Do not insert any dimensions.

Use discretion for gusset plate sizes, as well as information not given.

Make, to scale 1:5, detail drawings of each of the following and print the scale and a suitable title centrally beneath each detail drawing:

4.1 Detail A (5)

4.2 Detail B (5)

4.3 Detail C (5)

**[15]**

## QUESTION 5: TRUSSES

5.1 Draw, to scale 1:20, a line diagram of the bolted steel roof truss in FIGURE 1, DIAGRAM SHEET 1 (attached) (5)

5.2 Draw, to scale 1:5, bolted details at A and B.

Specifications:

- Top and bottom boom: 100 × 100 × 8 rolled steel angle profiles
- Internal members: 80 × 80 × 8 rolled steel angle profiles
- Gusset plates: 10 mm thick
- Bolt hole centres: 100 mm and edge distances 35 mm
- Bolt holes drilled on centre lines of angles and bolts M20

Insert suitable dimensions. (15)

**[20]**

**TOTAL: 100**

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**STRUCTURAL STEEL DETAILING**

**DIAGRAM SHEET 1**

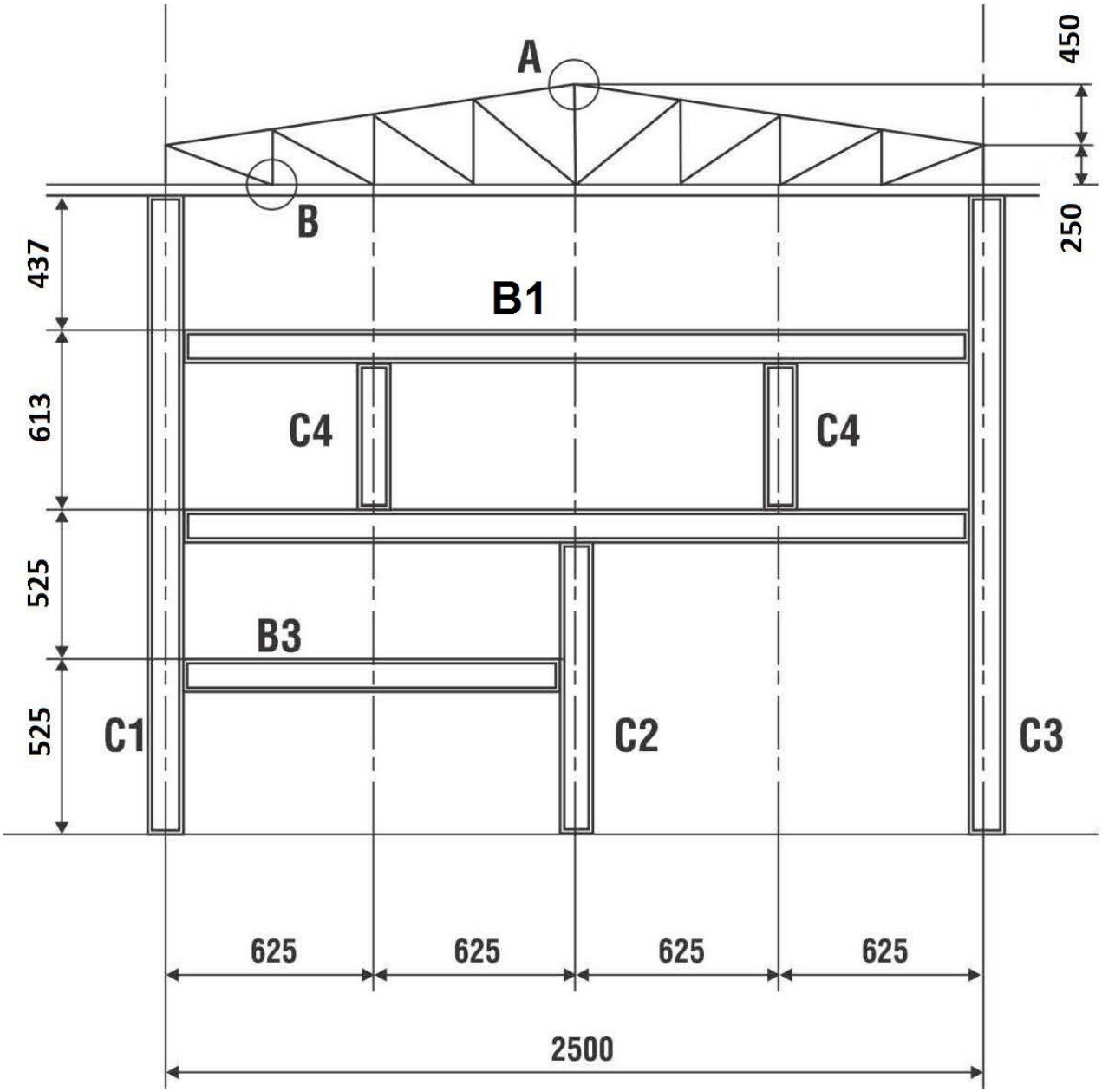



**FIGURE 1**

| | | | |
|---|---|---|---|
| **B1** | **UB 254 × 146 × 31 kg/m** | **C1** | **UC 203 × 203 × 46 kg/m** |
| **B2** | **UB 203 × 146 × 31 kg/m** | **C2** | **UC 203 × 203 × 46 kg/m** |
| **B3** | **UB 203 × 133 × 25 kg/m** | **C3** | **UC 203 × 203 × 46 kg/m** |
| | | **C4** | **UC 152 × 152 × 23 kg/m** |

| | |
|---|---|
| **END PLATES** | **10 mm with 4 × M20 BOLTS** |
| **BASE PLATES** | **20 mm with 2 × M20 BOLTS** |

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**STRUCTURAL STEEL DETAILING**

**DIAGRAM SHEET 2**

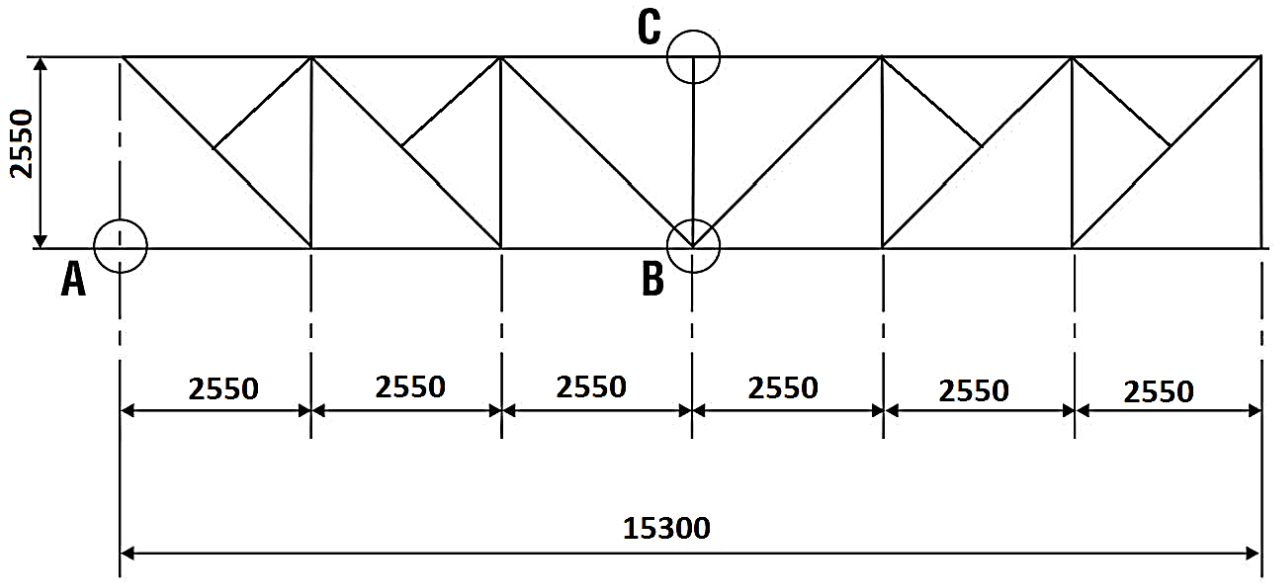


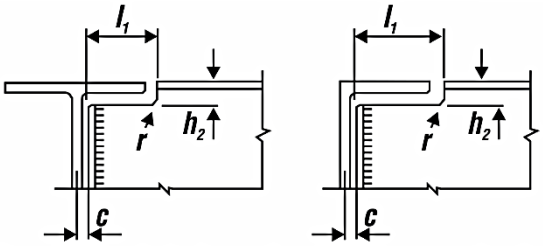

**FIGURE 2**

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## STRUCTURAL STEEL DETAILING

## INFORMATION SHEET 1




Dimension c is to face of end plate or angle cleat.
r = 10mm minimum
Dimensions are in mm.

| | Section | c | Notch | | | Section | c | Notch | |
|---|---|---|---|---|---|---|---|---|---|
| | | | $l_1$ | $h_1$ | | | | $l_1$ | $h_1$ |
| I - Sections (parallel flange) | 100 x 55 x 8 | 4 | 33 | 15 | I - Sections (parallel flange) | 533 x 210 x 82 | 4 | 33 | 15 |
| | 120 x 64 x 19 | 4 | 37 | 15 | | 93 | 4 | 37 | 15 |
| | 140 x 73 x 13 | 4 | 42 | 20 | | 101 | 4 | 42 | 20 |
| | 160 x 82 x 16 | 5 | 47 | 20 | | 109 | 5 | 47 | 20 |
| | 180 x 91 x 19 | 5 | 51 | 20 | | 122 | 5 | 51 | 20 |
| | 200 x 100 x 22 | 5 | 56 | 25 | | 610 x 229 x 101 | 5 | 56 | 25 |
| | 203 x 133 x 25 | 5 | 74 | 20 | | 113 | 5 | 74 | 20 |
| | 30 | 5 | 74 | 20 | | 125 | 5 | 74 | 20 |
| | 254 x 146 x 31 | 5 | 81 | 20 | | 140 | 5 | 81 | 20 |
| | 37 | 5 | 81 | 25 | I - Sections (taper flange) | 127 x 76 x 13 | 5 | 81 | 25 |
| | 43 | 6 | 81 | 25 | | 152 x 89 x 17 | 6 | 81 | 25 |
| | 305 x 102 x 25 | 5 | 57 | 25 | | 178 x 102 x 22 | 5 | 57 | 25 |
| | 29 | 5 | 57 | 20 | | 203 x 102 x 25 | 5 | 57 | 20 |
| | 33 | 5 | 57 | 20 | | 52 | 5 | 57 | 20 |
| | 41 | 5 | 91 | 25 | | 254 x 152 x 59 | 5 | 91 | 25 |
| | 46 | 5 | 91 | 25 | | 305 x 152 x 66 | 5 | 91 | 25 |
| | 54 | 6 | 91 | 25 | Channels | 100 x 50 x 11 | 6 | 91 | 25 |
| | 356 x 171 x 45 | 5 | 94 | 25 | | 120 x 55 x 13 | 5 | 94 | 25 |
| | 51 | 5 | 94 | 25 | | 140 x 60 x 16 | 5 | 94 | 25 |
| | 57 | 6 | 94 | 30 | | 160x 65 x 19 | 6 | 94 | 30 |
| | 67 | 7 | 94 | 30 | | 180 x 70 x 22 | 7 | 94 | 30 |
| | 104 x 140 x 39 | 5 | 78 | 25 | | 200 x 75 x 25 | 5 | 78 | 25 |
| | 46 | 5 | 78 | 25 | | 220 x 80 x 29 | 5 | 78 | 25 |
| | 54 | 6 | 97 | 25 | | 240 x 85 x 32 | 6 | 97 | 25 |
| | 60 | 6 | 97 | 30 | | 260 x 90 x 38 | 6 | 97 | 30 |
| | 67 | 6 | 97 | 30 | | 280 x 95 x 42 | 6 | 97 | 30 |
| | 457 x 191 x 67 | 6 | 103 | 25 | | 300 x 100 x 46 | 6 | 103 | 25 |
| | 75 | 7 | 103 | 30 | | 76 x 38 x 7 | 7 | 103 | 30 |
| | 82 | 7 | 103 | 30 | | 127 x 64 x 15 | 7 | 103 | 30 |
| | 90 | 7 | 103 | 30 | | 152 x 75 x 18 | 7 | 103 | 30 |
| | 98 | 8 | 103 | 35 | | 178 x 54 x 15 | 8 | 103 | 35 |
| H - Sections | 152 x 152 x 23 | 5 | 84 | 20 | | 381 x 102 x 55 | 5 | 84 | 20 |
| | 30 | 5 | 84 | 20 | H - Sections | 254 x 254 x 107 | 5 | 84 | 20 |
| | 37 | 6 | 84 | 20 | | 132 | 6 | 84 | 20 |
| | 203 x 203 x 45 | 6 | 111 | 25 | | 167 | 6 | 111 | 25 |
| | 52 | 6 | 111 | 25 | | 305 x 305 x 97 | 6 | 111 | 25 |
| | 60 | 7 | 111 | 30 | | 118 | 7 | 111 | 30 |
| | 72 | 7 | 111 | 30 | | 137 | 7 | 111 | 30 |
| | 86 | 8 | 111 | 35 | | 158 | 8 | 111 | 35 |
| | 254 x 254 x 73 | 6 | 138 | 30 | | 198 | 6 | 138 | 30 |
| | 89 | 7 | 138 | 35 | | 240 | 7 | 138 | 35 |

**DIMENSIONS OF BEAM NOTCHES**

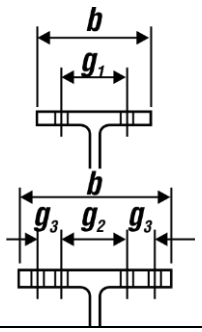
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## STRUCTURAL STEEL DETAILING

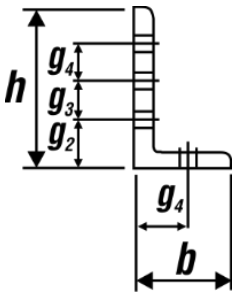
## INFORMATION SHEET 2

### RECOMMENDED GAUGES AND BACK MARKS FOR I- AND H-SECTIONS




| *b* (mm) | Gauge (mm) | | | Ø max. (mm) |
|---|---|---|---|---|
| | $g_1$ | $g_2$ | $g_3$ | |
| 64 | 32 | 120 | 60 | 12 |
| 73-82 | 40 | 140 | 75 | 12 |
| 89-91 | 50 | | | 12 |
| 102 | 54 | | | 16 |
| 133-146 | 70 | | | 20 |
| 152 | 90 | | | 20 |
| 165-191 | 90 | | | 24 |
| 203-254 | 140 | | | 24 |
| 305 | 140 | | | 24 |
| 368-406 | 140 | | | 24 |

### RECOMMENDED GAUGES AND BACK MARKS FOR ANGLES




| *h* or *b* (mm) | Back mark $g_1$ (mm) | Ø max. (mm) | *h* or *b* (mm) | Back mark (mm) | | | | *h* or *b* (mm) |
|---|---|---|---|---|---|---|---|---|
| | | | | $g_1$ | $g_2$ | $g_3$ | $g_4$ | |
| 25 | 15 | 8 | 90 | 50 | 45 | 45 | | 24 |
| 30 | 17 | 10 | 100 | 50 | | | | 24 |
| 35 | 20 | | 120 | 60 | | | | 24 |
| 40 | 22 | | 120 | 65 | | | | 16 |
| 45 | 25 | | 125 | | | | | 24 |

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