# CIV 101F - STRUCTURES, MATERIALS, AND DESIGN

Examiner: Staff in Civil Engineering

FAMILY NAME: _____ GIVEN NAMES: _____

(Please **print** clearly)

STUDENT NUMBER: _____

## CIRCLE THE NAME OF YOUR LECTURER AND YOUR GROUP LETTER

| | | | |
|---|---|---|---|
| A | Onsongo, W. | E | Seica, M. |
| B | Kuhn, E. | F | Birkemoe, P.C. |
| C | Bonacci, J.F. | G | Wright, P.M. |
| D | Pressnail, K. | H | Kuhn, E. |

## CIRCLE MODEL NUMBER OF CALCULATOR

CASIO 260          SHARP 520          TI 30

NOTES:

1. Be sure you have all 8 sheets of this examination paper. Page 8 is blank. If you continue the solution of a problem on another page, indicate clearly by page number where your calculations are continued. You may write on the back sides of sheets, if necessary.

2. Answer all 5 (five) equal-valued questions.

3. No other paper will be accepted for marking nor allowed on the desk.

4. The permissible calculators are listed above.

5. Solutions must include free body diagrams.

### DO NOT WRITE IN THIS SPACE.

| | |
|---|---|
| 1. | /12 |
| 2. | /12 |
| 3. | /12 |
| 4. | /12 |
| 5. | /12 |
| **TOTAL** | /60 |

1. (a) Sketch the shear and moment diagrams for the horizontal beam AD.
   (b) Select the most economical wide-flange steel section from those given on Page 3 for the beam AD. Assume that the yield stress for the steel is 360 MPa and the load factor is 2.0.

25 kN/m

A

B

C

D

70 kN·m

50 kN

2 m

6 m

3 m

FBD
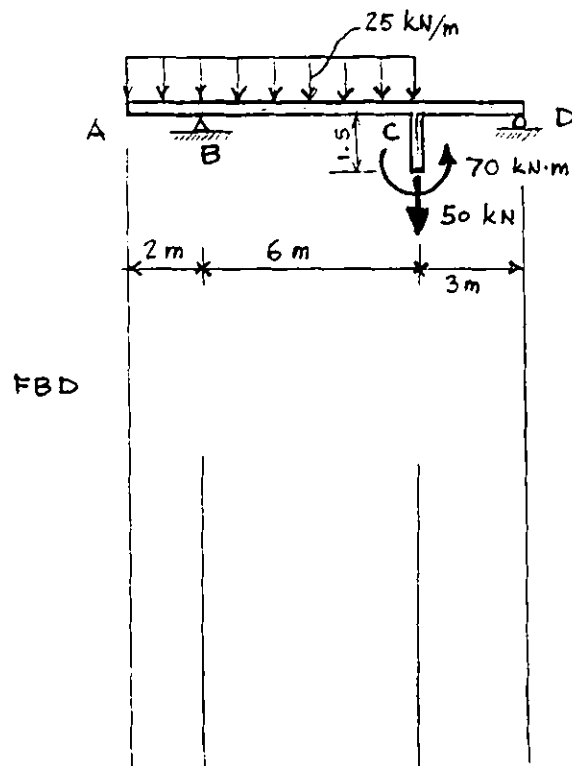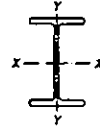
Wide-Flange Beams (SI Units)

| Designation[*] | Area (mm²) | Depth (mm) | FLANGE Width (mm) | FLANGE Thickness (mm) | Web Thickness (mm) | AXIS X-X I (10⁶ mm⁴) | AXIS X-X S (10³ mm³) | r (mm) | AXIS Y-Y I (10⁶ mm⁴) | AXIS Y-Y S (10³ mm³) | r (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| W914 × 342 | 43610 | 912 | 418 | 32.0 | 19.3 | 6245 | 13715 | 378 | 391 | 1870 | 94.7 |
| × 238 | 30325 | 915 | 305 | 25.9 | 16.5 | 4060 | 8880 | 366 | 123 | 805 | 63.5 |
| W838 × 299 | 38130 | 855 | 400 | 29.2 | 18.2 | 4785 | 11210 | 356 | 312 | 1560 | 90.4 |
| × 226 | 28850 | 851 | 294 | 26.8 | 16.1 | 3395 | 7980 | 343 | 114 | 775 | 62.7 |
| × 193 | 24710 | 840 | 292 | 21.7 | 14.7 | 2795 | 6655 | 335 | 90.7 | 620 | 60.7 |
| W762 × 196 | 25100 | 770 | 268 | 25.4 | 15.6 | 2400 | 6225 | 310 | 81.6 | 610 | 57.2 |
| × 161 | 20450 | 758 | 266 | 19.3 | 13.8 | 1860 | 4900 | 302 | 60.8 | 457 | 54.6 |
| W686 × 217 | 27675 | 695 | 355 | 24.8 | 15.4 | 2345 | 6735 | 290 | 184 | 1040 | 81.5 |
| × 140 | 17870 | 684 | 254 | 18.9 | 12.4 | 1360 | 3980 | 277 | 51.6 | 406 | 53.8 |
| W610 × 155 | 19740 | 611 | 324 | 19.1 | 12.7 | 1290 | 4230 | 257 | 108 | 667 | 73.9 |
| × 125 | 15935 | 612 | 229 | 19.6 | 11.9 | 985 | 3210 | 249 | 39.3 | 342 | 49.5 |
| × 92 | 11750 | 603 | 179 | 15.0 | 10.9 | 645 | 2145 | 234 | 14.4 | 161 | 35.1 |
| W533 × 150 | 19225 | 543 | 312 | 20.3 | 12.7 | 1005 | 3720 | 229 | 103 | 660 | 73.4 |
| × 124 | 15675 | 544 | 212 | 21.2 | 13.1 | 762 | 2800 | 220 | 33.9 | 320 | 46.5 |
| × 92 | 11805 | 533 | 209 | 15.6 | 10.2 | 554 | 2080 | 217 | 23.9 | 228 | 45.0 |
| W457 × 144 | 18365 | 472 | 283 | 22.1 | 13.6 | 728 | 3080 | 199 | 83.7 | 592 | 67.3 |
| × 113 | 14385 | 463 | 280 | 17.3 | 10.8 | 554 | 2395 | 196 | 63.3 | 452 | 66.3 |
| × 89 | 11355 | 463 | 192 | 17.7 | 10.5 | 410 | 1770 | 190 | 20.9 | 218 | 42.9 |
| W406 × 149 | 18970 | 431 | 265 | 25.0 | 14.9 | 620 | 2870 | 180 | 77.4 | 585 | 64.0 |
| × 100 | 12710 | 415 | 260 | 16.9 | 10.0 | 397 | 1915 | 177 | 49.5 | 380 | 62.5 |
| × 60 | 7615 | 407 | 178 | 12.8 | 7.7 | 216 | 1060 | 168 | 12.0 | 135 | 39.9 |
| × 39 | 4950 | 399 | 140 | 8.8 | 6.4 | 125 | 629 | 159 | 3.99 | 57.2 | 28.4 |
| W356 × 179 | 22775 | 368 | 373 | 23.9 | 15.0 | 574 | 3115 | 158 | 206 | 1105 | 95.0 |
| × 122 | 15550 | 363 | 257 | 21.7 | 13.0 | 367 | 2015 | 154 | 61.6 | 480 | 63.0 |
| × 64 | 8130 | 347 | 203 | 13.5 | 7.7 | 178 | 1025 | 148 | 18.8 | 185 | 48.0 |
| × 45 | 5710 | 352 | 171 | 9.8 | 6.9 | 121 | 688 | 146 | 8.16 | 95.4 | 37.8 |
| W305 × 143 | 18195 | 323 | 309 | 22.9 | 14.0 | 347 | 2145 | 138 | 112 | 728 | 78.5 |
| × 97 | 12325 | 308 | 305 | 15.4 | 9.9 | 222 | 1440 | 134 | 72.4 | 477 | 76.7 |
| × 74 | 9485 | 310 | 205 | 16.3 | 9.4 | 164 | 1060 | 132 | 23.4 | 228 | 49.8 |
| × 45 | 5670 | 313 | 166 | 11.2 | 6.6 | 99.1 | 633 | 132 | 8.45 | 102 | 38.6 |
| W254 × 89 | 11355 | 260 | 256 | 17.3 | 10.7 | 142 | 1095 | 112 | 48.3 | 377 | 65.3 |
| × 67 | 8580 | 257 | 204 | 15.7 | 8.9 | 103 | 805 | 110 | 22.2 | 218 | 51.1 |
| × 45 | 5705 | 266 | 148 | 13.0 | 7.6 | 70.8 | 531 | 111 | 6.95 | 94.2 | 34.8 |
| × 33 | 4185 | 258 | 146 | 9.1 | 6.1 | 49.1 | 380 | 108 | 4.75 | 65.1 | 33.8 |
| W203 × 60 | 7550 | 210 | 205 | 14.2 | 9.1 | 60.8 | 582 | 89.7 | 20.4 | 200 | 51.8 |
| × 46 | 5890 | 203 | 203 | 11.0 | 7.2 | 45.8 | 451 | 88.1 | 15.4 | 152 | 51.3 |
| × 36 | 4570 | 201 | 165 | 10.2 | 6.2 | 34.5 | 342 | 86.7 | 7.61 | 92.3 | 40.9 |
| × 22 | 2865 | 206 | 102 | 8.0 | 6.2 | 20.0 | 193 | 83.6 | 1.42 | 27.9 | 22.3 |
| W152 × 37 | 4735 | 162 | 154 | 11.6 | 8.1 | 22.2 | 274 | 68.6 | 7.12 | 91.9 | 38.6 |
| × 24 | 3060 | 160 | 102 | 10.3 | 6.6 | 13.4 | 167 | 66.0 | 1.84 | 36.1 | 24.6 |
| W127 × 24 | 3020 | 127 | 127 | 9.1 | 6.1 | 8.87 | 139 | 54.1 | 3.13 | 49.2 | 32.3 |
| W102 × 19 | 2470 | 106 | 103 | 8.8 | 7.1 | 4.70 | 89.5 | 43.7 | 1.61 | 31.1 | 25.4 |

*W means wide-flange beam, followed by the nominal depth in mm, then the mass in kg per meter of length.

2.  Members AB, BD, DF, and FH of the bridge truss shown are all to have the same size square timber sections as shown. Assuming that the failure stress for the timber is 40 MPa, and the load factor is 2.8, determine the required dimension "b" for the four members. $E = 12 \times 10^3$ MPa.
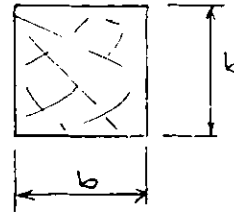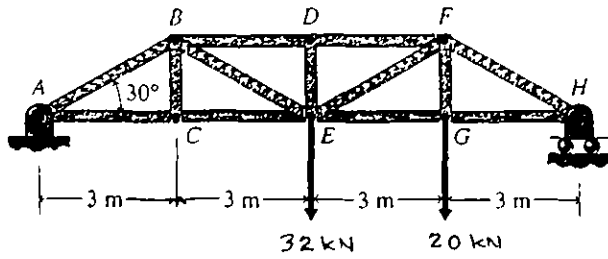
3.  The wall that separates liquid mud (density = 1760 kg/m³) and fresh water is supported by a continuous hinge at the base A and anchor bolts BC which are embedded in the bedrock at C. The attachments of the anchor bolts at the wall and the bedrock are equivalent to pin connections. What is the maximum safe uniform spacing of the anchor bolts in metres if the failure load for each bolt is 120 kN and the load factor is 3.
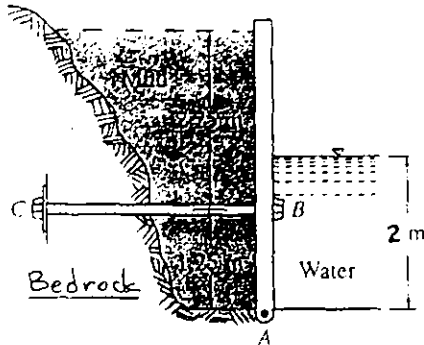
4. The assembly shown consists of two lengths of pipe AB and BC which have been welded together at B. The assembly is supported by special ball-and-socket at A which permits movement in the x-direction, a regular ball-and-socket at C, and by cable DE. The pipe weighs 20N/m. Determine the tension in the cable due to the weight of the pipe.
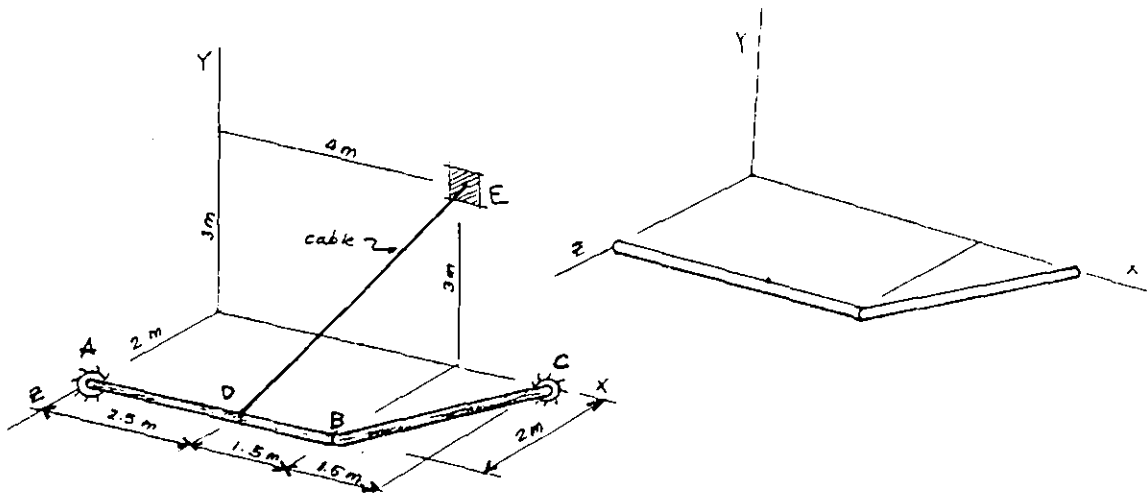
5. Determine the force on the roller at A given that the weight of the cylinder F is 200 N.

Name: _____ _