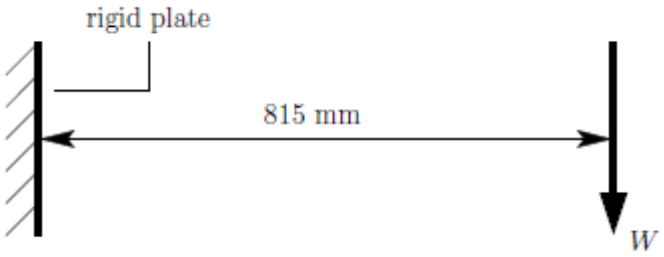
PROBLEM 1S

A structure is required to carry a vertical load *W* at a horizontal distance of 815 mm from a rigid vertical plate as shown. The plate has four pairs of *M*6 tapped holes to which the structure may be attached. The load is applied to the structure through a spreader bar length of 115 mm, thus dividing the applied load into two loads, *W*/2.



The working loads are: *W* = +1350 N and *W* = -135 N; at both these loads, there must be no visible deformation. The load factor at collapse equals 2, and is applicable to both positive and negative values of *W*.

It is essential to confirm the loading arrangements before detailed drawings are made; the designers are responsible for making any required measurements.

The objective is to design a structure with the given material that will satisfy the loading conditions; importantly, the structure must be lightweight and simply made.

MATERIAL DATA FOR MILD STEEL

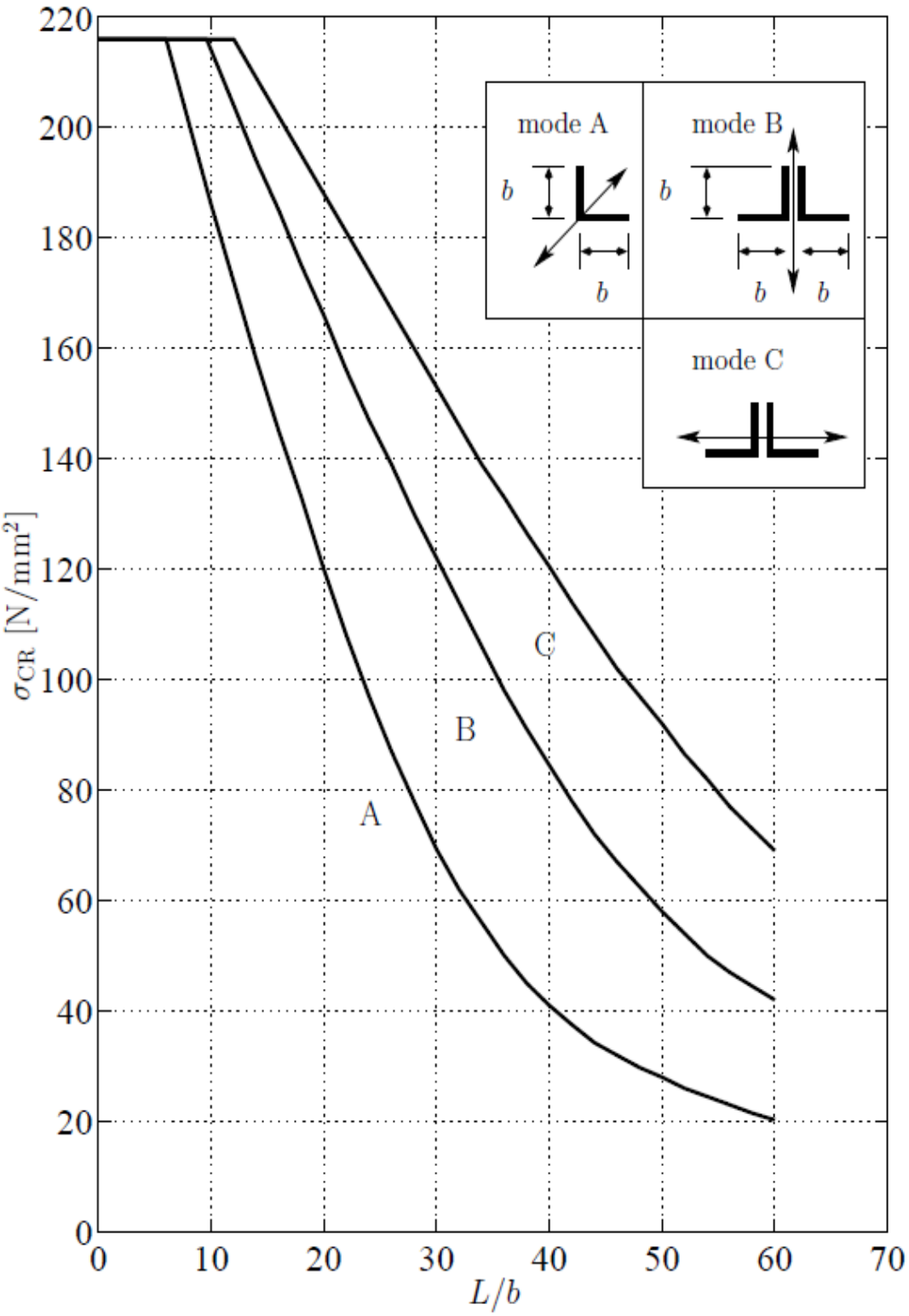
ANGLES			
size [mm]	thickness [mm]	area [mm^2]	mass/length [g/m]
9.5 x 9.5	0.7	13.3	104
12.5 x 12.5	0.7	17.5	137
12.5 x 12.5	0.9	22.5	176
16.0 x 16.0	0.9	28.8	226
16.0 x 16.0	1.1	35.2	276
19.0 x 19.0	1.1	41.8	328

SHEET	
thickness [mm]	mass/area [kg/m^2]
0.7	5.49
0.9	7.06
1.1	8.62
1.4	10.98

size	major diameter [mm]	core area [mm^2]	failure load [kN]			critical load in bearing of sheet thickness [kN]			
			single shear	double shear	tension	0.7 mm	0.9 mm	1.1 mm	1.4 mm
STEEL POP-RIVETS [1]									
-	3.20	-	1.26	2.52	-	1.37	1.76	2.16	2.75
CHEESE-HEAD STEEL NUTS AND BOLTS									
M6	6.00	17.9	4.49	8.98	7.78	1.93	2.48	3.05	3.85
M5	5.00	12.7	3.16	6.32	5.48	1.62	2.07	2.52	3.22
M4	4.00	7.7	1.96	3.92	3.40	1.30	1.66	2.02	2.58

Three lengths of rivet are available, offering three different ranges of grip length: ‘short’, 1.4 – 3.0 mm; ‘medium’, 3.0 – 5.0 mm; and ‘long’, 5.0 – 7.0 mm.

1) H A Evans, *Rivet Testing for the Structural Design Course*, CUED UROP report, 2016


220
200
180
160
140
120
100
80
60
40
20
0
0
10
20
30
40
50
60
70
σ_{CR} [N/mm^2]
L/b
mode A
mode B
mode C
b
b
b
b
b
C
B
A