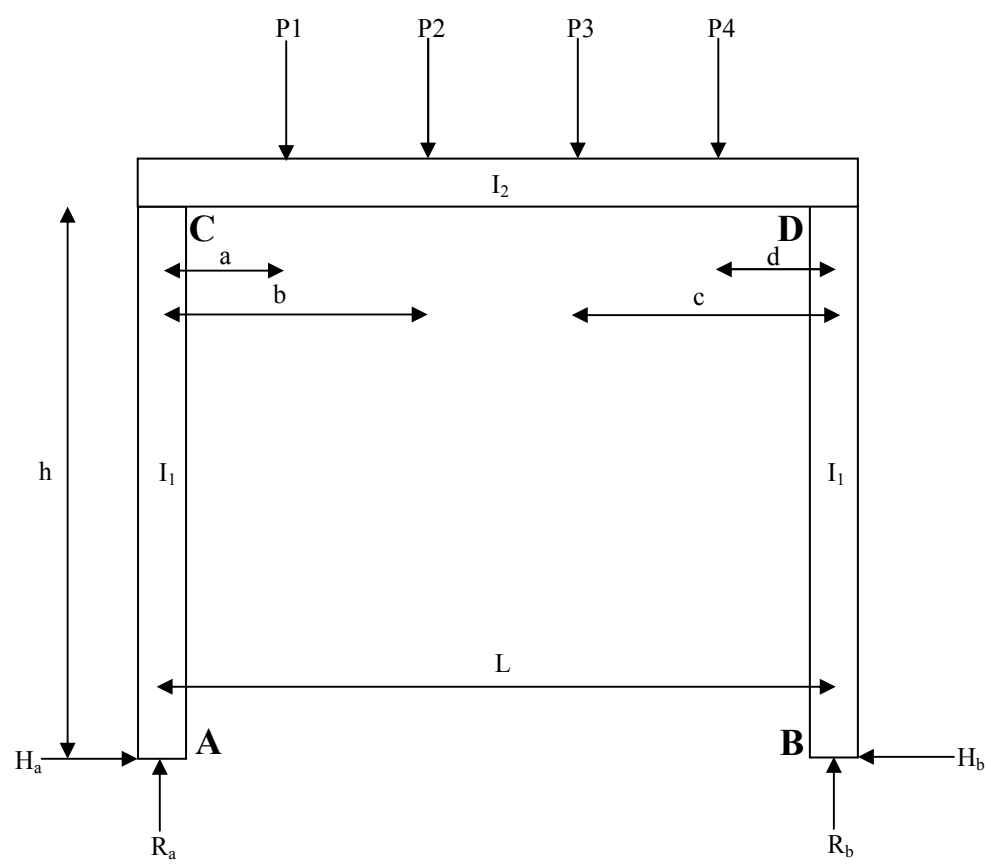


Calculations



L	3.353m
a	0.533m
b	1.295m
c	1.295m
d	0.533m
h	1.829m

Material Properties	
Minimum Yield Strength N/m^2	2.75E+08
Youngs Modulus N/m^2	2.05E+11
Ultimate Tensile Stress	4.10E+08

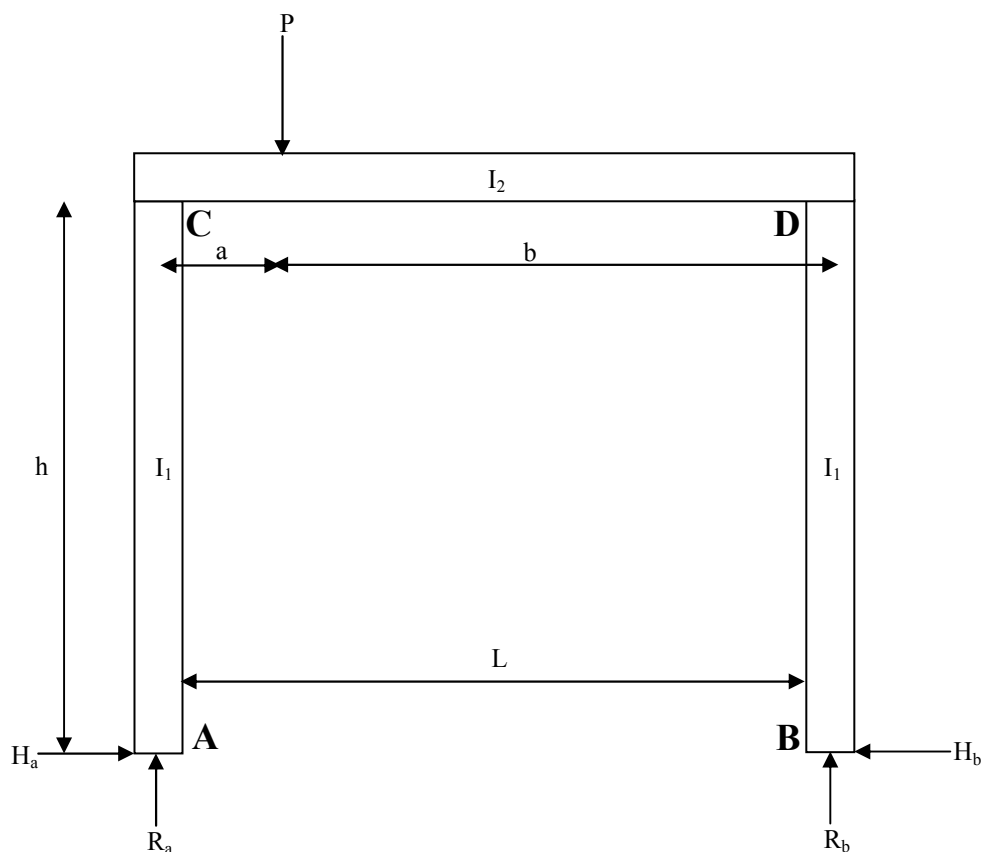
Advanced 275	UKB
Serial Size	254 x 146 x 43
Mass per Metre kg/m	43
Depth of Section D mm	259.6
Width of Section B mm	147.3
Web t mm	7.2
Flange T mm	12.7
Root Raduis r mm	7.6
Depth Between Fillets d mm	219
Second Moment of Area Axis x-x cm^4	6544
Second Moment of Area Axis y-y cm^4	677

Area of Section cm ²	54.8
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Load Properties	
Nominal Diameter m	0.4
Mass of Pipe Material kg/m	122
Density of Water kg/m ³	1000
Length of Supported Pipe P1 m	11.4
Length of Supported Pipe P2 m	9.8
Length of Supported Pipe P3 m	8.325
Length of Supported Pipe P4 m	6.6
Mass of Pipe P1 kg	1390.8
Mass of Pipe P2 kg	1195.6
Mass of Pipe P3 kg	1015.65
Mass of Pipe P4 kg	805.2
Mass of Water P1 kg	1432.56625
Mass of Water P2 kg	1231.50432
Mass of Water P3 kg	1046.150354
Mass of Water P4 kg	829.3804605
Mass of Lagging P1 kg	539.17326
Mass of Lagging P2 kg	463.49982
Mass of Lagging P3 kg	393.7383675
Mass of Lagging P4 kg	312.15294

Loads	
P1 N	33340.11159
P2 N	28710.42561
P3 N	24442.43385
P4 N	19451.05366

1.1.H_a and H_b Reaction Forces at Bases



Reaction Forces to be calculated for each individual load and then totalled.

$$k = \frac{I_2}{I_1} \cdot \frac{h}{L}$$

$$N_1 = k + 2$$

$$N_2 = 6k + 1$$

$$b = L - a$$

$$b_1 = \frac{b}{L}$$

$$a_1 = \frac{a}{L}$$

$$H_a = H_b = \frac{3Pab}{2LhN_1}$$

H_a due to P₁

$$k = \frac{0.00006544}{0.00000677} \cdot \frac{1.829}{3.353}$$

$$k = 0.056432$$

$$H_a = H_b = \frac{3 \times 33340.11159 \times 0.533 \times (3.353 - 0.533)}{2 \times 3.353 \times 1.829 \times (0.056432 + 2)}$$

$$H_a = H_b = 5960.367 N$$

H_a due to P₂

$$H_a = H_b = 9100.902 N$$

H_a due to P₃

$$H_a = H_b = 7747.993 N$$

H_a due to P₄

$$H_a = H_b = 3477.356 N$$

H_a Total

$$H_a = H_b = 26286.62 N$$

1.2.R_a and R_b Reaction Forces at Bases

1.2.1. R_a Reaction Forces

$$R_a = Pb_1 \left[1 + \frac{a_1(b_1 - a_1)}{N_2} \right]$$

R_a due to P₁

$$R_a = \frac{33340.11159 \times (3.353 - 0.533)}{3.353} \left[1 + \frac{\frac{0.533}{3.353} \times \left(\frac{(3.353 - 0.533)}{3.353} - \frac{0.533}{3.353} \right)}{(6 \times 0.056432) + 1} \right]$$

$$R_a = 30311.52\text{N}$$

R_a due to P₂

$$R_a = 18778.84\text{N}$$

R_a due to P₃

$$R_a = 8455.191\text{N}$$

R_a due to P₄

$$R_a = 1766.917\text{N}$$

R_a Total

$$R_a = 59312.47\text{N}$$

1.2.2. R_b Reaction Forces

$$R_b = P - R_a$$

$$R_b = 105944.025 - 59312.47$$

$$R_b = 46631.55\text{N}$$

1.3. Moments

1.3.1. Moments About A

$$M_A = \frac{Pab}{L} \left[\frac{1}{2N_1} - \frac{b_1 - a_1}{2N_2} \right]$$

M_A Due to P₁

$$M_A = \frac{33340.11159 \times 0.533 \times (3.353 - 0.533)}{3.353} \times \left[\frac{1}{2(0.056432 + 2)} - \frac{\frac{(3.353 - 0.533)}{3.353} - \frac{0.533}{3.353}}{2((6 \times 0.056432) + 1)} \right]$$

$$M_A = -173.876\text{Nm}$$

M_A Due to P₂

$$M_A = 3608.819\text{Nm}$$

M_A Due to P₃

$$M_A = 6375.042\text{Nm}$$

M_A Due to P₄

$$M_A = 4341.497\text{Nm}$$

M_A Total

$$M_A = 14151.48\text{Nm}$$

1.3.2. Moments About B

$$M_B = \frac{Pab}{L} \left[\frac{1}{2N_1} + \frac{b_1 - a_1}{2N_2} \right]$$
$$M_B = M_A + R_a L - Pb$$

M_B Due to P₁

$$M_B = -173.879 + (30311.52 \times 3.353) - (33340.11159 \times (3.353 - 0.533))$$
$$M_B = 7441.55 \text{Nm}$$

M_B Due to P₂

$$M_B = 7488.214 \text{Nm}$$

M_B Due to P₃

$$M_B = 3072.345 \text{Nm}$$

M_B Due to P₄

$$M_B = -101.441 \text{Nm}$$

M_B Total

$$M_B = 17900.67 \text{Nm}$$

1.3.3. Moments About C

$$M_C = -\frac{Pab}{L} \left[\frac{1}{N_1} - \frac{b_1 - a_1}{2N_2} \right]$$
$$M_C = -Hh + M_a$$

M_C Total

$$M_C = (-26289.62 \times 1.829) + 14151.48$$
$$M_C = -33926.7 \text{Nm}$$

1.3.4. Moments About D

$$M_D = -\frac{Pab}{L} \left[\frac{1}{N_1} + \frac{b_1 - a_1}{2N_2} \right]$$
$$M_D = -Hh + M_b$$

M_B Total

$$M_D = (-26289.62 \times 1.829) + 17900.67$$
$$M_D = -30177.6 \text{Nm}$$

1.4. Weld Strength

1.4.1. Upright Support

$$WeldLength = (2 \times 147.3) + (4 \times 12.7) + (2 \times 219) + (4 \times 70.05) = 1063.6mm$$

Using a partial load factor of 1.6 for an imposed load (BS5950)

$$1.6 \times 26286.62 = 42058.592N = 42.06kN$$

Calculating shear force (Structural Steelwork design To Limit State Theory 2nd Edition)

$$F_s = \frac{P}{L}$$
$$F_s = \frac{42.06}{1063.6}$$
$$F_s = 0.03954kN/mm$$

Second moment of inertia

$$I_x = \frac{BD^2}{2} + \frac{d^3}{6}$$
$$I_x = \frac{147.3 \times 259.6^2}{2} + \frac{219^3}{6}$$
$$I_x = 6714009.084mm^4$$

Load due to moment

$$F_T = \frac{1.6.(M_A.D)}{2I_x}$$
$$F_T = \frac{1.6.(17900.67 \times 219)}{2 \times 6714009.084}$$
$$F_T = 0.5537kN/mm$$

Resultant Force

$$F_R = \sqrt{F_T^2 + F_s^2}$$
$$F_R = \sqrt{0.5537^2 + 0.03954^2}$$
$$F_R = 0.5551kN/mm$$

Therefore a weld leg length of 8mm should be acceptable since:

$$1.2kN/mm > 0.5551kN/mm$$

1.4.2. Beam Welds

Assuming moment is taken on the beam depth of fillet

$$Force = \frac{M_c}{Depth\ of\ Fillet}$$

$$Force = \frac{33926.7}{0.219}$$

$$Force = 154916.44N$$

Using a partial load factor of 1.6 for an imposed load (BS5950)

$$1.6 \times 154916.44 = 247866.3N = 247.87kN$$

Weld leg length 8mm, therefore weld strength is 1.2kN/mm

$$WeldLength = \frac{Force}{Strength\ of\ fillet\ weld}$$

$$WeldLength = \frac{247.87}{1.2}$$

$$WeldLength = 206.56mm$$

Since the depth of the fillet is 219mm and we have a weld over the length of 2

$$438mm > 206.56mm$$

Therefore the weld should be acceptable.

Table 2 — Partial factors for loads γ_f

Type of load and load combination	Factor γ_f
Dead load, except as follows.	1.4
Dead load acting together with wind load and imposed load combined.	1.2
Dead load acting together with crane loads and imposed load combined.	1.2
Dead load acting together with crane loads and wind load combined.	1.2
Dead load whenever it counteracts the effects of other loads.	1.0
Dead load when restraining sliding, overturning or uplift.	1.0
Imposed load.	1.6
Imposed load acting together with wind load.	1.2
Wind load.	1.4
Wind load acting together with imposed load.	1.2
Storage tanks, including contents.	1.4
Storage tanks, empty, when restraining sliding, overturning or uplift.	1.0
Earth and ground-water load, worst credible values, see 2.2.4.	1.2
Earth and ground-water load, nominal values, see 2.2.4.	1.4
Exceptional snow load (due to local drifting on roofs, see 7.4 in BS 6399-3:1988).	1.05
Forces due to temperature change.	1.2
Vertical crane loads.	1.6
Vertical crane loads acting together with horizontal crane loads.	1.4 ^a
Horizontal crane loads (surge, see 2.2.3, or crabbing, see 4.11.2).	1.6
Horizontal crane loads acting together with vertical crane loads.	1.4
Vertical crane loads acting together with imposed load.	1.4 ^a
Horizontal crane loads acting together with imposed load.	1.2
Imposed load acting together with vertical crane loads.	1.4
Imposed load acting together with horizontal crane loads.	1.2
Crane loads acting together with wind load.	1.2 ^a
Wind load acting together with crane loads.	1.2

^a Use $\gamma_f = 1.0$ for vertical crane loads that counteract the effects of other loads.

4.4.7 Bracket connection

Various assumptions are made for the analysis of forces in bracket connections. Consider the bracket shown in Figure 4.25(a), which is cut from a universal beam with a flange added to the web. The bracket is connected by fillet welds to the column flange. The flange welds have a throat thickness of unity and the web welds a throat thickness q , a fraction of unity. Assume rotation about the centroidal axis XX. Then:

$$\begin{aligned}\text{Weld length} & L = 2b + 2aq \\ \text{Moment of inertia} & I_x = bd^2/2 + qa^3/6 \\ \text{Direct shear} & F_s = P/L \\ \text{Load due to moment} & F_T = Ped/2I_x \\ \text{Resultant load} & F_R = (F_T^2 + F_s^2)^{0.5}\end{aligned}$$

Select the weld size from Table 4.5.

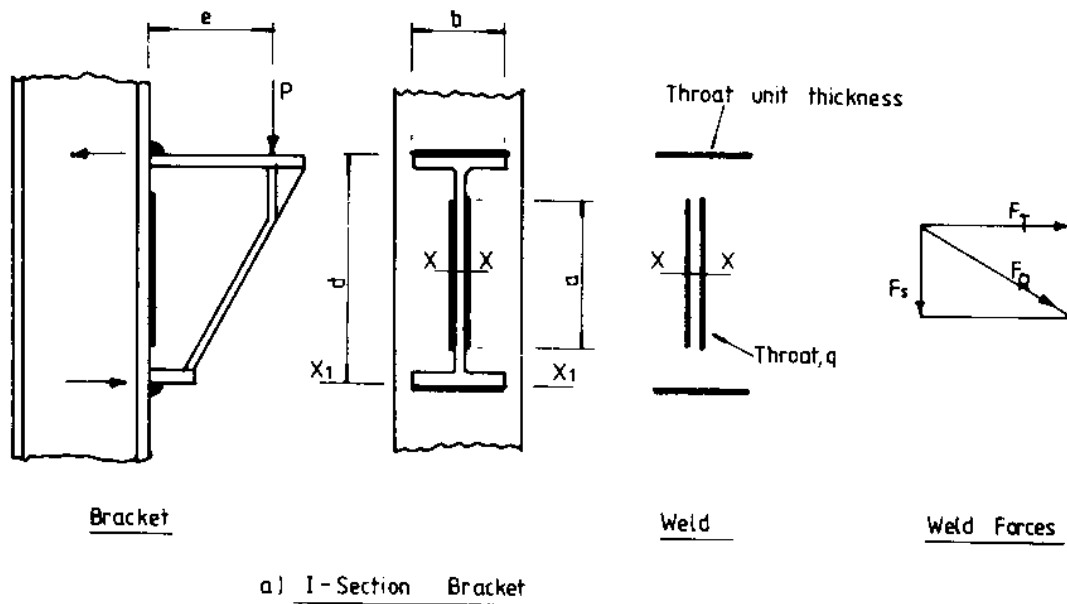


Table 4.5 Strength of fillet welds (kN/mm)

Weld size or leg length	43		Steel grade 50		55
	Electrode E-43 E-51		Electrode E-43 E-51		Electrode E-51
5	0.75		0.75	0.89	0.89
6	0.90		0.90	1.07	1.07
8	1.20		1.20	1.42	1.42
10	1.50		1.50	1.78	1.78
12	1.80		1.80	2.14	2.14