CALCULATION TITLE SHEET

Client: 10 Prendwick Avenue, Mr Craigs, Job No. UK22P02

Calculated by AM

Project: Steel beam calculation for 7.69m clear span Dates 09/08/2022

Purpose / Work Stage:	Method of Designing:
Assessment of the loading conditions and structural design of the steel beam to opening.	Hand calculation sheets and Tekla Structural Designer.

Rev. No.	Date	Description / Reason for Issue	Orig.
01	09/08/22	First Issue	AM

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Contents

1 Introduction

This report covers the structural design of the steel beam with a clear span of 7.69m to support flat roof and parapet.

2 References

- BS EN 1991-1-1:2002 – Eurocode 1: Actions on structures
- BS EN 1993-1-1:2005 – Eurocode 3: Design of steel structures
- BS EN 1997-1:2004 – Eurocode 7: Geotechnical Design
- NHBC Standards 2022

3 Proposed Works

3.1 Description

The proposed GA of the extension is shown in the figure below.

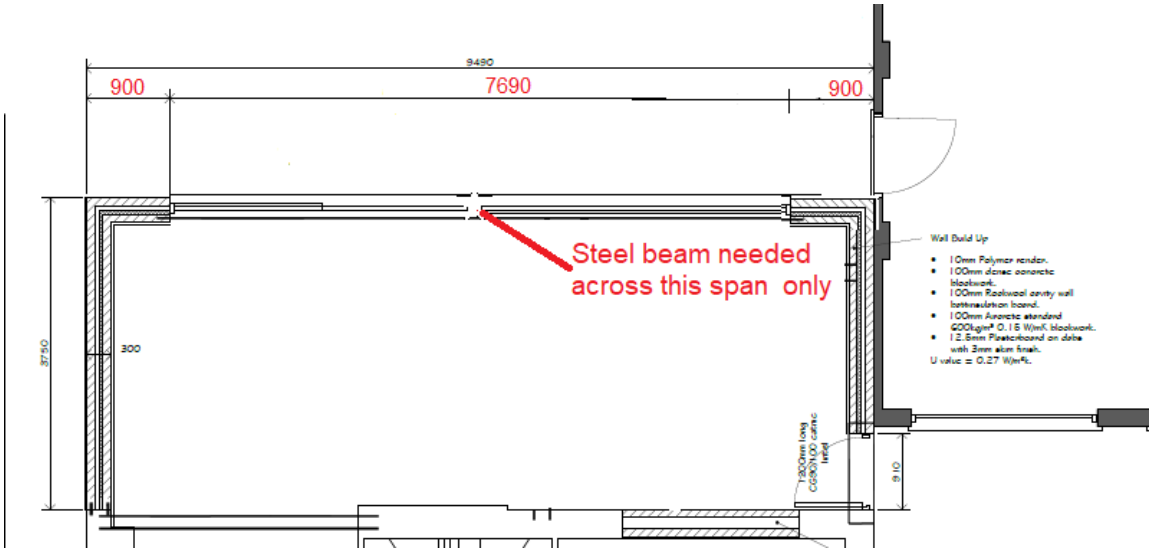


Figure 1: Plan view.

3.2 Loading Conditions

The loading conditions are summarized below.

Load Calculation

Flat Roof

Dead Load

Waterproofing	0.45	kN/m^2
Boarding	0.15	kN/m^2
Joists	0.3	kN/m^2
Insulation	0.05	kN/m^2
Ceiling and services	0.2	kN/m^2
Total	1.15	kN/m^2

Live Load

Snow	0.6	kN/m^2

Parapet load

Insulation	0.1	kN/m^2
Concrete Block work	5.4	kN/m^2
Additional Loading	1	kN/m^2
Total	6.5	kN/m^2

4 Design Calculations

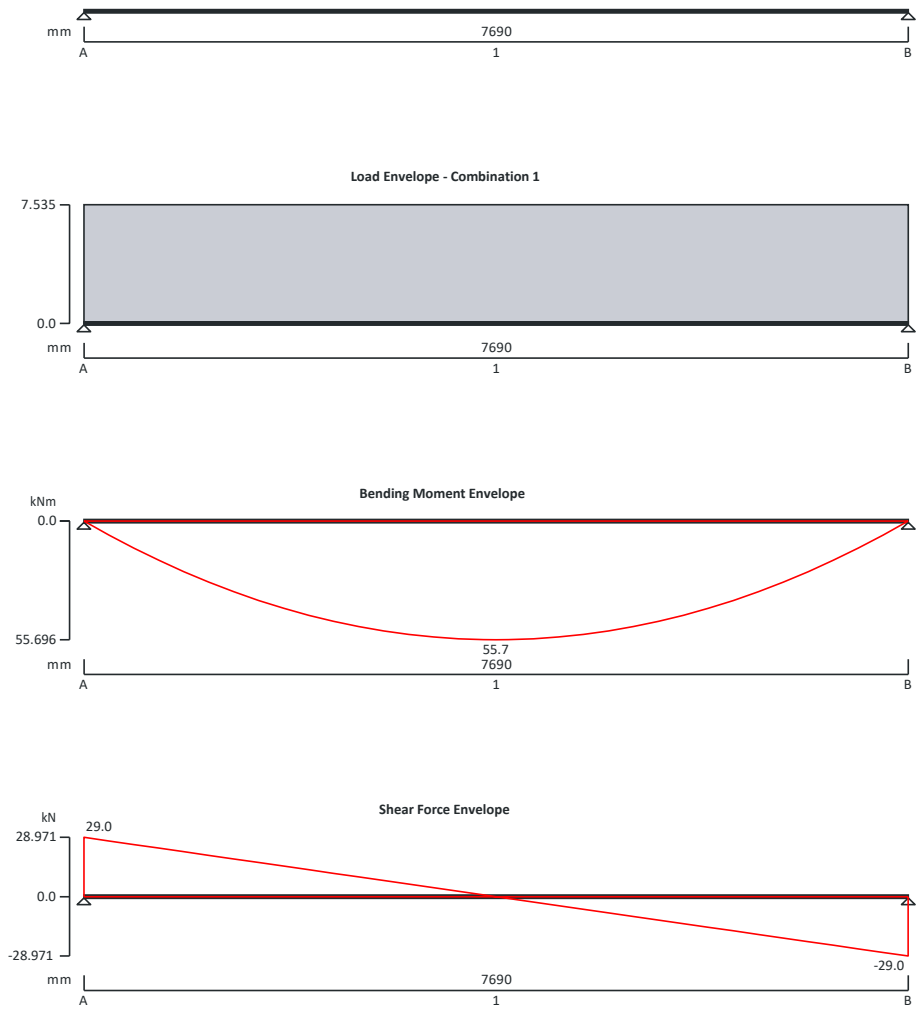
4.1 Beam design

Beam Design			***L =***		***7.69***	***m***		
Flat Roof								
	Horizontal distance of influence:			= 3.75m/2 =		1.875	m	
	Dead Load	1.15	kN/m^2 x		1.875	m =	2.16	kN/m
	Live Load	0.60	kN/m^2 x		1.875	m =	1.13	kN/m
Parapet	Parapet wall width:					0.3	m	
	Dead Load	6.50	kN/m^2 x		0.3	m =	1.95	kN/m
Total								
	Dead Load						4.11	kN/m
	Live Load						1.13	kN/m

STEEL BEAM ANALYSIS & DESIGN (EN1993-1-1:2005)

In accordance with EN1993-1-1:2005 incorporating Corrigenda February 2006 and April 2009 and the UK national annex

TEDDS calculation version 3.0.14



Support conditions	
Support A	Vertically restrained Rotationally free
Support B	Vertically restrained Rotationally free
Applied loading	
Beam loads	Permanent self weight of beam × 1 Variable full UDL 1.13 kN/m Permanent full UDL 4.11 kN/m

Load combinations

Load combination 1	Support A	Permanent × 1.35
		Variable × 1.50
		Permanent × 1.35
		Variable × 1.50
	Support B	Permanent × 1.35
		Variable × 1.50

Analysis results

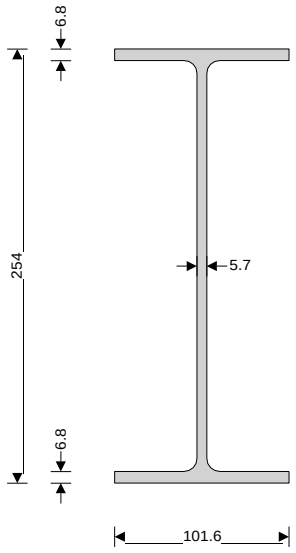
Maximum moment	M_{max} = **55.7** kNm	M_{min} = **0** kNm
Maximum shear	V_{max} = **29** kN	V_{min} = **-29** kN
Deflection	δ_{max} = **8.6** mm	δ_{min} = **0** mm
Maximum reaction at support A	R_{A_max} = **29** kN	R_{A_min} = **29** kN
Unfactored permanent load reaction at support A	$R_{A\_Permanent}$ = **16.6** kN	
Unfactored variable load reaction at support A	$R_{A\_Variable}$ = **4.3** kN	
Maximum reaction at support B	R_{B_max} = **29** kN	R_{B_min} = **29** kN
Unfactored permanent load reaction at support B	$R_{B\_Permanent}$ = **16.6** kN	
Unfactored variable load reaction at support B	$R_{B\_Variable}$ = **4.3** kN	

Section details

Section type	**UB 254x102x22 (BS4-1)**
Steel grade	**S275**

EN 10025-2:2004 - Hot rolled products of structural steels

Nominal thickness of element	t = max(t_f, t_w) = **6.8** mm
Nominal yield strength	f_y = **275** N/mm^2
Nominal ultimate tensile strength	f_u = **410** N/mm^2
Modulus of elasticity	E = **210000** N/mm^2



Partial factors - Section 6.1

Resistance of cross-sections	γ_{M0} = **1.00**
Resistance of members to instability	γ_{M1} = **1.00**
Resistance of tensile members to fracture	γ_{M2} = **1.10**

Lateral restraint

Span 1 has full lateral restraint

Effective length factors

Effective length factor in major axis	K_y = **1.000**
Effective length factor in minor axis	K_z = **1.000**
Effective length factor for torsion	$K_{LT.A}$ = **1.000**
	$K_{LT.B}$ = **1.000**

Classification of cross sections - Section 5.5

$\varepsilon = \sqrt{[235\ N/mm^2 / f_y]}$ = **0.92**

Internal compression parts subject to bending - Table 5.2 (sheet 1 of 3)

Width of section	c = d = **225.2** mm	
	$c / t_w = 42.7 \times \varepsilon <= 72 \times \varepsilon$	Class 1

Outstand flanges - Table 5.2 (sheet 2 of 3)

Width of section	$c = (b - t_w - 2 \times r) / 2$ = **40.3** mm	
	$c / t_f = 6.4 \times \varepsilon <= 9 \times \varepsilon$	Class 1

Section is class 1

Check shear - Section 6.2.6

Height of web	$h_w = h - 2 \times t_f$ = **240.4** mm
Shear area factor	η = **1.000**
	$h_w / t_w < 72 \times \varepsilon / \eta$

Shear buckling resistance can be ignored

Design shear force	$V_{Ed} = max(abs(V_{max}), abs(V_{min}))$ = **29** kN
Shear area - cl 6.2.6(3)	$A_v = max(A - 2 \times b \times t_f + (t_w + 2 \times r) \times t_f, \eta \times h_w \times t_w)$ = **1562** mm^2
Design shear resistance - cl 6.2.6(2)	$V_{c,Rd} = V_{pl,Rd} = A_v \times (f_y / \sqrt{[3]}) / \gamma_{M0}$ = **248** kN

PASS - Design shear resistance exceeds design shear force

Check bending moment major (y-y) axis - Section 6.2.5

Design bending moment	$M_{Ed} = max(abs(M_{s1\_max}), abs(M_{s1\_min}))$ = **55.7** kNm
Design bending resistance moment - eq 6.13	$M_{c,Rd} = M_{pl,Rd} = W_{pl.y} \times f_y / \gamma_{M0}$ = **71.2** kNm

PASS - Design bending resistance moment exceeds design bending moment

Check vertical deflection - Section 7.2.1

Consider deflection due to variable loads

Limiting deflection	$\delta_{lim} = L_{s1} / 360$ = **21.4** mm
Maximum deflection span 1	$\delta = max(abs(\delta_{max}), abs(\delta_{min}))$ = **8.624** mm

PASS - Maximum deflection does not exceed deflection limit

Padstone Calculator

COMPLIES WITH LATEST EUROPEAN DESIGN CODES

structural calculations for padstones

Beam End Reaction = **32.50** kN (factored) Variable Load Safety Factor = 1.5
Factored Load at End of Beam Permanent Load Safety Factor = 1.35

Characteristic strength of masonry = **4.5** N/mm² (Brickwork usually = 4.5 N/mm²)
(3.6N Blockwork usually = 2.6 N/mm²)
Width of beam end bearing = **102** mm (A Engineering Brick = 13.2 N/mm²)
Length of beam end bearing = **100** mm (B Engineering Brick = 10.5 N/mm²)
(Weak Brickwork = approx 2.8 N/mm²)
(7.3N Blockwork usually = 4.2 N/mm²)
(10.4N Blockwork usually = 5.4 N/mm²)

γm = 3.5 Factor of safety

Bearing Factor = **1.25** Use 1.25 for beam perpendicular to wall
Use 1.5 for beam parallel to wall

Results

Maximum Bearing Stress = 1.61 N/mm²
Actual Bearing Stress = 3.19 N/mm²

Padstone Required

Padstone Results

Characteristic strength of Padstone = **30.0** N/mm² (A Engineering Brick = 13.2 N/mm²)
(B Engineering Brick = 10.5 N/mm²)
Width of Padstone = **140** mm (Concrete C15 = 15 N/mm²)
Length of Padstone = **215** mm (Concrete C30 = 30 N/mm²)
(Concrete C40 = 40 N/mm²)
(Steel Plate = 275 N/mm²)

Allowable padstone stress = 12.50 N/mm²
Stress under beam end bearing = 3.19 N/mm² Therefore Padstone Stress OK
Allowable masonry stress = 1.88 N/mm²
Stress under padstone = 1.08 N/mm² Therefore Masonry Stress OK

5 Conclusions

The calculation shows that to carry the loads of the roof and parapet a UB254x102x22 beam would be required with a minimum steel grade of S275. Beam to extend on the sides over the clear span for a minimum of 300mm on both side and a C30 140mmx215mm padstone to be used.