STRUCTURAL ALTERATIONS AT
1 NORTHCOTE DRIVE, BARROW
STRUCTURAL DESIGN

D. J LINGARD BSc (Hons) C Eng MICE

D. J. LINGARD AND ASSOCIATES LTD

CONSULTING CIVIL AND STRUCTURAL ENGINEERS

26 ST. JAMES STREET

ACCRINGTON

LANCS. BB5 1NT

PROJECT NO. 8066 **DATE: 19TH MAY, 2025**

BEAM DESIGN

DESIGN REFERENCES:

EUROCODE 3 THE DESIGN OF STRUCTURAL STEELWORK

LOADINGS

Roof

Dead 1.25 kN/m^2

Live 0.75 kN/m^2

First Floor

Dead 0.50 kN/m^2

Live 1.50 kN/m^2

Timber Partitions

Dead 0.50 kN/m^2

Masonry

102 mm Brickwork	2.00 kN/m^2
100 mm Concrete Blockwork	2.00 kN/m^2
Plaster Per Side	0.30 kN/m^2
Render Per Side	0.60 kN/m^2

STRUCTURAL ANALYSIS AND DESIGN

The structural analysis will be carried out using "Masterseries" software utilising the following Load Factors.

Safety Factors For Loads	ULS	SLS
Dead Loads	1.35	1.00
Live Loads	1.50	1.00

DESIGN OF BEAM OVER BI-FOLD DOORS

Clear Span 6.0 m

Design Span 6.2 m

Roof Loads

Dead = (3/2) x 1.25 = 1.875 kN/m

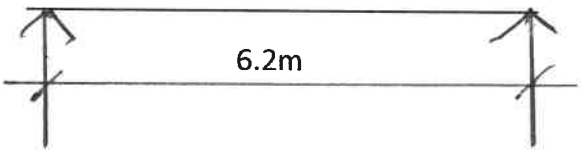
Live = (3/2) x 0.75 = 1.125 kN/m

Masonry Loads

Dead = 0.3 x 5.00 = 1.50 kN/m

Dead = 3.375 kN/m

Live = 1.125 kN/m



UNFACTORED LOADINGS

USE 203 X 203 X 46 UC WITH 6mm STEEL PLATE WELDED TO BOTTOM FLANGE – 150 mm MINIMUM BEARINGS

D.J. LINGARD & ASSOCIATES
Consulting Civil and Structural Engineers
26 St. James Street
Accrington, Lancashire BB5 1NT
Tel : (01254) 399711 **Fax : (01254) 233804**

11302

Job Ref : BEAM SPAN 6.2 m
Sheet : 8066 /003
Made by : DJL
Date : 19 May 2025 / Ver. 2018.06
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Approved :

MasterFrame Data File
Loading Cases and Load Combination

Load Group Labels

Load Group UT	Unity Load Factor (All Cases)
Load Group D1	Dead Load
Load Group L1	Live Load

Load Case 001 : Dead + Live (Ultimate)
Load Combination + 1.00 UT + 1.35 D1 + 1.50 L1

Load Case 002 : Dead + Live (Serviceability)
Load Combination + 1.00 UT + 1.00 D1 + 1.00 L1

Load Case 003 : Live Load Only (Serviceability)
Load Combination + 1.00 UT + 1.00 L1

The Nodal Co-ordinates

Node	X (m)	Y (m)	Z (m)	Node	X (m)	Y (m)	Z (m)
1	0.000	0.000	0.000	2	6.200	0.000	0.000

Member Properties

Member 1
M ... ... 203x203 UC 46 [S 275]
A 58.73E-4 Iy 4571E-8 Iz 1551E-8 It 22.15E-8
E 210.0E6 G 80.77E6

Member Loading

Member Self Weight Density Load Included in Load Group D1, defined by Modulus of Elasticity

E kN/mm²	Density kN/m³
>= 200.00	77.01
>= 20.00	24.00
>= 2.00	10.00

Member 1
D1 UDLY -003.375 (kN/m)
L1 UDLY -001.125 (kN/m)

Nodal Loading and Support Conditions

NODE 2
L1 Ls +0000.000 +0000.000 +0000.000 +0000.000 +0000.000 +0000.000
NODE 1
UT Rs 1 1 1 0 0 0 (Pinned)
NODE 2
UT Rs 0 1 0 0 0 0 (Vertical Restraint)

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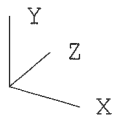

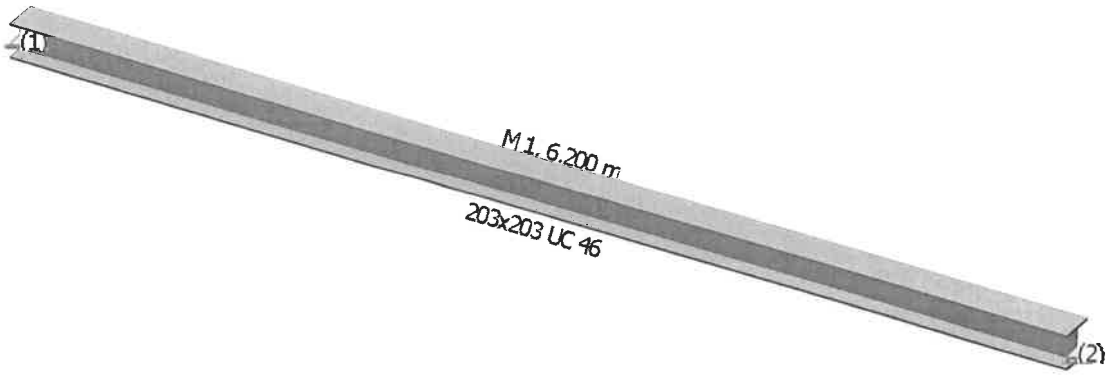

Section Size	
Default Grade S 275	
203x203 UC 46	

Frame Geometry - (Full Frame) - 3D Front View

Not to Scale

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Member Forces Ultimate (001 : Dead + Live (Ultimate))

Member No.	Node End1 End2	Axial Force (kN)	Shear Force (kN)	Bending Moment (kN.m)	Maximum Moment (kN.m @ m)	Maximum Deflection (mm @ m)
1	1	0.000C	21.248	0.000	32.935 @ 3.100	13.737 @ 3.100
	2	0.000C	-21.248	0.000		

Support Reactions (001 : Dead + Live (Ultimate))

Node	Support Reactions (kN and kN.m) Rx→ (kN)	Ry↑ (kN)	Mz↗ (kN.m)	Node	Support Reactions (kN and kN.m) Rx→ (kN)	Ry↑ (kN)	Mz↗ (kN.m)
1	0.000	21.248	0.000	2	0.000	21.248	0.000
Total	0.000	42.497	0.000				

Support Reactions (002 : Dead + Live (Serviceability))

Node	Support Reactions (kN and kN.m) Rx→ (kN)	Ry↑ (kN)	Mz↗ (kN.m)	Node	Support Reactions (kN and kN.m) Rx→ (kN)	Ry↑ (kN)	Mz↗ (kN.m)
1	0.000	15.352	0.000	2	0.000	15.352	0.000
Total	0.000	30.704	0.000				

Support Reactions (003 : Live Load Only (Serviceability))

Node	Support Reactions (kN and kN.m) Rx→ (kN)	Ry↑ (kN)	Mz↗ (kN.m)	Node	Support Reactions (kN and kN.m) Rx→ (kN)	Ry↑ (kN)	Mz↗ (kN.m)
1	0.000	3.488	0.000	2	0.000	3.488	0.000
Total	0.000	6.975	0.000				

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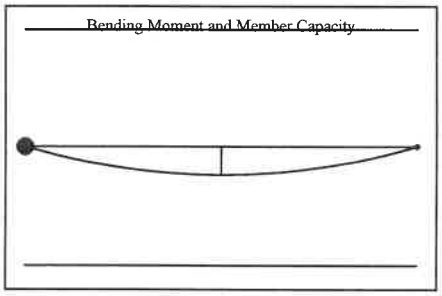
Axial with Moments (Member)
Member SBL1Id 1 @ Level 1 in Load Case 1

Member Loading and Member Forces

Loading Combination : 1 UT + 1.35 D1 + 1.5 L1

D1 UDLY -003.375 (kN/m)
L1 UDLY -001.125 (kN/m)



Member Forces in Load Case 1 and Maximum Deflection from Load Case 2

Member No.	Node End1 / End2	Axial Force (kN)	Shear Force (kN)	Bending Moment (kN.m)	Maximum Moment (kN.m @ m)	Maximum Deflection (mm @ m)
1	1	0.000C	21.248	0.000	32.935	9.925
	2	0.000C	-21.248	0.000 @	3.100 @	3.100

Classification and Effective Area (EN 1993: 2006)

Section (46.1 kg/m)	203x203 UC 46 [S 275]		
Class = Fn(b/T,d/t,f_y,N,M_y,M_z)	9.25, 22.33, 275, 0, 32.93, 0	(Axial: Non-Slender)	Class 1
Auto Design Load Cases	1		

Moment Capacity Check M.c.y.Rd

$V_{y.Ed}/V_{pl.y.Rd}$	0.002 / 269.498 =	0	Low Shear
$M_{c.y.Rd} = f_y.W_{pl.y}/\gamma_{M0}$	275 x 497.4/1	136.785 kN.m	
$M_{y.Ed}/M_{c.y.Rd}$	32.928 / 136.785 =	0.241	OK

Equivalent Uniform Moment Factor C1

C_1= fn(M_1, M_2, M_o,ψ,μ)	0.0, 0.0, 32.9, 0.864, 300.000	1.127	Uniform

Lateral Buckling Check M.b.Rd

Le = 1.00 L	1 x 6.2 =	6.2 m	
M_{cr}= Fn(C_1,L_e,I_z,I_t,I_w,E)	1.127, 6.200, 1551, 22.15, 0.1429, 210000	164.898 kN.m	
$\lambda_{LT}=\sqrt{}$ W.f_y/M_{cr}	$\sqrt{}$ 497.4 x 275 / 164.898	0.911	
γ_{LT}= Fn(λ_{LT},λ_{LT5950})	0.911, 0.872	0.754	Curve b
γ_{LT}.mod = Fn($\gamma_{I.T}$,λ_{LT},k_c,f)	0.754, 0.911, 0.942, 0.972	0.776	6.3.2.3
$M_{b.Rd} = \chi$ $W_{pl.y}.f_y \leq M_{c.y.Rd}$	0.776 x 497.4 x 275≤ 136.785 =	106.084 kN.m	
$M_{y.Ed}/M_{b.Rd}$	32.928 / 106.084	0.310	OK

Deflection Check - Load Case 2

In-span$\delta \leq$ Span/360	9.93≤ 6200 / 360	9.93 mm	OK

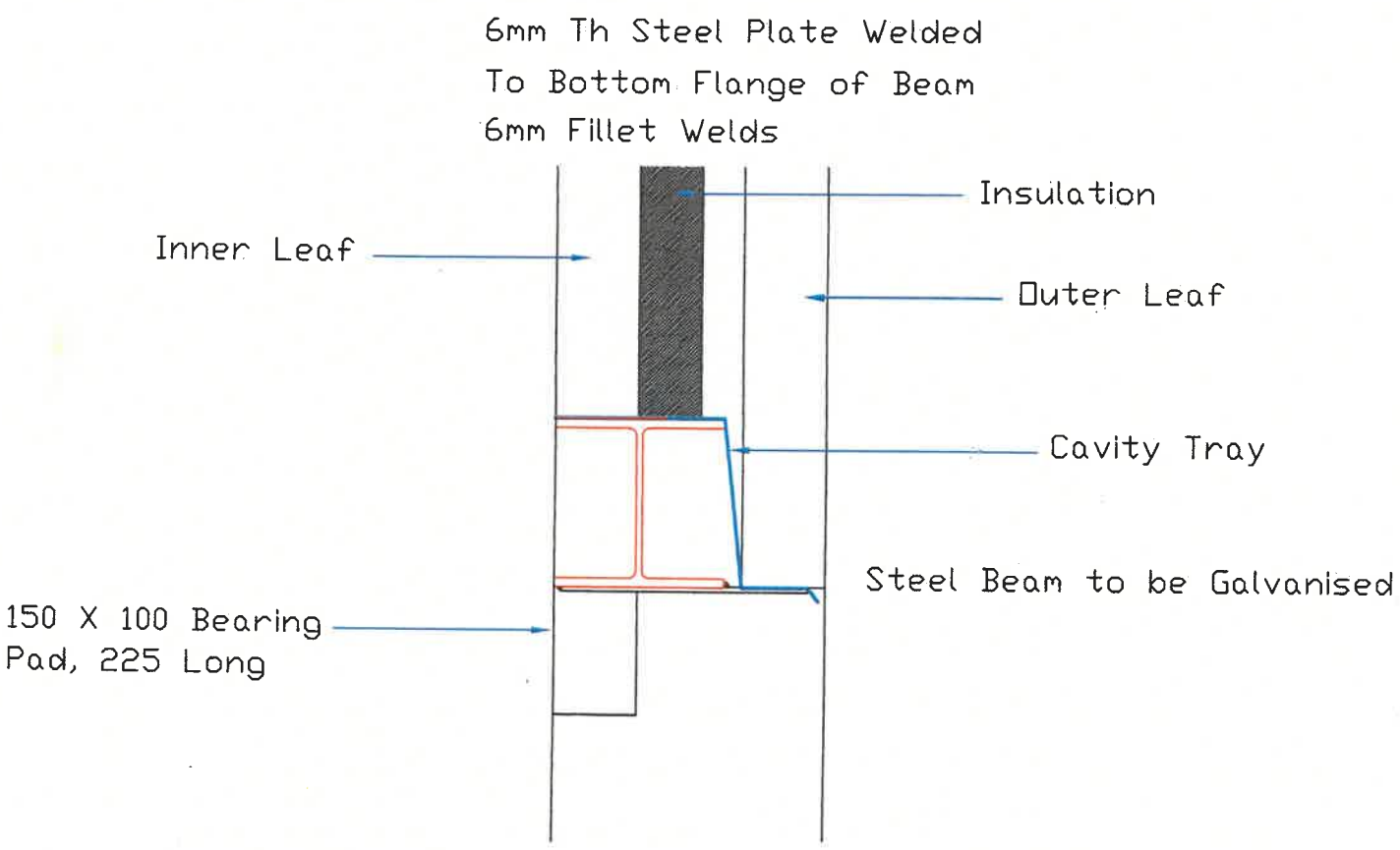
Factored Reaction Under Beam Ends (Max) = 22 kN

For 150 x 100 Concrete Bearing Pad, 225 Long

Design Stress = 22000 / (225 x 100) = 0.977 N/mm^2

Design Strength = (1.5 x f_k) / γ_m = (1.5 x 3.5) / 3.1 = 1.693 N/mm^2 **OK**

USE 150 x 100 CONCRETE BEARING PADS, 225 LONG



DETAIL OF BEAM ARRANGEMENT

EXISTING BEAMS TO SIDE WALL OF UPPER STOREY EXTENSION

Design Span 3.2 m

Roof Load

Dead = (5.6/2) x 1.25 = 3.50 kN/m

Live = (5.6/2) x 0.75 = 2.10 kN/m

Masonry Loads

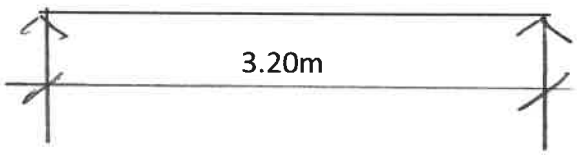
Dead = 2.5 x 5 = 12.50 kN/m

Total Unfactored Dead Load = 16.00 kN/m

Total Unfactored Live Load = 4.50 kN/m

Dead = 16.00 kN/m

Live = 2.10 kN/m



TOTAL UNFACTORED LOADINGS ON BEAMS

DESIGN OF BEAMS SUPPORTING REAR ELEVATION WALL

Clear Span = 6.6 m

Design Span = 6.8 m

INNER BEAM

Unfactored Reactions From Latter Beams

Dead = 8.00 kN

Live = 2.10 kN

Roof Loads

Dead = (3.6/2) x 1.25 = 2.250 kN/m

Live = (3.6/2) x 0.75 = 1.35 kN/m

First Floor Loads

Dead = (3.2/2) x 0.50 = 0.80 kN/m

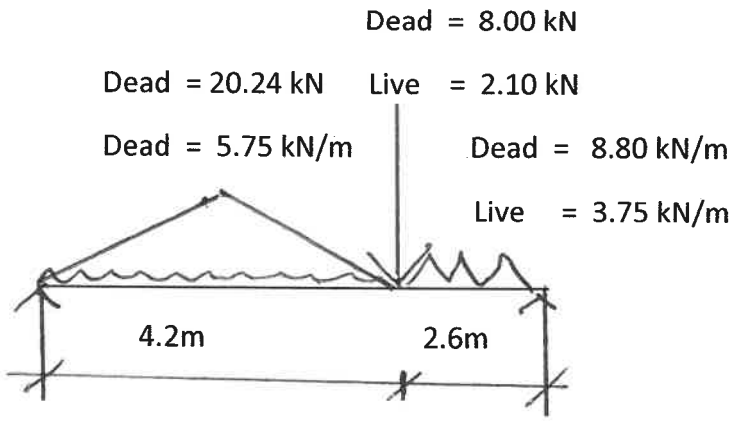
Live = (3.2/2) x 1.50 = 2.40 kN/m

Masonry Loads (UDL)

Dead = 2.5 x 2.3 = 5.75 kN/m

Masonry Load (Triangular)

Dead = (5.5 x 3.2 /2) x 2.3 = 20.24 kN



UNFACTORED LOADINGS ON INNER BEAM

INNER BEAM

Roof Loads

Dead = (3.0/2) x 1.25 = 1.875 kN/m

Live = (3.0/2) x 0.75 = 1.125 kN/m

First Floor Loads (Nil)

Masonry Loads (UDL)

Dead = 2.5 x 2.0 = 5.00 kN/m

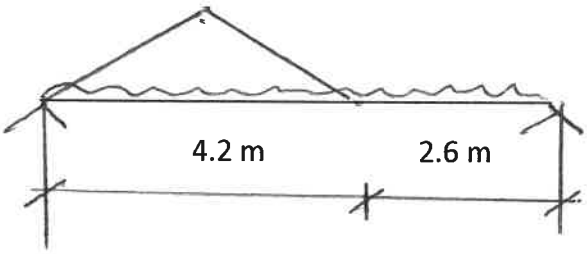
Masonry Load (Triangular)

Dead = (5.5 x 3.2 /2) x 2.0 = 17.60 kN

Dead = 6.875 kN/m

Live = 1.125 kN/m

Dead = 17.80 kN



UNFACTORED LOADINGS ON OUTER BEAM

D.J. LINGARD & ASSOCIATES
Consulting Civil and Structural Engineers
26 St. James Street
Accrington, Lancashire BB5 1NT
Tel : (01254) 399711

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Sheet : 8066 /011
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MasterFrame Data File
Loading Cases and Load Combination

Load Group Labels

Load Group UT	Unity Load Factor (All Cases)
Load Group D1	Dead Load
Load Group L1	Live Load

Load Case 001 : Dead + Live (Ultimate)
Load Combination + 1.00 UT + 1.35 D1 + 1.50 L1

Load Case 002 : Dead + Live (Serviceability)
Load Combination + 1.00 UT + 1.00 D1 + 1.00 L1

Load Case 003 : Live Load Only (Serviceability)
Load Combination + 1.00 UT + 1.00 L1

The Nodal Co-ordinates

Node	X (m)	Y (m)	Z (m)	Node	X (m)	Y (m)	Z (m)
1	0.000	0.000	0.000	2	6.800	0.000	0.000

Member Properties

Member 1
M ... ... 2 No. 305x165 UB 46 [S 275]
A 117.5E-4 Iy 19801E-8 Iz 1795E-8 It 44.39E-8
E 210.0E6 G 80.77E6

Member Loading

Member Self Weight Density Load Included in Load Group D1, defined by Modulus of Elasticity

E kN/mm^2	Density kN/m^3
>= 200.00	77.01
>= 20.00	24.00
>= 2.00	10.00

Member 1
D1 PDLY -024.150 0.000 4.200 (kN,m,m)
D1 PDLY -020.240 0.000 4.200 (kN,m,m)
D1 PDLY -022.880 4.200 6.800 (kN,m,m)
L1 PDLY -009.750 4.200 6.800 (kN,m,m)
D1 PY -008.000 4.200 (kN,m)
L1 PY -002.100 4.200 (kN,m)
D1 UDLY -006.875 (kN/m)
L1 UDLY -001.125 (kN/m)
D1 PDLY -017.800 0.000 4.200 (kN,m,m)

Nodal Loading and Support Conditions

NODE 2
L1 Ls +0000.000 +0000.000 +0000.000 +0000.000 +0000.000 +0000.000
NODE 1
UT Rs 1 1 1 0 0 0 (Pinned)
NODE 2
UT Rs 0 1 0 0 0 0 (Vertical Restraint)

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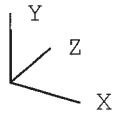

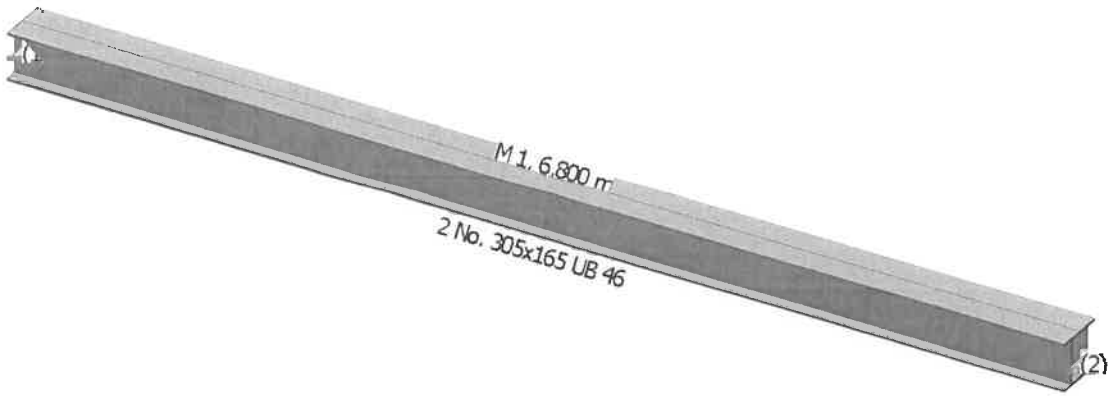

Section Size
Default Grade S 275
2 No. 305x165 UB 46

Frame Geometry - (Full Frame) - 3D Front View

Not to Scale

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Member Forces Ultimate (001 : Dead + Live (Ultimate))

Member No.	Node End1 End2	Axial Force (kN)	Shear Force (kN)	Bending Moment (kN.m)	Maximum Moment (kN.m @ m)	Maximum Deflection (mm @ m)
1	1	0.000C	113.510	0.000	200.191	23.044
	2	0.000C	-112.802	0.000 @	3.545 @	3.400

Support Reactions (001 : Dead + Live (Ultimate))

Node	Support Reactions (kN and kN.m) Rx→ (kN)	Ry↑ (kN)	Mz↗ (kN.m)	Node	Support Reactions (kN and kN.m) Rx→ (kN)	Ry↑ (kN)	Mz↗ (kN.m)
1	0.000	113.510	0.000	2	0.000	112.802	0.000
Total	0.000	226.312	0.000				

Support Reactions (002 : Dead + Live (Serviceability))

Node	Support Reactions (kN and kN.m) Rx→ (kN)	Ry↑ (kN)	Mz↗ (kN.m)	Node	Support Reactions (kN and kN.m) Rx→ (kN)	Ry↑ (kN)	Mz↗ (kN.m)
1	0.000	83.360	0.000	2	0.000	82.112	0.000
Total	0.000	165.472	0.000				

Support Reactions (003 : Live Load Only (Serviceability))

Node	Support Reactions (kN and kN.m) Rx→ (kN)	Ry↑ (kN)	Mz↗ (kN.m)	Node	Support Reactions (kN and kN.m) Rx→ (kN)	Ry↑ (kN)	Mz↗ (kN.m)
1	0.000	6.492	0.000	2	0.000	13.008	0.000
Total	0.000	19.500	0.000				

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Axial with Moments (Member)
Member SBL1Id 1 @ Level 1 in Load Case 1

Member Loading and Member Forces

Loading Combination : 1 UT + 1.35 D1 + 1.5 L1

```
D1 PDLY -024.150 0.000 4.200 (kN,m,m)
D1 PDLY -020.240 0.000 4.200 (kN,m,m)
D1 PDLY -022.880 4.200 6.800 (kN,m,m)
L1 PDLY -009.750 4.200 6.800 (kN,m,m)
D1 PY   -008.000 4.200       ( kN,m )
L1 PY   -002.100 4.200       ( kN,m )
D1 UDLY -006.875             ( kN/m )
L1 UDLY -001.125             ( kN/m )
D1 PDLY -017.800 0.000 4.200 (kN,m,m)
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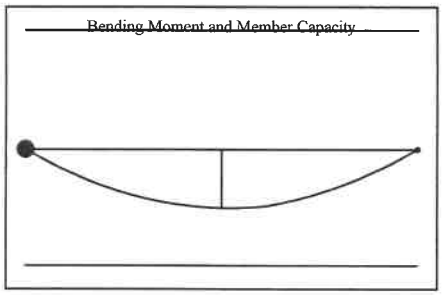


Member Forces in Load Case 1 and Maximum Deflection from Load Case 2

Member No.	Node End1 / End2	Axial Force (kN)	Shear Force (kN)	Bending Moment (kN.m)		Maximum Moment (kN.m @ m)		Maximum Deflection (mm @ m)
1	1	0.000C	113.510	0.000		200.191		16.864
	2	0.000C	-112.802	0.000	@	3.545	@	3.400

Classification and Effective Area (EN 1993: 2006)

Section (46.11 kg/m)	2 No. 305x165 UB 46 [S 275]		
Class = Fn(b/T,d/t,f_y,N,M_y,M_z)	7.02, 39.58, 275, 0, 200.18, 0	(Axial: Non-Slender)	Class 1
Auto Design Load Cases	1		

Moment Capacity Check M.c.y.Rd

$V_{y.Ed}/V_{pl.y.Rd}$	4.109 / 715.29 =	0.006	Low Shear
$M_{c.y.Rd} = f_y.W_{pl.y}/\gamma_{M0}$	275 x 1440/1	396 kN.m	
$M_{y.Ed}/M_{c.y.Rd}$	199.946 / 396 =	0.505	OK

Equivalent Uniform Moment Factor C1

C_1= fn(M_1, M_2, M_o,ψ,μ)	0.1, 0.1, 199.8, 0.800, 300.000	1.127	Uniform

Lateral Buckling Check M.b.Rd

Le = 1.00 L	1 x 6.8 =	6.8 m	
M_{cr}= Fn(C_1,L_e,I_z,I_t,I_w,E)	1.127, 6.800, 1795, 44.39, 0.3888, 210000	233.320 kN.m	
$\lambda_{LT}=\sqrt{}$ W.f_y/M_{cr}	$\sqrt{}$ 1440 x 275 / 233.32	1.303	
γ_{LT}= Fn(λ_{LT},λ_{LT5950})	1.303, 1.352	0.522	Curve b
γ_{LT}.mod = Fn($\gamma_{I.T}$,λ_{LT},k_c,f)	0.522, 1.303, 0.942, 0.986	0.530	6.3.2.3
$M_{b.Rd} = \chi$ $W_{pl.y}.f_y \leq M_{c.y.Rd}$	0.530 x 1440 x 275≤ 396.000 =	209.771 kN.m	
$M_{y.Ed}/M_{b.Rd}$	200.181 / 209.771	0.954	OK

Deflection Check - Load Case 2

In-span$\delta \leq$ Span/360	16.86≤ 6800 / 360	16.86 mm	OK

Maximum Factored Reaction Under Beam Ends (Max) = 114 kN

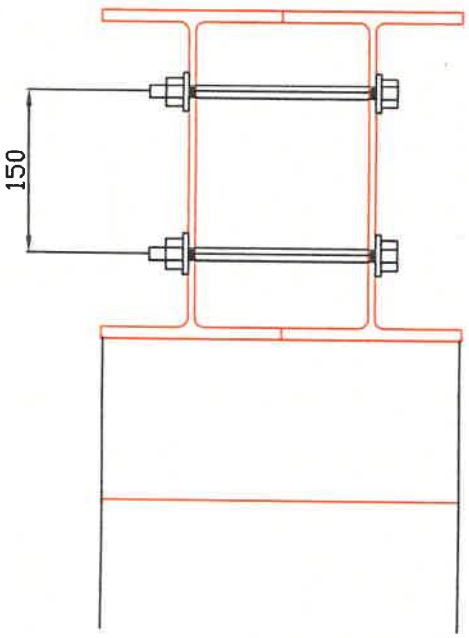
For Concrete Bearing Pad, 327 x 327 x 159 thick

Design Stress = 114000 / (327 x 327) = 1.066 N/mm^2

Design Strength = (1.5 x f_k) / Y_m = (1.5 x 5.4) / 3.1 = 2.613 N/mm^2 **OK**

USE CONCRETE BEARING PADS 327 x 327 x 150 THICK

USE 2NO. 305 X 165 X 46 UB TIED TOGETHER WITH M16 BOLTS AND SPACERS AT 1m MAXIMUM CENTRES– 300 mm MINIMUM BEARINGS.



305 x 165 x 46 UB's
Bearing Length 300mm Minimum

M16 Grade 8.8 Bolts At
1.0m Maximum Spacings
Along Span of Beam

Concrete Bearing Pad
327 x 327 x 150 Thick

327 x 327 Concrete
Common Brickwork Pier

DETAIL OF BEAM ARRANGEMENT

DESIGN OF MASONRY PIERS AND FOUNDATIONS

Maximum Factored Load on Masonry Pier = 114 kN

Slenderness Ratio of Pier = 3000/327 = 9.174

For 0.1t Eccentricity β = 0.88

Design Vertical Load Resistance of Pier = (β x b x t x f_k) / γ_m

DVLR = (0.88 x 327^2 x 5.4) / (3.1×10^3) = 163.91 > 114 OK

USE 327 x 327 CONCRETE COMMON BRICKWORK PIERS WITH 150 THICK FULL PLAN AREA CONCRETE BEARING PADS

Assumed Safe Ground Bearing Pressure of Supporting Strata = 107 kN/m^2 or Greater

Maximum Unfactored Beam Reactions = 84 kN

Weight of Pier = 8 kN

Total Unfactored Load on Foundation = 84 + 8 = 92KN

For 1m x 1m x 0.5m Mass Concrete (Grade C28/35) Foundation

Self Weight = 12 kN

Total Unfactored Load on Ground = 104 kN

Ground Bearing Pressure = 104/(1 x1) = 104 kN/m^2 < 107 OK

USE 1m x 1m x 0.5m MASS CONCRETE (GRADE C28/35) FOUNDATION

DESIGN OF CONNECTIONS

Connection of Existing Beams to 305 x 165 x 46 UB

Maximum Factored Reaction = 16 kN

For M16 Grade 8.8 Bolts

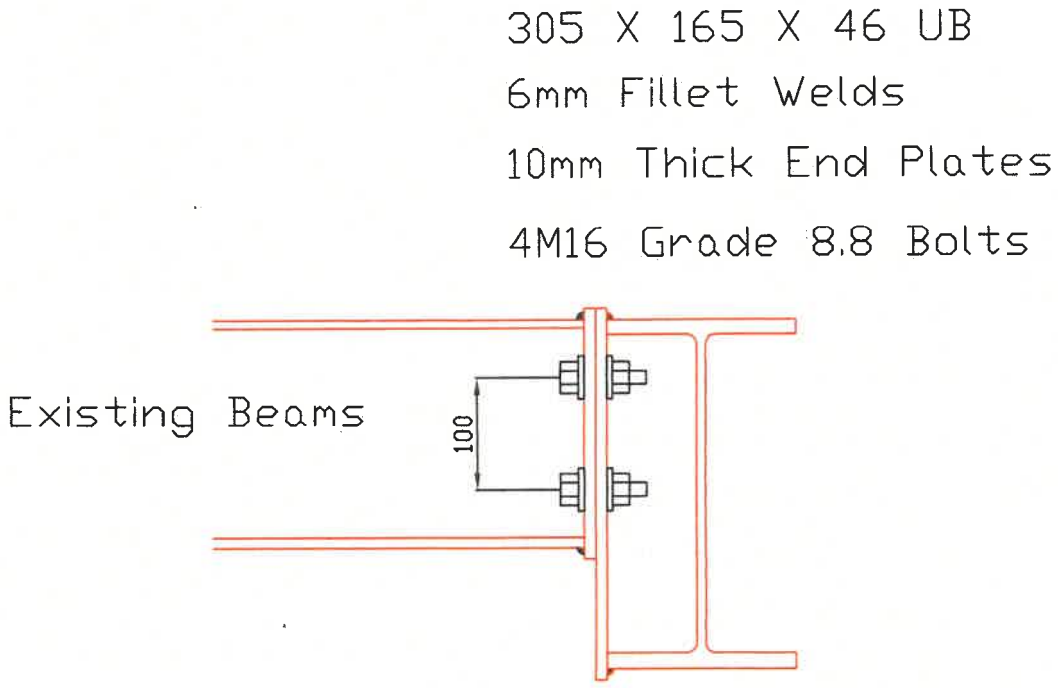
A_s = 157 mm^2

Tensile Capacity of Bolt = 90 kN

Shear Capacity of Bolt = 60 kN

Bearing Capacity of Bolt $_{(10)}$ = 73 kN

Use 4M16 Grade 8.8 Bolts At Each Beam Position With 10mm Thick End Plates



CONNECTION OF EXISTING BEAMS TO 305 X 165 x 46 UB