

Project Title	MOSI Timber Repairs			Project No:	Rev:
				11796R	A
Calculations	Notes	Meeting Minutes	Made By:	Checked By:	Date:
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					Scanned:

Introduction:

- This calculation is for a new timber repair splice connection to the bottom chord of an existing timber truss.
- The existing chord is 165mm wide by 310mm deep, assumed to be C24 timber.
- Calculations are in accordance with BS5268-2

Final loads provided by Buro Happold via email on 17.01.2025:

Truss Type A Location A (7.15m)				
	Fxc	Fxt	Fz	My
DL	0	-56.13	0	1.04
LL	0	-33.20	0	0.62
SN	0	-19.18	0	0.39
W Downward	0	-24.62	0	0.57
W Uplift	23.61	0.00	1.92	0.89
WL - L Down R Up	0	-5.00	5.00	4.50
Truss Type A Location B (9.45m)				
	Fxc	Fxt	Fz	My
DL	0	-65.38	-0.29	0.84
LL	0	-38.68	-0.17	0.5
SN	0	-24.64	-0.11	0.31
W Downward	0	-32.7	-0.16	0.46
W Uplift	30.42	0	-1.09	3.16
WL - L Down R Up	0	-10.00	-4.00	7.00

Loading Sheet (Rev C Loads advised by BH 17.01.2025)

Combination Key

Timber (SLS) Combs

		Load Duration to BS 5268-2	k3
COMB 1	D + L	Medium-Term	1.25
COMB 2	D + L + SN + Wdown	Short term	1.5
COMB 3	D + SN + WL Ldown Rup	Short term	1.5
COMB 4	Wup	Very short-term	1.75
COMB 5	D + L + WL Ldown Rup	Short term	

Steel (ULS) Combs

ULS COMB 1	1.4 D + 1.6 L
ULS Comb 2	1.2D + 1.2L + 1.2Wdown + 1.2S
ULS Comb 3	1.2D + 1.2L + 1.2WLdownRup + 1.2S
ULS Comb 4	1.2D + 1.2L + 1.2WLdownRup

Location A -

7.15m	Fxc	Fxt	Fz	My
DL	0	-56.13	0	1.04
LL	0	-33.2	0	0.62
SN	0	-19.18	0	0.39
W DOWN	0	-24.62	0	0.57
W UP	23.61	0	1.92	0.89
WL - LDOWN R UP	0	-5	5	4.5

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COMB 1	0	-89.3	0.0	1.7
COMB 2	0	-133.1	0.0	2.6
COMB 3	0	-80.3	5.0	5.9
COMB 4	23.61	0.0	1.9	0.9
COMB 5	0	-94.3	5.0	6.2
ULS COMB 1	0	-131.7	0.0	2.4
ULS COMB 2	0	-159.8	0.0	3.1
ULS COMB 3	0	-136.2	6.0	7.9
ULS COMB 4	0	-86.6	8.0	8.7

Location B -

9.45m	Fxc	Fxt	Fz	My
DL	0	-65.38	-0.29	0.84
LL	0	-38.68	-0.17	0.5
SN	0	-24.64	-0.11	0.31
W DOWN	0	-32.7	-0.16	0.46
W UP	30.42	0	-1.09	3.16
WL - LDOWN R				
UP	0	-10	-4	7
COMB 1	0	-104.1	-0.5	1.3
COMB 2	0	-161.4	-0.7	2.1
COMB 3	0	-100.0	-4.4	8.2
COMB 4	30.42	0.0	-1.1	3.2
COMB 5	0	-114.1	-4.5	8.3
ULS COMB 1	0	-153.4	-0.7	2.0
ULS COMB 2	0	-193.7	-0.9	2.5
ULS COMB 3	0	-166.4	-5.5	10.4
ULS COMB 4	0	-107.5	-6.8	12.4

Bolt Forces for 3-member joint to BS5268 - Annex G

Duration of load	Short	
Fd	1.4	
Kd	1	
K2b	1.33	1.33 for bolted, 1.0 for dowelled
d	16 mm	
t1	82 mm	
t2	165 mm	
Myd	196608 Nmm	
a//	75 mm	Spacing parallel to grain
a0	0 degrees	
a90	90 degrees	
Ka,0	0.818317088	0.818317088
Ka,90	1.082531755	1
K90	1.59	
pk	350 kg/m3	Softwoods C24

fh, 0, d, a0	13.71335777
fh, 0, d, a90	16.758
fh, a0, d	13.71335777
fh, a90, d	10.53962264
β	1

fh, 0, d, a0 Long	9.142239
fh, 0, d, a0 Medium	12.02926
fh, 0, d, a0 Short	13.71336
fh, 0, d, a90 Long	11.172
fh, 0, d, a90 Medium	14.7
fh, 0, d, a90 Short	16.758

For a=0:	
G.7	17991.92539
G.8	18101.63225

For a=90:	
G.7	13827.9849
G.8	13912.3019

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G.9	9013.22911		G.9	7432.53509	
G.10	10217.39469		G.10	8957.37586	
F parallel	6.44	kN			
F perp	5.31	kN			
Duration of load	Medium				
Fd	1.4				
Kd	1				
K2b	1.33				1.33 for bolted, 1.0 for dowelled
d	16	mm			
t1	82	mm			
t2	165	mm			
Myd	196608	Nmm			
a//	75	mm			Spacing parallel to grain
a0	0	degrees			
a90	90	degrees			
Ka,0	0.818317088	0.818317088			
Ka,90	1.082531755	1			
K90	1.59				
pk	350	kg/m3			Softwoods C24
fh, 0, d, a0	12.0292612				fh, 0, d, a0 Long 9.142239
fh, 0, d, a90	14.7				fh, 0, d, a0 Medium 12.02926
					fh, 0, d, a0 Short 13.71336
fh, a0, d	12.0292612				fh, 0, d, a90 Long 11.172
fh, a90, d	9.245283019				fh, 0, d, a90 Medium 14.7
β	1				fh, 0, d, a90 Short 16.758
For α=0:					For α=90:
G.7	15782.39069				G.7 12129.8113
G.8	15878.62478				G.8 12203.7736
G.9	8177.419327				G.9 6779.3924
G.10	9569.466899				G.10 8389.35114
F parallel	5.84	kN			
F perp	4.84	kN			Basic loads per shear plane

Calculation of force/bolt for a pair of plates each side of member - Truss Location B

Reference: 165x310 dp chord - COMB 5 Short term

Design Moment 8.3 kNm
 Design shear 4.5 kN
 Design axial 114.1 kN
 Check OK 88%

Vertical (one side of symmetrical arrangement):

Horizontal:

Total no. bolts each side of joint 14 no.
 Max. dist to bolt from CoG 0.225 m
 End distance from 1st row to splice 0.12 m
 No. bolts on CL 0 no.
 1st row from CL 0.075 m

Total no. bolts 14 no.
 Max. dist to bolt from CL 0.08 m
 1st row from CL 0.08 m

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No. bolts row 1	2 no.	No. bolts row 1	6 no.
2nd row from CL	0.15 m	2nd row from CL	0 m
No. bolts row 2	2 no.	No. bolts row 2	0 no.
3rd row from CL	0.225 m	3rd row from CL	0 m
No. bolts row 3	3 no.	No. bolts row 3	0 no.
4th row from CL	0 m	4th row from CL	0 m
No. bolts row 4	0 no.	No. bolts row 4	0 no.
5th row from CL	0 m		
No. bolts row 5	0 no.		

Position of bolt group centroid from splice
0.35 m

Madd due to offset from splice
1.55 kNm

Vertical shear per bolt due to shear
0.32 kN
Horizontal shear per bolt due to axial
8.15 kN

Polar moment of inertia
0.49
Fm, vert
4.50 kN
F,v
4.82 kN
Fm, horiz
1.60 kN
F,H
9.75 kN

Vector force
10.87 kN
Angle from grain, α
26.30 °
Force in timber per shear plane
5.44 kN

Resistances:
Fparallel
6.44 kN
Fperp
5.31 kN
K46
1.00
K56
1.00
K57
1.00

Annex G

1.0 if loaded perpendicular
1.0 for joint in SC1 & 2

Basic load F, adj. for load inclination
6.18 kN

Reference: 165x310 dp chord - COMB2 Short term

Design Moment 2.1 kNm

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Design shear 0.7 kN
 Design axial 162 kN
 Check OK 88%
 Vertical (one side of symmetrical arrangement):

Horizontal:

Total no. bolts
 each side of joint 14 no.
 Max. dist to bolt
 from CoG 0.225 m

Total no. bolts 14 no.
 Max. dist to
 bolt from CL 0.08 m

End distance from
 1st row to splice 0.12 m
 No. bolts on CL 0 no.

1st row from CL 0.075 m

No. bolts row 1 2 no.

2nd row from CL 0.15 m

No. bolts row 2 2 no.

3rd row from CL 0.225 m

No. bolts row 3 3 no.

4th row from CL 0 m

No. bolts row 4 0 no.

5th row from CL 0 m
 No. bolts row 5 0 no.

1st row from
 CL 0.08 m
 No. bolts row
 1 6 no.
 2nd row from
 CL 0 m
 No. bolts row
 2 0 no.
 3rd row from
 CL 0 m
 No. bolts row
 3 0 no.
 4th row from
 CL 0 m
 No. bolts row
 4 0 no.

Position of bolt
 group centroid
 from splice 0.35 m

Madd due to
 offset from splice 0.24 kNm

Vertical shear per
 bolt due to shear 0.05 kN
 Horizontal shear
 per bolt due to
 axial 11.57 kN

Polar moment of
 inertia 0.49
 Fm, vert 1.07 kN
 F,v 1.12 kN
 Fm, horiz 0.38 kN
 F,H 11.95 kN

Vector force 12.00 kN
 Angle from grain,
 α 5.35 °
 Force in timber
 per shear plane 6.00 kN

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Resistances:

Fparallel	6.44 kN
Fperp	5.31 kN
K46	1.25
K56	1.00
K57	0.85

ANNEX G

1.25 for steel to timber if loaded parallel to the grain
1.0 for joint in SC1 & 2

Basic load F, adj.
for load inclination

6.83 kN

Reference:

165x310 dp chord - COMB1 Medium Term

Design Moment	1.3 kNm
Design shear	0.5 kN
Design axial	104.1 kN

Check OK 62%

Vertical (one side of symmetrical arrangement):

Horizontal:

Total no. bolts each side of joint	14 no.
Max. dist to bolt from CoG	0.225 m

Total no. bolts	14 no.
Max. dist to bolt from CL	0.08 m

End distance from 1st row to splice	0.12 m
No. bolts on CL	0 no.
1st row from CL	0.075 m
No. bolts row 1	2 no.
2nd row from CL	0.15 m
No. bolts row 2	2 no.
3rd row from CL	0.225 m
No. bolts row 3	3 no.
4th row from CL	0 m
No. bolts row 4	0 no.
5th row from CL	0 m
No. bolts row 5	0 no.

1st row from CL	0.08 m
No. bolts row 1	6 no.
2nd row from CL	0 m
No. bolts row 2	0 no.
3rd row from CL	0 m
No. bolts row 3	0 no.
4th row from CL	0 m
No. bolts row 4	0 no.

Position of bolt
group centroid
from splice 0.35 m

Madd due to
offset from splice 0.17 kNm

Vertical shear per
bolt due to shear 0.04 kN

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Horizontal shear
per bolt due to
axial 7.44 kN

Polar moment of
inertia 0.49
Fm, vert 0.67 kN
F,v 0.71 kN
Fm, horiz 0.24 kN
F,H 7.67 kN

Vector force 7.71 kN
Angle from grain,
 α 5.27 °
Force in timber
per shear plane 3.85 kN

Resistances:

Fparallel 5.84 kN
Fperp 4.84 kN
K46 1.25
K56 1.00
K57 0.85

Annex G

1.25 for steel to timber if loaded parallel to the grain
1.0 for joint in SC1 & 2, 0.7 for SC3

Basic load F, adj.
for load inclination 6.19 kN

Calculation of force/bolt for a pair of plates each side of member - Truss Location A

Reference: 165x310 dp chord - COMB 5 Short term

Design Moment 6.2 kNm
Design shear 5 kN
Design axial 94.3 kN
Check OK 87%
Vertical (one side of symmetrical arrangement):

Horizontal:

Total no. bolts
each side of joint 12 no.
Max. dist to bolt
from CoG 0.225 m

Total no. bolts 12 no.
Max. dist to
bolt from CL 0.08 m

End distance from
1st row to splice 0.12 m
No. bolts on CL 0 no.

1st row from CL 0.075 m

No. bolts row 1 2 no.

2nd row from CL 0.15 m

No. bolts row 2 2 no.

3rd row from CL 0.225 m

No. bolts row 3 2 no.

1st row from
CL 0.08 m

No. bolts row
1 6 no.

2nd row from
CL 0 m

No. bolts row
2 0 no.

3rd row from
CL 0 m

No. bolts row
3 0 no.

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4th row from CL	0 m	4th row from CL	0 m
No. bolts row 4	0 no.	No. bolts row 4	0 no.
5th row from CL	0 m		
No. bolts row 5	0 no.		

Position of bolt group centroid from splice **0.35 m**

Madd due to offset from splice **1.73 kNm**

Vertical shear per bolt due to shear **0.42 kN**

Horizontal shear per bolt due to axial **7.86 kN**

Polar moment of inertia **0.39**
 Fm, vert **4.55 kN**
 F,v **4.97 kN**
 Fm, horiz **1.62 kN**
 F,H **9.48 kN**

Vector force **10.70 kN**
 Angle from grain, α **27.66 °**
 Force in timber per shear plane **5.35 kN**

Resistances:
 Fparallel **6.44 kN**
 Fperp **5.31 kN**
 K46 **1.00**
 K56 **1.00**
 K57 **1.00**

Annex G
 1.0 if loaded perpendicular
 1.0 for joint in SC1 & 2

Basic load F, adj. for load inclination **6.16 kN**

Reference: 165x310 dp chord - COMB2 Short term

Design Moment **2.6 kNm**
 Design shear **0 kN**
 Design axial **133.1 kN**
 Check **OK** 86%
 Vertical (one side of symmetrical arrangement):

Horizontal:

Total no. bolts each side of joint **12 no.**
 Max. dist to bolt from CoG **0.225 m**

Total no. bolts **12 no.**
 Max. dist to bolt from CL **0.08 m**

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End distance from
1st row to splice 0.12 m
No. bolts on CL 0 no.

1st row from CL 0.075 m
No. bolts row 1 2 no.

2nd row from CL 0.15 m
No. bolts row 2 2 no.

3rd row from CL 0.225 m
No. bolts row 3 2 no.

4th row from CL 0 m
No. bolts row 4 0 no.

5th row from CL 0 m
No. bolts row 5 0 no.

1st row from
CL 0.08 m
No. bolts row 1 6 no.

2nd row from
CL 0 m
No. bolts row 2 0 no.

3rd row from
CL 0 m
No. bolts row 3 0 no.

4th row from
CL 0 m
No. bolts row 4 0 no.

Position of bolt
group centroid
from splice 0.35 m

Madd due to
offset from splice 0.00 kNm

Vertical shear per
bolt due to shear 0.00 kN
Horizontal shear
per bolt due to
axial 11.09 kN

Polar moment of
inertia 0.39
Fm, vert 1.49 kN
F,v 1.49 kN
Fm, horiz 0.53 kN
F,H 11.62 kN

Vector force 11.72 kN
Angle from grain,
 α 7.32 °
Force in timber
per shear plane 5.86 kN

Resistances:
Fparallel 6.44 kN
Fperp 5.31 kN
K46 1.25
K56 1.00
K57 0.85

Annex G

1.25 for steel to timber if loaded parallel to the grain
1.0 for joint in SC1 & 2

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Basic load F, adj.
for load inclination

6.82 kN

Reference:

165x310 dp chord - COMB1 Medium Term

Design Moment 1.3 kNm
Design shear 0.5 kN
Design axial 104.1 kN
Check OK 73%
Vertical (one side of symmetrical arrangement):

Horizontal:

Total no. bolts each side of joint 12 no.
Max. dist to bolt from CoG 0.225 m

Total no. bolts 12 no.
Max. dist to bolt from CL 0.08 m

End distance from 1st row to splice 0.12 m
No. bolts on CL 0 no.
1st row from CL 0.075 m
No. bolts row 1 2 no.
2nd row from CL 0.15 m
No. bolts row 2 2 no.
3rd row from CL 0.225 m
No. bolts row 3 2 no.
4th row from CL 0 m
No. bolts row 4 0 no.
5th row from CL 0 m
No. bolts row 5 0 no.

1st row from CL 0.08 m
No. bolts row 1 6 no.
2nd row from CL 0 m
No. bolts row 2 0 no.
3rd row from CL 0 m
No. bolts row 3 0 no.
4th row from CL 0 m
No. bolts row 4 0 no.

Position of bolt group centroid from splice 0.35 m

Madd due to offset from splice 0.17 kNm

Vertical shear per bolt due to shear 0.04 kN
Horizontal shear per bolt due to axial 8.68 kN

Polar moment of inertia 0.39
Fm, vert 0.85 kN
F,v 0.89 kN

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Fm, horiz 0.30 kN
F,H 8.98 kN

Vector force 9.02 kN
Angle from grain, α 5.65 °
Force in timber per shear plane 4.51 kN

Resistances:

Fparallel 5.84 kN
Fperp 4.84 kN
K46 1.25
K56 1.00
K57 0.85

Annex G

1.25 for steel to timber if loaded parallel to the grain
1.0 for joint in SC1 & 2

Basic load F, adj.
for load inclination 6.19 kN

Check on Pair Steel Plates to BS5950 - ULS Forces

Location B

m 12.4 kNm
V 6.8 kN
N 194 kN
h 250 mm
b 6 mm
Z 125000 mm³
fyk 275 N/mm²
Mc 34.375 kNm
shear stress 6.8 N/mm²
 σ 129.3333333 N/mm²
Combined OK

Thickness of each plate i.e. half moment each
Combined

0.3607273 UR
0.0247273 Low shear

83.10 %

Provide 2no. 6 mm Plates, 1 each side

Location A

m 8.7 kNm
V 8 kN
N 160 kN
h 250 mm
b 6 mm
Z 125000 mm³
fyk 275 N/mm²
Mc 34.375 kNm
shear stress 8 N/mm²
 σ 106.6666667 N/mm²
Combined OK

Thickness of each plate i.e. half moment each
Combined

0.2530909 UR
0.0290909 Low shear

64.10 %

Provide 2no. 6 mm Plates, 1 each side

For Bolts in steel (Blue book to BS5950):

For M16 (4.6) bolt in 6mm ply, bearing resistance = 44.2kN > 5.44 * 1.5 = 8.2kN - OK
For M16 (4.6) bolt in double shear, capacity = 50.2kN > 8.2kN - OK
Provide min 35mm end distance