

KEEP

46 ELM PARK



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SuperBeam 4 421343h

46 ELM PARK.SBW

Beam: BEAM 1(PATIO DOOR)

Span: 1.800 m.

	Load name	Loading w1	Start x1	Loading w2	End x2	R1comp	R2comp
U T	Ceiling	1.0MX0.5	0		L	0.45	0.45
U T	Pitch Roof	1.05MX1.7	0		L	1.61	1.61
					Total:	2.06	2.06

Load types: U:UDL (positions in m. from R1) T: Total

Maximum B.M. = 0.93 kNm at 0.90 m. from R1

Maximum S.F. = 2.06 kN at R1

Total deflection = $0.3124 \times 1e8/EI$ at 0.90 m. from R1 (E in N/mm², I in cm⁴)

Timber beam calculation to BS5268 Part 2 (1996,1997) using C24 timber

Use 2no 50 x 100 C24

 $z = 166.7 \text{ cm}^3$ $I = 833 \text{ cm}^4$ Timber grade: C24 2 members acting together: $K_8 = 1.1$ K_3 (loading duration factor) = 1.00 K_7 (depth factor) = 1.128 $E = 7200 \times 1.14 = 8208 \text{ N/mm}^2$ ($E_{min} \times K_9$)Permissible bending stress, $\sigma_{m,adm} = 7.500 \times 1.00 \times 1.1 \times 1.128 = 9.31 \text{ N/mm}^2$ Applied bending stress, $\sigma_{m,a} = 0.925 \times 1000/166.7 = 5.55 \text{ N/mm}^2$ OKPermissible shear stress, $\tau_{adm} = 0.71 \times 1.1 = 0.78 \text{ N/mm}^2$ Applied shear stress, $\tau_a = 2.057 \times 1000 \times 3/2 \times 100 \times 100 = 0.31 \text{ N/mm}^2$ OKBending deflection = $0.312 \times 1e8/8,208 \times 833 = 4.57 \text{ mm}$ Mid-span shear deflection = $1.2 \times 0.93 \times 1e6/(E/16) \times 100 \times 100 = 0.22 \text{ mm}$ Total deflection = $4.57 + 0.22 = 4.78 \text{ mm}$ (0.0027 L) OK (0.003L=5.40mm)

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Beam: BEAM 2 (CEILING)

Span: 2.700 m.

	Load name	Loading w1	Start x1	Loading w2	End x2	R1comp	R2comp
U T	Ceiling	1.0MX0.5	0		L	0.68	0.68
U T	Ceiling	0.2MX0.5	0		L	0.14	0.14
					Total:	0.81	0.81

Load types: U:UDL (positions in m. from R1) T: Total

Maximum B.M. = 0.55 kNm at 1.35 m. from R1

Maximum S.F. = 0.81 kN at R1

Total deflection = $0.4152 \times 1e8/EI$ at 1.35 m. from R1 (E in N/mm², I in cm⁴)

Timber beam calculation to BS5268 Part 2 (1996,1997) using C24 timber

Use 2no 50 x 100 C24

$$z = 166.7 \text{ cm}^3 \quad I = 833 \text{ cm}^4$$

Timber grade: C24 2 members acting together: $K_8 = 1.1$

K_3 (loading duration factor) = 1.00 K_7 (depth factor) = 1.128

$$E = 7200 \times 1.14 = 8208 \text{ N/mm}^2 \quad (E_{\min} \times K_9)$$

$$\text{Permissible bending stress, } \sigma_{m,adm} = 7.500 \times 1.00 \times 1.1 \times 1.128 = 9.31 \text{ N/mm}^2$$

$$\text{Applied bending stress, } \sigma_{m,a} = 0.547 \times 1000/166.7 = 3.28 \text{ N/mm}^2 \text{ OK}$$

$$\text{Permissible shear stress, } \tau_{adm} = 0.71 \times 1.1 = 0.78 \text{ N/mm}^2$$

$$\text{Applied shear stress, } \tau_a = 0.810 \times 1000 \times 3/2 \times 100 \times 100 = 0.12 \text{ N/mm}^2 \text{ OK}$$

$$\text{Bending deflection} = 0.415 \times 1e8/8,208 \times 833 = 6.07 \text{ mm}$$

$$\text{Mid-span shear deflection} = 1.2 \times 0.55 \times 1e6/(E/16) \times 100 \times 100 = 0.13 \text{ mm}$$

$$\text{Total deflection} = 6.07 + 0.13 = 6.20 \text{ mm} \quad (0.0023 \text{ L}) \text{ OK} \quad (0.003L=8.10\text{mm})$$

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Beam: BEAM 3 (SINGLE DOOR)

Span: 0.800 m.

	Load name	Loading w1	Start x1	Loading w2	End x2	R1comp	R2comp
U T	Ceiling	1.35MX0.5	0		L	0.27	0.27
U T	Pitch Roof	0.8MX1.7	0		L	0.54	0.54
					Total:	0.81	0.81

Load types: U:UDL (positions in m. from R1) T: Total

Maximum B.M. = 0.16 kNm at 0.40 m. from R1

Maximum S.F. = 0.81 kN at R1

Total deflection = $0.0109 \times 1e8/EI$ at 0.40 m. from R1 (E in N/mm², I in cm⁴)

Timber beam calculation to BS5268 Part 2 (1996,1997) using C24 timber

Use 2no 50 x 100 C24

$$z = 166.7 \text{ cm}^3 \quad I = 833 \text{ cm}^4$$

Timber grade: C24 2 members acting together: $K_8 = 1.1$

K_3 (loading duration factor) = 1.00 K_7 (depth factor) = 1.128

$$E = 7200 \times 1.14 = 8208 \text{ N/mm}^2 \quad (E_{\min} \times K_9)$$

$$\text{Permissible bending stress, } \sigma_{m,adm} = 7.500 \times 1.00 \times 1.1 \times 1.128 = 9.31 \text{ N/mm}^2$$

$$\text{Applied bending stress, } \sigma_{m,a} = 0.163 \times 1000/166.7 = 0.98 \text{ N/mm}^2 \text{ OK}$$

$$\text{Permissible shear stress, } \tau_{adm} = 0.71 \times 1.1 = 0.78 \text{ N/mm}^2$$

$$\text{Applied shear stress, } \tau_a = 0.814 \times 1000 \times 3/2 \times 100 \times 100 = 0.12 \text{ N/mm}^2 \text{ OK}$$

$$\text{Bending deflection} = 0.011 \times 1e8/8,208 \times 833 = 0.16 \text{ mm}$$

$$\text{Mid-span shear deflection} = 1.2 \times 0.16 \times 1e6/(E/16) \times 100 \times 100 = 0.04 \text{ mm}$$

$$\text{Total deflection} = 0.16 + 0.04 = 0.20 \text{ mm} \quad (0.0002 \text{ L}) \text{ OK} \quad (0.003\text{L}=2.40\text{mm})$$

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Beam: RAFTER

Span: 2.100 m.

	Load name	Loading w1	Start x1	Loading w2	End x2	R1comp	R2comp
U T	Pitch Roof	0.4MX1.7	0		L	0.71	0.71
					Total:	0.71	0.71

Load types: U:UDL (positions in m. from R1) T: Total

Maximum B.M. = 0.37 kNm at 1.05 m. from R1

Maximum S.F. = 0.71 kN at R1

Total deflection = $0.1722 \times 10^8 / EI$ at 1.05 m. from R1 (E in N/mm², I in cm⁴)

Timber beam calculation to BS5268 Part 2 (1996,1997) using C24 timber

Use 50 x 100 C24

$z = 83.3 \text{ cm}^3$ $I = 417 \text{ cm}^4$

Timber grade: C24 Load sharing system: $K_8 = 1.1$

K_3 (loading duration factor) = 1.00 K_7 (depth factor) = 1.128

$E = 10800 \text{ N/mm}^2$ (E_{mean})

Permissible bending stress, $\sigma_{m,adm} = 7.500 \times 1.00 \times 1.1 \times 1.128 = 9.31 \text{ N/mm}^2$

Applied bending stress, $\sigma_{m,a} = 0.375 \times 1000 / 83.3 = 4.50 \text{ N/mm}^2$ OK

Permissible shear stress, $\tau_{adm} = 0.71 \times 1.1 = 0.78 \text{ N/mm}^2$

Applied shear stress, $\tau_a = 0.714 \times 1000 \times 3/2 \times 50 \times 100 = 0.21 \text{ N/mm}^2$ OK

Bending deflection = $0.172 \times 10^8 / 10,800 \times 417 = 3.83 \text{ mm}$

Mid-span shear deflection = $1.2 \times 0.37 \times 10^6 / (E/16) \times 50 \times 100 = 0.13 \text{ mm}$

Total deflection = $3.83 + 0.13 = 3.96 \text{ mm}$ (0.0019 L) OK (0.003L=6.30mm)

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Beam: CEILING JOIST

Span: 2.700 m.

	Load name	Loading w1	Start x1	Loading w2	End x2	R1comp	R2comp
U T	Ceiling	0.4MX0.5	0		L	0.27	0.27
					Total:	0.27	0.27

Load types: U:UDL (positions in m. from R1) T: Total

Maximum B.M. = 0.18 kNm at 1.35 m. from R1

Maximum S.F. = 0.27 kN at R1

Total deflection = $0.1384 \times 1e8/EI$ at 1.35 m. from R1 (E in N/mm², I in cm⁴)

Timber beam calculation to BS5268 Part 2 (1996,1997) using C24 timber

Use 50 x 100 C24

$z = 83.3 \text{ cm}^3$ $I = 417 \text{ cm}^4$

Timber grade: C24 Load sharing system: $K_8 = 1.1$

K_3 (loading duration factor) = 1.00 K_7 (depth factor) = 1.128

$E = 10800 \text{ N/mm}^2$ (E_{mean})

Permissible bending stress, $\sigma_{m,adm} = 7.500 \times 1.00 \times 1.1 \times 1.128 = 9.31 \text{ N/mm}^2$

Applied bending stress, $\sigma_{m,a} = 0.182 \times 1000/83.3 = 2.19 \text{ N/mm}^2$ OK

Permissible shear stress, $\tau_{adm} = 0.71 \times 1.1 = 0.78 \text{ N/mm}^2$

Applied shear stress, $\tau_a = 0.270 \times 1000 \times 3/2 \times 50 \times 100 = 0.08 \text{ N/mm}^2$ OK

Bending deflection = $0.138 \times 1e8/10,800 \times 417 = 3.08 \text{ mm}$

Mid-span shear deflection = $1.2 \times 0.18 \times 1e6/(E/16) \times 50 \times 100 = 0.06 \text{ mm}$

Total deflection = $3.08 + 0.06 = 3.14 \text{ mm}$ (0.0012 L) OK (0.003L=8.10mm)

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Beam: BEAM A (KITCHEN/DINING)

Span: 3.200 m.

	Load name	Loading w1	Start x1	Loading w2	End x2	R1comp	R2comp
U T	Floor	1.3MX2.0	0		L	4.16	4.16
U T	Floor	1.35MX2.0	0		L	4.32	4.32
					Total:	8.48	8.48

Load types: U:UDL (positions in m. from R1) T: Total

Maximum B.M. = 6.78 kNm at 1.60 m. from R1

Maximum S.F. = 8.48 kN at R1

Total deflection = $7.237 \times 10^8 / EI$ at 1.60 m. from R1 (E in N/mm², I in cm⁴)

Timber beam calculation to BS5268 Part 2 (1996, 1997) using C24 timber

Use 3no 50 x 200 C24

$z = 1,000.0 \text{ cm}^3$ $I = 10,000 \text{ cm}^4$

Timber grade: C24 3 members acting together: $K_8 = 1.1$

K_3 (loading duration factor) = 1.00 K_7 (depth factor) = 1.046

$E = 7200 \times 1.21 = 8712 \text{ N/mm}^2$ ($E_{\min} \times K_9$)

Permissible bending stress, $\sigma_{m,adm} = 7.500 \times 1.00 \times 1.1 \times 1.046 = 8.63 \text{ N/mm}^2$

Applied bending stress, $\sigma_{m,a} = 6.784 \times 1000 / 1,000.0 = 6.78 \text{ N/mm}^2$ OK

Permissible shear stress, $\tau_{adm} = 0.71 \times 1.1 = 0.78 \text{ N/mm}^2$

Applied shear stress, $\tau_a = 8.480 \times 1000 \times 3/2 \times 150 \times 200 = 0.42 \text{ N/mm}^2$ OK

Bending deflection = $7.237 \times 10^8 / 8,712 \times 10,000 = 8.31 \text{ mm}$

Mid-span shear deflection = $1.2 \times 6.78 \times 10^6 / (E/16) \times 150 \times 200 = 0.50 \text{ mm}$

Total deflection = $8.31 + 0.50 = 8.81 \text{ mm}$ (0.0028 L) OK (0.003L=9.60mm)

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Beam: BEAM B (KITCHEN/EXTENSION)

Span: 5.400 m.

	Load name	Loading w1	Start x1	Loading w2	End x2	R1comp	R2comp
U T	Ceiling	1.0MX0.5	0		L	1.35	1.35
U T	Pitch Roof	1.05X1.7	0		L	4.82	4.82
U T	Partition	2.3MX0.9	0		L	5.59	5.59
U T	Main Roof	2.2MX1.7	0		L	10.10	10.10
P T	React B/F	8.480 [B/F]	2.7M			4.24	4.24
Total:						26.10	26.10

Load types: U:UDL P:PL (positions in m. from R1) T: Total

Maximum B.M. = 40.95 kNm at 2.70 m. from R1

Maximum S.F. = 26.10 kN at R1

Total deflection = $117.5 \times 1e8/EI$ at 2.70 m. from R1 (E in N/mm², I in cm⁴)

Steel calculation to BS449 Part 2 using Grade 43 steel

SECTION SIZE : 203 x 203 x 46 UC

D=203.2 mm B=203.6 mm t=7.2 mm T=11.0 mm $I_x=4,570 \text{ cm}^4$ $r_y=5.13 \text{ cm}$ $Z_x=450 \text{ cm}^3$

$L_E/r_y = 5.40 \times 100/5.13 = 105$ D/T = 18.5

Permissible bending stress, $p_{bc} = 134.9 \text{ N/mm}^2$ (Table 3a)

Actual bending stress, $f_{bc} = 40.95 \times 1000/450.0 = 91.0 \text{ N/mm}^2$ OK

Maximum shear in web, $f_s = 26.10 \times 1000/(7.2 \times 203.2) = 17.8 \text{ N/mm}^2$ OK

Unstiffened web capacity at bearings (min) = 55.5 kN (web crushing limit with $b_1=0$)

Total deflection = $117 \times 1e8/205,000 \times 4,570 = 12.5 \text{ mm}$ (0.0023 L) OK (L/360=15.0mm)

Bearing details (bearing plate sizing to BS5950:2000)

203x203x46 UC stiff bearing length, $b_1 = t + 1.6r + 2T = 45.5 \text{ mm}$

Factor reactions by 1.55 (user selected value)

Local design strength of masonry (factored) = 0.700 N/mm^2 (user entered value)

R1 (26.10kN unfactored): Padstone size 300 x 200mm

Factored stress under padstone = $1.55 \times 26.10 \times 1000/300 \times 200 = 0.67 \text{ N/mm}^2$

R2 (26.10kN unfactored): 24 mm m.s. bearing plate size 300 x 200 mm

Factored stress under plate = $1.55 \times 26.10 \times 1000/300 \times 200 = 0.67 \text{ N/mm}^2$

Required plate thickness = $\sqrt{(3 \times 0.67 \times 127 \times 127/275)} = 10.9 \text{ mm}$

Factored bending stress in plate = $0.67 \times 127 \times (127/2)/(24 \times 24/6) = 56.8 \text{ N/mm}^2$ ($p_y=275 \text{ N/mm}^2$)

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Beam: BEAM C (HALL/LOUNGE)

Span: 4.300 m.

	Load name	Loading w1	Start x1	Loading w2	End x2	R1comp	R2comp
U T	Floor	1.7MX2.0	0		L	7.31	7.31
R T	Floor	0.9MX2.0	0		2.2M	2.95	1.01
R T	Floor	0.5MX2.0	2.2M		4.3M	0.51	1.59
Total:						10.77	9.91

Load types: U:UDL R:Part UDL (positions in m. from R1) T: Total

Maximum B.M. = 11.15 kNm at 2.07 m. from R1

Maximum S.F. = 10.77 kN at R1

Total deflection = $21.44 \times 10^{-8} / EI$ at 2.15 m. from R1 (E in N/mm², I in cm⁴)

Timber beam calculation to BS5268 Part 2 (1996,1997) using C24 timber

Use 2no 50 x 225 C24 + 10 x 200 flitch plate

$z = 843.8 \text{ cm}^3$ $I = 9,492 \text{ cm}^4$ Flitch plate $z = 66.7 \text{ cm}^3$ $I = 667 \text{ cm}^4$

Timber grade: C24 2 members acting together: $K_8 = 1.1$

K_3 (loading duration factor) = 1.00 K_7 (depth factor) = 1.032

Loading will be carried by the timber members and flitch plate in proportion to their EI values. Checks are made using the mean and minimum E-values for timber to produce worst case stresses on timber and steel members respectively.

Flitch plate EI = $205,000 \times 667 = 1,367 \times 10^9 \text{ Nmm}^2$

Check timber members:

Using E_{mean} Timber EI = $10,800 \times 9,492 = 1,025 \times 10^9 \text{ Nmm}^2$

Timber carries $1,025 / (1,025 + 1,367) = 0.429$ of total load (in worst case)

Permissible bending stress, $\sigma_{m,adm} = 7.500 \times 1.00 \times 1.1 \times 1.032 = 8.52 \text{ N/mm}^2$

Applied bending stress, $\sigma_{m,a} = 0.429 \times 11.153 \times 1000 / 843.8 = 5.67 \text{ N/mm}^2$ OK

Permissible shear stress, $\tau_{adm} = 0.71 \times 1.1 = 0.78 \text{ N/mm}^2$

Applied shear stress, $\tau_a = 0.429 \times 10.770 \times 1000 \times 3 / (2 \times 100 \times 225) = 0.31 \text{ N/mm}^2$ OK

Check flitch plate:

Using E_{min} Timber EI = $7,200 \times 9,492 = 683 \times 10^9 \text{ Nmm}^2$

Flitch plate carries $1,367 / (683 + 1,367) = 0.667$ of total load (in worst case)

Flitch plate $f_{bc} = 0.667 \times 11.15 \times 1000 / 66.7 = 111.52 \text{ N/mm}^2$ OK

Deflection:

Using $E_{\text{min}} \times K_9$ (2 members) Timber EI = $8,208 \times 9,492 = 779 \times 10^9 \text{ Nmm}^2$

Timber carries $779 / (779 + 1,367) = 0.363$ of total load (average case)

Bending deflection = $0.363 \times 21.436 \times 10^{-8} / 8,208 \times 9,492 = 9.99 \text{ mm}$

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Mid-span shear deflection = $0.363 \times 1.2 \times 11.14 \times 1e6 / (E/16) \times 100 \times 225 = 0.42 \text{ mm}$

Total deflection = $9.99 + 0.42 = 10.41 \text{ mm}$ (0.0024 L) OK

Bolting:

Use M16 4.6 bolts. Bolt numbers are calculated assuming worst case load on flitch plate

Load capacity per bolt in double shear = 7.70kN (BS5268 eq. G.9)

($F_d = 1350$; $M_{y,d} = 196,608 \text{ N-mm}$; $p_k = 350 \text{ kg/m}^3$; $K_{90} = 1.59$; $f_{h,1,d} = 7.026$)

Bearings: R1 (10.8kN): Required number of bolts = $0.667 \times 10.8 / 7.70 = 0.93$ i.e. 1 bolt min.

R2 (9.91kN): Required number of bolts = $0.667 \times 9.91 / 7.70 = 0.86$ i.e. 1 bolt min.

For load transference a minimum of 2 bolts are also required across the span

To ensure structural integrity consider providing bolts spaced at 600mm max c/s, bolt centres alternately min. 65mm from top and bottom of beam

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Calculations for timber post/stud to BS5268 Part 2 (1996,1997) using C24 timber

Location: UNDER BEAM C

Member is axially loaded only Axial load = 10.77 kN

Effective lengths: $L_{Ex} = 2.0$ m. $L_{Ey} = 2.0$ m.

Use: 100 x 100 C24

Cross sectional area = 10,000 mm² $Z = 166.7$ cm³ $I = 833$ cm⁴

K_3 (loading duration factor) = 1.00 K_8 (load sharing factor) = 1.0

Slenderness is critical about the yy axis $r_{yy} = 100/\sqrt{12} = 28.9$ mm

Slenderness ratio, $\lambda_{yy} = 2.000 \times 1000/28.9 = 69.3$

Compressive stress used to determine $K_{12} = 7.9 \times 1.00 = 7.90$ N/mm²

Grade permissible compressive stress, $\sigma_{c,g} = 7.90$ N/mm²

E value used to determine $K_{12} = 7,200$ N/mm² (E_{min})

K_{12} (compression modification factor) = 0.600

Permissible compressive stress, $\sigma_{c,adm} = 7.90 \times 0.600 = 4.74$ N/mm²

Applied compressive stress, $\sigma_{c,a} = 10.770 \times 1000/10,000 = 1.08$ N/mm² OK