XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

1B1

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(1B1) 2 / 290mm x 42mm Smart LVL15* (Oregon) (Single span)**	
Bending:	**M(dl)* = 4.89kNm (+ve) < øM(dl) = 6.53kNm, M* = 6.68kNm (+ve) < øM = 10.60kNm**	**OK (0.75,0.63)**
Shear:	**V(dl)* = 10.45kN < øV(dl) = 36.93kN, V* = 14.14kN < øV = 51.84kN**	**OK (0.28,0.27)**
Deflection:	**δDL = L/1058 (3mm) , δΨs.LL = L/2604 (1mm), δTotal = L/752 (5mm), 1kN mid. δ = 0.4mm**	**OK**
Reactions:	**(1 End) Rdl.max = 4.09kN, Rll.max = 6.15kN, R.max* = 14.14kN**	
	(1 End) Rdl.min = 1.18kN, Rll.min = 2.45kN, R.min* = 5.10kN	
Geometry	(House member affecting ≤ 25m² or secondary building member)	

Category = 1 (1) House, (2) Primary building elements, (3) Important
House = N (Y)es,(N)o
Edge restrained = C (T)ension, (C)ompression, (B)oth
Span (L) = 3600 mm
Lay.t (Top) = 3600 mm
Centres (cts) = 450 mm
Span type = S (S)ingle,(D)ouble

Loadings

Floor area (A) = 1.62 m²
Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50 kPa *	450 mm +		kN/m =	0.23	kN/m
Wall dead load (wdl) =	kPa *	450 mm +		kN/m =	0.00	kN/m
Other dead load (wdl) =	kPa *	mm +		kN/m =	0.00	kN/m
Include S.Wt =	Y (Y)es,(N)o			S.Wt =	0.15	kN/m
				Σwdl =	0.37	kN/m

Uniform live loads

Floor live load (wll) =	1.50 kPa *	450 mm +		kN/m =	0.68	kN/m
Partitions (wll) =	kPa *	450 mm +		kN/m =	0.00	kN/m
Alternate point live load =	1.80 kN (critical)	Distr. to	1 members	Σwll =	1.00	kN/m

Point loads

Dead load (pdl) = 3.94 kN
Live load (pll) = 5.01 kN

	DL	LL	
1B2	3.9	5.0	: L|L
Σ	3.9	5.0	

Position = 470 mm from LHS
ing PL at support = N (Y)es,(N)o

Short term LL factor (Ψsu) =	0.70	(Ψsp) =	1.00
Long term LL factor (Ψlu) =	0.40	(Ψlp) =	0.60
wdl* = 1.2*wdl+1.5*Ψlu*wll =	1.35 kN/m	M(dl+Ψl.ll)* =	4.89 kNm (Max at 904mm)
w* = 1.2*wdl+1.5*wll =	1.95 kN/m	M* =	6.68 kNm (Max at 979mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	9.23 kN	V(dl+Ψl.ll)* =	10.45 kN
p* = 1.2*pdl+1.5*pll =	12.24 kN	V* =	14.14 kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member = 2 / 290mm x 42mm Smart LVL15*
Description = LVL15 seasoned softwood
Design depth (dD) = 290 mm
Design width (dW) = 42 mm
Area (A) = 24360 mm²
Section modulus (Zx) = 1177 x10³ mm³
Stiffness (Ix) = 170.7 x10⁶ mm⁴
Modulus of elasticity (E) = 15300 MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 = 30.41 For top comp. edge restrained - Cl 3.2.3.2(a)
k12d = 200/(S1*ρbd)² = 0.219 for ρbd*S1 ≥ 20 - Cl 3.2.4
k12 = 1.5-0.05*ρb*S1 = 0.253 for ρb*S1 ≥ 20 - Cl 3.2.4
f'b = 46.9 MPa
f's = 4.2 MPa
Material constant (ρbd) = 0.99 (rbd=0.25)
Material constant (ρb) = 0.92 (rb=0.82)

Strength reduction factor (ø) =	0.95 Table 2.1	Duration factor (k1) =	0.80
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	6.53 kNm	Moisture factor (k4) =	1.00
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	10.60 kNm	Temp. factor (k6) =	1.00
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	36.93 kN	Sharing factor (k9) =	1.00
øV = ø*k1*k4*k6*f's*(2/3*A) =	51.84 kN	Size modifier (mod.b) =	1.00
		Size modifier (mod.s) =	1.00

Deflections

Duration factor (j2) = 2.0

Ireq'd j2.(DL+Ψl.LL) (L/300) =	48.4 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	3.4 mm	Span / 1058
Ireq'd Ψs.LL (12mm) =	19.7 x10⁶ mm⁴		Ψs.δLL =	1.4 mm	Span / 2604
Ireq'd Total (L/250) =	56.7 x10⁶ mm⁴		δTotal =	4.8 mm	Span / 752
			1kN midspan δ =	0.4 mm	

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1B2

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(1B2) 2 / 140mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 3.36kNm (+ve) < øM(dl) = 8.04kNm, M* = 5.01kNm (+ve) < øM = 11.28kNm**	**OK (0.42,0.44)**
Shear:	**V(dl)* = 7.94kN < øV(dl) = 17.83kN, V* = 12.24kN < øV = 25.03kN**	**OK (0.45,0.49)**
Deflection:	**δDL = L/421 (3mm) , δΨs.LL = L/1393 (1mm), δTotal = L/323 (4mm), 1kN mid. δ = 0.2mm**	**OK**
Reactions:	**(Each end) Rdl = 3.94kN, Rll = 5.01kN, R* = 12.24kN**	

Geometry

(House member affecting ≤ 25m² or secondary building member)

Category =	1	(1) House, (2) Primary building elements, (3) Important			
House =	N	(Y)es,(N)o	Edge restrained =	C	(T)ension, (C)ompression, (B)oth
Span (L) =	1400	mm	Lay.t (Top) =	450	mm
Centres (cts) =	3600	mm			
Span type =	S	(S)ingle,(D)ouble			

Loadings

Floor area (A) = 5.04 m²

Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	3600	mm +		kN/m =	1.80 kN/m
Wall dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35 kN/m
Other dead load (wdl) =	0.40	kPa *	3000	mm +		kN/m =	1.20 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.07 kN/m
						Σwdl =	4.42 kN/m

Uniform live loads

Floor live load (wll) =	1.50	kPa *	3600	mm +		kN/m =	5.40 kN/m
Partitions (wll) =	0.25	kPa *	3000	mm +		kN/m =	0.75 kN/m
Alternate point live load =	1.80	kN	Distr. to	1	members	Σwll =	6.15 kN/m

Point loads

Dead load (pdl) =	1.69	kN	Large	DL 1.7	LL 1.4 : L|L	Position =	700 mm from LHS
Live load (pll) =	1.40	kN	Σ	1.7	1.4	ing PL at support =	N (Y)es,(N)o

Short term LL factor (Ψsu) =	0.70		(Ψsp) =	1.00	
Long term LL factor (Ψlu) =	0.40		(Ψlp) =	0.60	
wdl* = 1.2*wdl+1.5*Ψlu*wll =	8.99	kN/m	M(dl+Ψl.ll)* =	3.36	kNm (Max at 700mm)
w* = 1.2*wdl+1.5*wll =	14.53	kN/m	M* =	5.01	kNm (Max at 700mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	3.29	kN	V(dl+Ψl.ll)* =	7.94	kN
p* = 1.2*pdl+1.5*pll =	4.13	kN	V* =	12.24	kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	2 / 140mm x 42mm Smart LVL15		Area (A) =	11760	mm²
Description =	LVL15 seasoned softwood		Section modulus (Zx) =	274	x10³ mm³
Design depth (dD) =	140	mm	Stiffness (Ix) =	19.2	x10⁶ mm⁴
Design width (dW) =	42	mm	Modulus of elasticity (E) =	15300	MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 =	7.47	For top comp. edge restrained - Cl 3.2.3.2(a)			
k12d =	1.000	for ρbd*S1 ≤ 10 - Cl 3.2.4	f'b =	54.1	MPa
k12 =	1.000	for ρb*S1 ≤ 10 - Cl 3.2.4	f's =	4.2	MPa
			Material constant (ρbd) =	1.07	(rbd=0.25)
Strength reduction factor (ø) =	0.95	Table 2.1	Material constant (ρb) =	1.01	(rb=0.60)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	8.04	kNm	Duration factor (k1) =	0.80	
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	11.28	kNm	Moisture factor (k4) =	1.00	
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	17.83	kN	Temp. factor (k6) =	1.00	
øV = ø*k1*k4*k6*f's*(2/3*A) =	25.03	kN	Sharing factor (k9) =	1.00	
			Size modifier (mod.b) =	1.00	
			Size modifier (mod.s) =	1.00	

Deflections

			Duration factor (j2) =	2.0	
Ireq'd j2.(DL+Ψl.LL) (L/300) =	13.7 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	3.3 mm	Span / 421
Ireq'd Ψs.LL (L/300) =	4.1 x10⁶ mm⁴		Ψs.δLL =	1.0 mm	Span / 1393
Ireq'd Total (L/250) =	14.9 x10⁶ mm⁴		δTotal =	4.3 mm	Span / 323
			1kN midspan δ =	0.2 mm	

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1B3

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(1B3) 2 / 120mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 1.27kNm (+ve) < øM(dl) = 5.41kNm, M* = 1.61kNm (+ve) < øM = 7.85kNm**	**OK (0.23,0.21)**
Shear:	**V(dl)* = 7.10kN < øV(dl) = 15.28kN, V* = 8.99kN < øV = 21.45kN**	**OK (0.46,0.42)**
Deflection:	**δDL = L/807 (1mm) , δΨs.LL = L/3124 (0mm), δTotal = L/641 (2mm), 1kN mid. δ = 0.2mm**	**OK**
Reactions:	**(1 End) Rdl.max = 3.56kN, Rll.max = 3.14kN, R.max* = 8.99kN**	
	(1 End) Rdl.min = 2.01kN, Rll.min = 1.86kN, R.min* = 5.20kN	
Geometry	(House member affecting ≤ 25m² or secondary building member)	

Category = 1 (1) House, (2) Primary building elements, (3) Important
House = N (Y)es,(N)o
Edge restrained = C (T)ension, (C)ompression, (B)oth
Span (L) = 1200 mm
Lay.t (Top) = 1200 mm
Centres (cts) = 450 mm
Span type = S (S)ingle,(D)ouble

Loadings

Floor area (A) = 0.54 m²
Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50 kPa *	450 mm +		kN/m =	0.23	kN/m
Wall dead load (wdl) =	0.50 kPa *	2700 mm +		kN/m =	1.35	kN/m
Other dead load (wdl) =	0.40 kPa *	4000 mm +		kN/m =	1.60	kN/m
Include S.Wt =	Y (Y)es,(N)o			S.Wt =	0.06	kN/m
				Σwdl =	3.24	kN/m

Uniform live loads

Floor live load (wll) =	1.50 kPa *	450 mm +		kN/m =	0.68	kN/m
Partitions (wll) =	0.25 kPa *	4000 mm +		kN/m =	1.00	kN/m
Alternate point live load =	1.80 kN (critical)	Distr. to	1 members	Σwll =	3.00	kN/m

Point loads

	DL	LL	
Large	1.7	1.4	: L|L
Σ	1.7	1.4	

Dead load (pdl) = 1.69 kN
Live load (pll) = 1.40 kN
Position = 50 mm from LHS
ing PL at support = N (Y)es,(N)o

Short term LL factor (Ψsu) =	0.70	(Ψsp) =	1.00
Long term LL factor (Ψlu) =	0.40	(Ψlp) =	0.60
wdl* = 1.2*wdl+1.5*Ψlu*wll =	6.58 kN/m	M(dl+Ψl.ll)* =	1.27 kNm (Max at 579mm)
w* = 1.2*wdl+1.5*wll =	8.38 kN/m	M* =	1.61 kNm (Max at 579mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	3.29 kN	V(dl+Ψl.ll)* =	7.10 kN
p* = 1.2*pdl+1.5*pll =	4.13 kN	V* =	8.99 kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member = 2 / 120mm x 42mm Smart LVL15
Description = LVL15 seasoned softwood
Design depth (dD) = 120 mm
Design width (dW) = 42 mm
Area (A) = 10080 mm²
Section modulus (Zx) = 202 x10³ mm³
Stiffness (Ix) = 12.1 x10⁶ mm⁴
Modulus of elasticity (E) = 15300 MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 = 11.29 For top comp. edge restrained - Cl 3.2.3.2(a)
k12d = 1.5-0.05*ρbd*S1 = 0.889 for 10 ≤ ρbd*S1 ≤ 20 - Cl 3.2.4
k12 = 1.5-0.05*ρb*S1 = 0.919 for 10 ≤ ρb*S1 ≤ 20 - Cl 3.2.4
f'b = 55.7 MPa
f's = 4.2 MPa
Material constant (ρbd) = 1.08 (rbd=0.25)
Material constant (ρb) = 1.03 (rb=0.56)

Strength reduction factor (ø) =	0.95 Table 2.1	Duration factor (k1) =	0.80
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	5.41 kNm	Moisture factor (k4) =	1.00
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	7.85 kNm	Temp. factor (k6) =	1.00
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	15.28 kN	Sharing factor (k9) =	1.00
øV = ø*k1*k4*k6*f's*(2/3*A) =	21.45 kN	Size modifier (mod.b) =	1.00
		Size modifier (mod.s) =	1.00

Deflections

Duration factor (j2) = 2.0

Ireq'd j2.(DL+Ψl.LL) (L/300) =	4.5 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	1.5 mm	Span / 807
Ireq'd Ψs.LL (L/300) =	1.2 x10⁶ mm⁴		Ψs.δLL =	0.4 mm	Span / 3124
Ireq'd Total (L/250) =	4.7 x10⁶ mm⁴		δTotal =	1.9 mm	Span / 641
			1kN midspan δ =	0.2 mm	

XSTRUCT CONSULTING ENGINEERS

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1B4

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(1B4) 2 / 300mm x 58mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 17.50kNm (+ve) < øM(dl) = 20.66kNm, M* = 22.81kNm (+ve) < øM = 31.69kNm**	**OK (0.85,0.72)**
Shear:	**V(dl)* = 16.76kN < øV(dl) = 52.76kN, V* = 21.82kN < øV = 74.05kN**	**OK (0.32,0.29)**
Deflection:	**δDL = L/524 (6mm) , δΨs.LL = L/2032 (2mm), δTotal = L/417 (7mm), 1kN mid. δ = 0.2mm**	**OK**
Reactions:	**(1 End) Rdl.max = 9.25kN, Rll.max = 7.15kN, R.max* = 21.82kN**	
	(1 End) Rdl.min = 8.14kN, Rll.min = 5.88kN, R.min* = 18.59kN	
Geometry	(House member affecting ≤ 25m² or secondary building member)	

Category = 1 (1) House, (2) Primary building elements, (3) Important
House = N (Y)es,(N)o
Edge restrained = C (T)ension, (C)ompression, (B)oth
Span (L) = 3100 mm
Lay.t (Top) = 3100 mm
Centres (cts) = 450 mm
Span type = S (S)ingle,(D)ouble

Loadings

Floor area (A) = 1.40 m²
Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50 kPa *	450 mm +		kN/m =	0.23	kN/m
Wall dead load (wdl) =	0.50 kPa *	2700 mm +		kN/m =	1.35	kN/m
Other dead load (wdl) =	0.40 kPa *	4000 mm +		kN/m =	1.60	kN/m
Include S.Wt =	Y (Y)es,(N)o			S.Wt =	0.21	kN/m
				Σwdl =	3.38	kN/m

Uniform live loads

Floor live load (wll) =	1.50 kPa *	450 mm +		kN/m =	0.68	kN/m
Partitions (wll) =	0.25 kPa *	4000 mm +		kN/m =	1.00	kN/m
Alternate point live load =	1.80 kN	Distr. to	1 members	Σwll =	1.68	kN/m

Point loads

Dead load (pdl) = 6.90 kN
Live load (pll) = 7.83 kN

	DL	LL	
1B5	6.9	7.8	: L|L
Σ	6.9	7.8	

Position = 1300 mm from LHS
ing PL at support = N (Y)es,(N)o

Short term LL factor (Ψsu) =	0.70	(Ψsp) =	1.00
Long term LL factor (Ψlu) =	0.40	(Ψlp) =	0.60
wdl* = 1.2*wdl+1.5*Ψlu*wll =	5.07 kN/m	M(dl+Ψl.ll)* =	17.50 kNm (Max at 1300mm)
w* = 1.2*wdl+1.5*wll =	6.57 kN/m	M* =	22.81 kNm (Max at 1300mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	15.34 kN	V(dl+Ψl.ll)* =	16.76 kN
p* = 1.2*pdl+1.5*pll =	20.04 kN	V* =	21.82 kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member = 2 / 300mm x 58mm Smart LVL15
Description = LVL15 seasoned softwood
Design depth (dD) = 300 mm
Design width (dW) = 58 mm
Area (A) = 34800 mm²
Section modulus (Zx) = 1740 x10³ mm³
Stiffness (Ix) = 261.0 x10⁶ mm⁴
Modulus of elasticity (E) = 15300 MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 = 20.78 For top comp. edge restrained - Cl 3.2.3.2(a)
k12d = 200/(S1*ρbd)² = 0.471 for ρbd*S1 ≥ 20 - Cl 3.2.4
k12 = 1.5-0.05*ρb*S1 = 0.515 for 10 ≤ ρb*S1 ≤ 20 - Cl 3.2.4
f'b = 46.5 MPa
f's = 4.2 MPa
Material constant (ρbd) = 0.99 (rbd=0.25)
Material constant (ρb) = 0.95 (rb=0.52)

Strength reduction factor (ø) =	0.95 Table 2.1	Duration factor (k1) =	0.80
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	20.66 kNm	Moisture factor (k4) =	1.00
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	31.69 kNm	Temp. factor (k6) =	1.00
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	52.76 kN	Sharing factor (k9) =	1.00
øV = ø*k1*k4*k6*f's*(2/3*A) =	74.05 kN	Size modifier (mod.b) =	1.00
		Size modifier (mod.s) =	1.00

Deflections

Duration factor (j2) = 2.0

Ireq'd j2.(DL+Ψl.LL) (L/300) =	149.4 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	5.9 mm	Span / 524
Ireq'd Ψs.LL (L/300) =	38.5 x10⁶ mm⁴		Ψs.δLL =	1.5 mm	Span / 2032
Ireq'd Total (L/250) =	156.6 x10⁶ mm⁴		δTotal =	7.4 mm	Span / 417
			1kN midspan δ =	0.2 mm	

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1B5

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(1B5) 2 / 240mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 9.65kNm (+ve) < øM(dl) = 21.24kNm, M* = 14.32kNm (+ve) < øM = 29.81kNm**	**OK (0.45,0.48)**
Shear:	**V(dl)* = 16.90kN < øV(dl) = 30.57kN, V* = 24.53kN < øV = 42.90kN**	**OK (0.55,0.57)**
Deflection:	**δDL = L/362 (7mm) , δΨs.LL = L/1348 (2mm), δTotal = L/285 (9mm), 1kN mid. δ = 0.2mm**	**OK**
Reactions:	**(1 End) Rdl.max = 9.13kN, Rll.max = 9.05kN, R.max* = 24.53kN**	
	(1 End) Rdl.min = 6.90kN, Rll.min = 7.83kN, R.min* = 20.04kN	
Geometry	(House member affecting ≤ 25m² or secondary building member)	

Category = 1 (1) House, (2) Primary building elements, (3) Important
House = N (Y)es,(N)o
Edge restrained = C (T)ension, (C)ompression, (B)oth
Span (L) = 2600 mm
Lay.t (Top) = 450 mm
Centres (cts) = 3100 mm
Span type = S (S)ingle,(D)ouble

Loadings

Floor area (A) = 8.06 m²
Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50 kPa *	3100 mm +		kN/m =	1.55	kN/m
Wall dead load (wdl) =	0.50 kPa *	2700 mm +		kN/m =	1.35	kN/m
Other dead load (wdl) =	0.40 kPa *	4000 mm +		kN/m =	1.60	kN/m
Include S.Wt =	Y (Y)es,(N)o			S.Wt =	0.12	kN/m
				Σwdl =	4.62	kN/m

Uniform live loads

Floor live load (wll) =	1.50 kPa *	3100 mm +		kN/m =	4.65	kN/m
Partitions (wll) =	0.25 kPa *	4000 mm +		kN/m =	1.00	kN/m
Alternate point live load =	1.80 kN	Distr. to	1 members	Σwll =	5.65	kN/m

Point loads

Dead load (pdl) = 4.02 kN
Live load (pll) = 2.19 kN

	DL	LL
GT	4.0	2.2 : L|L
Σ	4.0	2.2

Position = 2020 mm from LHS
ing PL at support = N (Y)es,(N)o

Short term LL factor (Ψsu) =	0.70	(Ψsp) =	1.00
Long term LL factor (Ψlu) =	0.40	(Ψlp) =	0.60
wdl* = 1.2*wdl+1.5*Ψlu*wll =	8.94 kN/m	M(dl+Ψl.ll)* =	9.65 kNm (Max at 1470mm)
w* = 1.2*wdl+1.5*wll =	14.02 kN/m	M* =	14.32 kNm (Max at 1429mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	6.80 kN	V(dl+Ψl.ll)* =	16.90 kN
p* = 1.2*pdl+1.5*pll =	8.11 kN	V* =	24.53 kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member = 2 / 240mm x 42mm Smart LVL15
Description = LVL15 seasoned softwood
Design depth (dD) = 240 mm
Design width (dW) = 42 mm
Area (A) = 20160 mm²
Section modulus (Zx) = 806 x10³ mm³
Stiffness (Ix) = 96.8 x10⁶ mm⁴
Modulus of elasticity (E) = 15300 MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 = 9.78 For top comp. edge restrained - Cl 3.2.3.2(a)
k12d = 1.000 for ρbd*S1 ≤ 10 - Cl 3.2.4
k12 = 1.000 for ρb*S1 ≤ 10 - Cl 3.2.4
f'b = 48.6 MPa
f's = 4.2 MPa
Material constant (ρbd) = 1.01 (rbd=0.25)
Strength reduction factor (ø) = 0.95 Table 2.1
Material constant (ρb) = 0.96 (rb=0.60)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx = 21.24 kNm
Duration factor (k1) = 0.80
øM = ø*k1*k4*k6*k9*k12*f'b*Zx = 29.81 kNm
Moisture factor (k4) = 1.00
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) = 30.57 kN
Temp. factor (k6) = 1.00
øV = ø*k1*k4*k6*f's*(2/3*A) = 42.90 kN
Sharing factor (k9) = 1.00
Size modifier (mod.b) = 1.00
Size modifier (mod.s) = 1.00

Deflections

Duration factor (j2) = 2.0

Ireq'd j2.(DL+Ψl.LL) (L/300) =	80.2 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	7.2 mm	Span / 362
Ireq'd Ψs.LL (L/300) =	21.5 x10⁶ mm⁴		Ψs.δLL =	1.9 mm	Span / 1348
Ireq'd Total (L/250) =	84.7 x10⁶ mm⁴		δTotal =	9.1 mm	Span / 285
			1kN midspan δ =	0.2 mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

1B6

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(1B6) 2 / 190mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 5.12kNm (+ve) < øM(dl) = 13.94kNm, M* = 7.82kNm (+ve) < øM = 19.56kNm**	**OK (0.37,0.40)**
Shear:	**V(dl)* = 10.34kN < øV(dl) = 24.20kN, V* = 15.93kN < øV = 33.96kN**	**OK (0.43,0.47)**
Deflection:	**δDL = L/526 (3mm) , δΨs.LL = L/1536 (1mm), δTotal = L/392 (5mm), 1kN mid. δ = 0.2mm**	**OK**
Reactions:	**(1 End) Rdl.max = 4.81kN, Rll.max = 6.77kN, R.max* = 15.93kN**	
	(1 End) Rdl.min = 4.58kN, Rll.min = 6.20kN, R.min* = 14.79kN	

Geometry (House member affecting ≤ 25m² or secondary building member)

Category =	1	(1) House, (2) Primary building elements, (3) Important			
House =	N	(Y)es,(N)o	Edge restrained =	C	(T)ension, (C)ompression, (B)oth
Span (L) =	1800	mm	Lay.t (Top) =	450	mm
Centres (cts) =	3100	mm			
Span type =	S	(S)ingle,(D)ouble			

Loadings

Floor area (A) = 5.58 m²

Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	3100	mm +		kN/m =	1.55 kN/m
Wall dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35 kN/m
Other dead load (wdl) =	0.40	kPa *	4000	mm +		kN/m =	1.60 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.10 kN/m
						Σwdl =	4.60 kN/m

Uniform live loads

Floor live load (wll) =	1.50	kPa *	3100	mm +		kN/m =	4.65 kN/m
Partitions (wll) =	0.25	kPa *	4000	mm +		kN/m =	1.00 kN/m
Alternate point live load =	1.80	kN	Distr. to	1	members	Σwll =	5.65 kN/m

Point loads

			DL	LL			
Dead load (pdl) =	1.11	kN	Small	1.1	2.8 : 2*L|2*L	Position =	1085 mm from LHS
Live load (pll) =	2.80	kN	Σ	1.1	2.8	at support =	N (Y)es,(N)o

Short term LL factor (Ψsu) =	0.70	(Ψsp) =	1.00	
Long term LL factor (Ψlu) =	0.40	(Ψlp) =	0.60	
wdl* = 1.2*wdl+1.5*Ψlu*wll =	8.90 kN/m	M(dl+Ψl.ll)* =	5.12	kNm (Max at 1072mm)
w* = 1.2*wdl+1.5*wll =	13.99 kN/m	M* =	7.82	kNm (Max at 1057mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	3.85 kN	V(dl+Ψl.ll)* =	10.34	kN
p* = 1.2*pdl+1.5*pll =	5.53 kN	V* =	15.93	kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	2 / 190mm x 42mm Smart LVL15	Area (A) =	15960 mm²
Description =	LVL15 seasoned softwood	Section modulus (Zx) =	505 x10³ mm³
Design depth (dD) =	190 mm	Stiffness (Ix) =	48.0 x10⁶ mm⁴
Design width (dW) =	42 mm	Modulus of elasticity (E) =	15300 MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 = 8.70 For top comp. edge restrained - Cl 3.2.3.2(a)

k12d =	1.000	for ρbd*S1 ≤ 10 - Cl 3.2.4	f'b =	50.9	MPa
k12 =	1.000	for ρb*S1 ≤ 10 - Cl 3.2.4	f's =	4.2	MPa
			Material constant (ρbd) =	1.04	(rbd=0.25)
Strength reduction factor (ø) =	0.95	Table 2.1	Material constant (ρb) =	0.97	(rb=0.67)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	13.94	kNm	Duration factor (k1) =	0.80	
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	19.56	kNm	Moisture factor (k4) =	1.00	
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	24.20	kN	Temp. factor (k6) =	1.00	
øV = ø*k1*k4*k6*f's*(2/3*A) =	33.96	kN	Sharing factor (k9) =	1.00	
			Size modifier (mod.b) =	1.00	
			Size modifier (mod.s) =	1.00	

Deflections

Duration factor (j2) = 2.0

Ireq'd j2.(DL+Ψl.LL) (L/300) =	27.4 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	3.4 mm	Span / 526
Ireq'd Ψs.LL (L/300) =	9.4 x10⁶ mm⁴		Ψs.δLL =	1.2 mm	Span / 1536
Ireq'd Total (L/250) =	30.6 x10⁶ mm⁴		δTotal =	4.6 mm	Span / 392
			1kN midspan δ =	0.2 mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

1B7

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(1B7) 120mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 0.61kNm (+ve) < øM(dl) = 3.04kNm, M* = 0.91kNm (+ve) < øM = 4.27kNm**	**OK (0.20,0.21)**
Shear:	**V(dl)* = 2.23kN < øV(dl) = 7.64kN, V* = 3.31kN < øV = 10.73kN**	**OK (0.29,0.31)**
Deflection:	**δDL = L/1067 (1mm) , δΨs.LL = L/2039 (1mm), δTotal = L/701 (2mm), 1kN mid. δ = 0.3mm**	**OK**
Reactions:	**(Each end) Rdl = 0.51kN, Rll = 1.80kN, R* = 3.31kN**	

Geometry

(House member affecting ≤ 25m² or secondary building member)

Category =	1	(1) House, (2) Primary building elements, (3) Important			
House =	N	(Y)es,(N)o	Edge restrained =	C	(T)ension, (C)ompression, (B)oth
Span (L) =	1100	mm	Lay.t (Top) =	450	mm
Centres (cts) =	1800	mm			
Span type =	S	(S)ingle,(D)ouble			

Loadings

Floor area (A) =	1.98	m²	Live load type =	N	(N)ormal, (S)torage, (M)anual		
					AS/NZS 1170.0 - Table 4.1		

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	1800	mm +		kN/m =	0.90	kN/m
Wall dead load (wdl) =		kPa *		mm +		kN/m =	0.00	kN/m
Other dead load (wdl) =		kPa *		mm +		kN/m =	0.00	kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.03	kN/m
						Σwdl =	0.93	kN/m

Uniform live loads

Floor live load (wll) =	1.50	kPa *	1800	mm +		kN/m =	2.70	kN/m
Partitions (wll) =		kPa *	1800	mm +		kN/m =	0.00	kN/m
Alternate point live load =	1.80	kN (critical)	Distr. to	1	members	Σwll =	3.27	kN/m

Point loads

Dead load (pdl) =		kN	Position =	550	mm from LHS
Live load (pll) =		kN	Shear using PL at support =	N	(Y)es,(N)o

Short term LL factor (Ψsu) =	0.70		(Ψsp) =	1.00	
Long term LL factor (Ψlu) =	0.40		(Ψlp) =	0.60	
wdl* = 1.2*wdl+1.5*Ψlu*wll =	4.06	kN/m	M(dl+Ψl.ll)* =	0.61	kNm (Max at 550mm)
w* = 1.2*wdl+1.5*wll =	6.03	kN/m	M* =	0.91	kNm (Max at 550mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	0.00	kN	V(dl+Ψl.ll)* =	2.23	kN
p* = 1.2*pdl+1.5*pll =	0.00	kN	V* =	3.31	kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	120mm x 42mm Smart LVL15		Area (A) =	5040	mm²
Description =	LVL15 seasoned softwood		Section modulus (Zx) =	101	x10³ mm³
Design depth (dD) =	120	mm	Stiffness (Ix) =	6.0	x10⁶ mm⁴
Design width (dW) =	42	mm	Modulus of elasticity (E) =	15300	MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 =	6.92	For top comp. edge restrained - Cl 3.2.3.2(a)			
k12d =	1.000	for ρbd*S1 ≤ 10 - Cl 3.2.4	f'b =	55.7	MPa
k12 =	1.000	for ρb*S1 ≤ 10 - Cl 3.2.4	f's =	4.2	MPa
			Material constant (ρbd) =	1.08	(rbd=0.25)
Strength reduction factor (ø) =	0.95	Table 2.1	Material constant (ρb) =	1.01	(rb=0.81)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	3.04	kNm	Duration factor (k1) =	0.80	
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	4.27	kNm	Moisture factor (k4) =	1.00	
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	7.64	kN	Temp. factor (k6) =	1.00	
øV = ø*k1*k4*k6*f's*(2/3*A) =	10.73	kN	Sharing factor (k9) =	1.00	
			Size modifier (mod.b) =	1.00	
			Size modifier (mod.s) =	1.00	

Deflections

			Duration factor (j2) =	2.0		
Ireq'd j2.(DL+Ψl.LL) (L/300) =	1.7 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	1.0	mm	Span / 1067
Ireq'd Ψs.LL (L/300) =	0.9 x10⁶ mm⁴		Ψs.δLL =	0.5	mm	Span / 2039
Ireq'd Total (L/250) =	2.2 x10⁶ mm⁴		δTotal =	1.6	mm	Span / 701
			1kN midspan δ =	0.3	mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

1B8

STEEL MEMBER V5.14

Xstruct

Section:	**(1B8) 250x90PFC (G300)**	
Bending:	**Mx* = 32.6kNm < øMb(4500,αm=1.30) = 73.7kNm, øMb(αm=1) = 56.7kNm**	**OK (0.44)**
	No minor bending	
Shear:	**Vx* = 0.022kN < øVvm = 345.6kN (Web area full depth)**	**OK (0.00)**
	No minor shear	
Compression:	**No compression**	
Tension:	**No tension**	
Torsion:	**No torsion**	
Deflection:	**δDL = L/1127 (4mm), δΨs.LL = L/2461 (2mm), δTotal= L/773 (6mm) at 2400mm from LHS**	**OK**

Bending & Shear at 2650mm from LHS (Max +ve M) - Section 5

Max. restraint (2.5% flange force) = 3.5 kN

(M* to include first order amplification as required - Cl 4.4.2)

Analysis values = X (M)anual, (L)eft, Position (X) from analysis, (R)ight, (C)ritical

Refer to the analysis output

Analysis Axis = X (X),(Y)

Major bending (Mx*) =	32.6	kNm			
Minor bending (My*) =	0.000	kNm	Minor bending (My*) =	0	kNm
Shear Force (Vx*) =	0.022	kN	Torsion (Mz*) =	0	kNm
Shear Force (Vy*) =	0.000	kN			
Effective length factor (ke) =	Calc		Shear Force (Vy*) =	0	kN
ke = (kt=1.00)*(kl=1.00)*(kr=1.00) =	1.00	(From Le Tab)	Span / Segment Length (L) =	4500	mm
Effective length (Le = L*ke) =	4500	mm	Moment modification factor (αm) =	1.30	
ø =	0.9	Table 3.4			
øMsx =	113.7	kNm	Bending (x) =	OK (0.44)	
øMbx(αm=1) =	56.7	kNm			
øMbx =	73.7	kNm	Shear =	OK (0.00)	
øMsyL =	23.9	kNm	øMsyR =	24.0 kNm	
øVv =	345.6	kN			
øVvm =	345.6	kN	Ix =	45.1	x10⁶ mm⁴
øMz =	2.68	kNm	S.Wt =	0.355	kN/m

Compression - Section 6 (No compression)

Axial compression (Nc*) =	0.0	kN	Axial compression (Nc*) =	0	kN
Major axis length (Lx) =	10000	mm	Eff. X length factor (kex) =	1.00	
Minor axis length (Ly) =	1500	mm	Eff. Y length factor (key) =	1.00	
Braced or Sway member =	S	(B)raced, (S)way			
			Major axis effective length (Lex) =	10000	mm
øNs =	1220.4	kN	Minor axis effective length (Ley) =	1500	mm
øNcx(kex=1.00) =	527.7	kN			
In-Plane øNcx(kex=1.00) =	527.7	kN			
øNcy(key=1.00) =	926.9	kN			
In-Plane øNcy(key=1.00) =	926.9	kN			
øNc =	527.7	kN			

Tension - Section 7 (No tension)

Axial tension (Nt*) =	0.0	kN	Axial tension (Nt*) =	0	kN
kt =	1.00	Table 7.3.2			
øNt =	1220.4	kN			

Combined

øMrxt =	113.7 kNm	øMixt =	113.7 kNm	øMoxt =	73.7 kNm
øMrxc =	113.7 kNm	øMixc =	113.7 kNm	øMoxc =	73.7 kNm
øMryt =	23.9 kNm	øMiyc =	23.9 kNm	øMtx =	73.7 kNm
øMryc =	23.9 kNm			øMcx =	73.7 kNm

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

1B8 (Ana)

ANALYSIS V5.05 Xstruct

Geometry for (1B8): Steel Simple Beam

Description =	250x90PFC (G300)		Ix =	45.1	x10⁶ mm⁴
Span (L) =	4800	mm	Axis =	X	(X),(Y)
Span type =	S	(S)imple,(E)xt,(I)nt,(C)ant,(P)rop,(F)ixed,(O)ther	Ag =	4520	mm²
Material type =	S	(T)imber,(S)teel,(C)onc.,(SC)comp. steel,(O)ther	Density =	78.6	kN/m³
			E =	200000	MPa

Loading

Uniform loads (kN/m)

Uniform loads	UDL	Partial 1	Partial 2
Dead load (wdl) =	3.65		
Live load (wll) =	1.93		
Start from LHS (mm) =	0		
End from LHS (mm) =	4800		
S.Wt =	0.36	kN/m	
Ultimate load (w*) =	7.70	0.00	0.00

Point loads (kN)

Point loads	PL 1	PL 2	PL 3
Dead load (pdl) =	6.68	3.38	
Live load (pll) =	4.35	2.80	
Pos. from LHS (mm) =	380	3000	
Ultimate load (p*) =	14.53	8.26	0.00

Live Load type =	Floor	(Steel)		
Short term LL (Ψsu) =	0.70	(Ψsp) =	1.00	
Long term LL (Ψlu) =	0.40	(Ψlp) =	0.60	
Actual LL (Ψsa) =	0.81	(Ψla) =	0.48	

Include S.Wt = Y (Y)es,(N)o
Strength loadcase = C (D)ead Only,(C)omb.

	DL	LL
1B9	5.0	2.9 : L|L
Large	1.7	1.4 : L|L
Σ	6.7	4.3

Results at 2650mm from LHS (Max +ve M)

Position of result (x) = 2650 mm

1.20*G+1.50*Q analysed

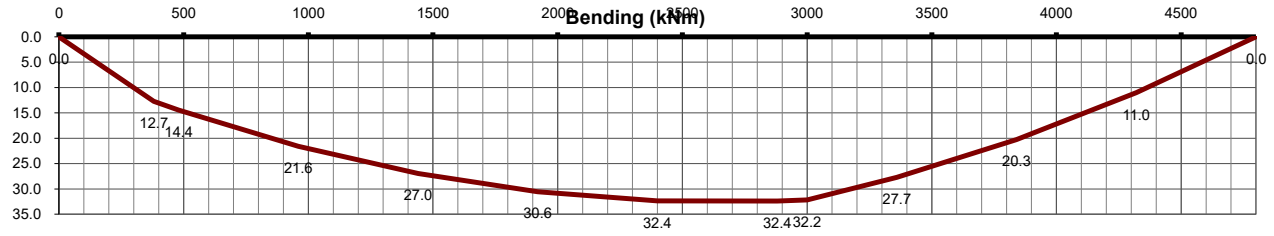
	Left	At x	Right	Max	At	Min	At	Units	
Rdl	17.03		12.26					kN	
Rll	9.69		6.73					kN	
R*	34.96		24.80					kN	
M*	0.00	32.62	0.00	32.62	2650	0.00	0	kNm	
V*	34.96	0.02	-24.80	34.96	0			kN	Span /
δdl	0.00	4.21	0.00	4.26	2400	0.00	0	mm	1127
δll	0.00	2.37	0.00	2.39	2400	0.00	0	mm	2005
δdl+Ψs*δll	0.00	6.13	0.00	6.21	2400	0.00	0	mm	773

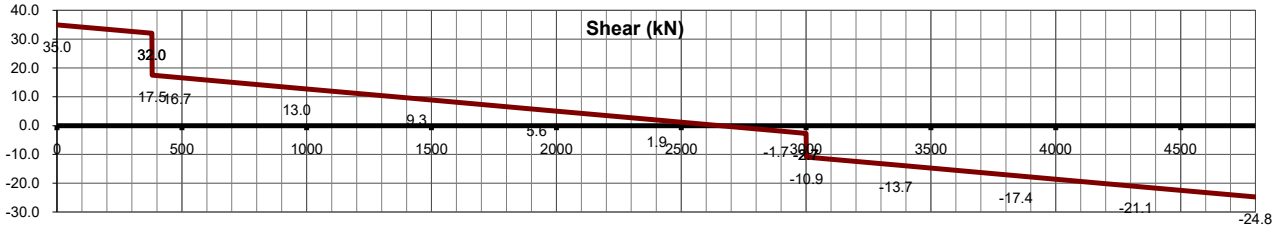
	DL	LL
Large	3.4	2.8 : 2*L|2*L
Σ	3.4	2.8

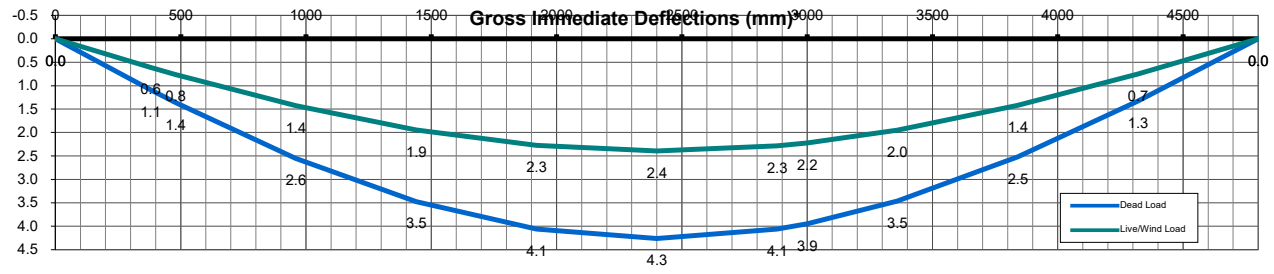
δPll/δTot.ll = 0.382

Graphs

* Deflections are Gross Ig immediate - assessment of long term effects to be considered







XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

TIMBER ROOF BEAM V5.10

Xstruct

Beam:	**(1B9) 2 / 300mm x 58mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 6.40kNm (+ve) < øM(dl) = 14.89kNm, M* = 8.79kNm (+ve) < øM = 26.13kNm**	**OK (0.43,0.34)**
	Mw* = 0.00kNm (-ve) < øMw = 30.94kNm	**OK (0.00)**
Shear:	**V(dl)* = 6.92kN < øV(dl) = 52.76kN, V* = 10.95kN < øV = 87.01kN**	**OK (0.13,0.13)**
	Vw* = 2.82kN < øVw = 92.57kN	**OK (0.03)**
Deflection:	**δDL = L/932 (5mm) , δΨs.LL = L/4858 (1mm), δWLs = L/6821 (-1mm)**	**OK**
Reactions:	**(1 End) Rdl.max = 4.98kN, Rll.max = 2.95kN, Rwl.max* = -1.79kN, R.dn.max* = 10.40kN, R.up.max* = -2.70kN (Down)**	
	(1 End) Rdl.min = 4.26kN, Rll.min = 1.65kN, Rwl.min* = -1.79kN, R.dn.min* = 7.59kN, R.up.min* = -2.05kN (Down)	

Geometry

(House member affecting ≤ 25m² or secondary building member)

Category = 1 (1) House, (2) Primary building elements, (3) Important — House = N (Y)es,(N)o
Span (L) = 4300 mm — Edge restrained (down) = C (T)ension,(C)ompression,(B)oth
Centres (cts) = 900 mm — Lay.t (Top) = 4300 mm
Span type = S (S)ingle,(D)ouble

Loadings

Roof area (A) = 3.87 m² — Apply wind reduction = Y (Y)es,(N)o
LL = 1.8/A+0.12 ≥ 0.25 = 0.59 kPa — Roof reduction (Ka) = 1.00 AS/NZS 1170.2, Table 5.4
Ratio Ws/Wu = 0.68 (Refer wind analysis)

Uniform dead loads

Roof dead load (wdl) =	0.40	kPa *	900	mm +		kN/m =	0.36 kN/m
Other dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.21 kN/m
						Σwdl =	1.92 kN/m

Uniform live loads

Roof live load (wll) =	0.59	kPa *	900	mm +		kN/m =	0.53 kN/m
Other live load (wll) =		kPa *	900	mm +		kN/m =	0.00 kN/m
Alternate point live load =	1.40	kN (critical)	Distr. to	1	members	Σwll =	0.65 kN/m

Uniform wind loads

Ult. wind load (Wu) = 0.84 kPa * — 900 mm
Cp,e = 0.9 — Cp,i = 0.2 — Σwwl* = -0.83 kN/m (up)

Point loads

	DL	LL	WLu	
T1	1.0	1.8	-	: L|L|-
Σ	1.0	1.8	0.0	

Dead load (pdl) = 1.00 kN — ition = 600 mm from LHS
Live load (pll) = 1.80 kN — port = Y (Y)es,(N)o
Wind load (pwl*) = kN (-ve up)

w(dl)* = 1.35*wdl = 2.59 kN/m — M(dl)* = 6.40 kNm (Max at 2077mm)
w* = 1.2*wdl + 1.5*wll = 3.28 kN/m — M* = 8.79 kNm (Max at 1984mm)
w.up* = 0.9*wdl + wwl* = -0.90 kN/m (down) — Mw.dn* = 0.00 kNm
p(dl)* = 1.35*pdl = 1.35 kN — V(dl)* = 6.92 kN
p* = 1.2*pdl+1.5*pll = 3.90 kN — V* = 10.95 kN
p.up* = 0.9*pdl + pwl* = -0.90 kN (down) — Vw.up* = 2.82 kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member = 2 / 300mm x 58mm Smart LVL15 — Area (A) = 34800 mm²
Description = LVL15 seasoned softwood — Section modulus (Zx) = 1740 x10³ mm³
Design depth (dD) = 300 mm — Stiffness (Ix) = 261.0 x10⁶ mm⁴
Design width (dW) = 58 mm — Modulus of elasticity (E) = 15300 MPa - Cl 8.3

S1d = 1.25*dD/dW*(Lay.t/dD)^0.5 = 24.48 For top comp. edge restrained - Cl 3.2.3.2(a)
S1ud = 1.25*dD/dW*(Lay.t/dD)^0.5 = 24.48 For top comp. edge restrained - Cl 3.2.3.2(a)
k12d = 200/(S1d*pbd)² = 0.340 for ρbd*S1d ≥ 20 - Cl 3.2.4
k12 = 200/(S1d*ρb)² = 0.361 for ρb*S1d ≥ 20 - Cl 3.2.4 — f'b = 46.5 MPa
k12u = 200/(S1u*ρbu)² = 0.402 for ρbu*S1u ≥ 20 - Cl 3.2.4 — f's = 4.2 MPa

Strength reduction factor (ø) = 0.95 Table 2.1 — Material constant (ρbd) = 0.99 (rbd=0.25)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx = 14.89 kNm — Material constant (ρb) = 0.96 (rb=0.42)
øM = ø*k1*k4*k6*k9*k12*f'b*Zx = 26.13 kNm — Stress reversal (ρbu) = 0.91 (rbu=1.00)
øMw = ø*(k1=1)*k4*k6*k9*k12u*f'b*Zx = 30.94 kNm — Duration factor (k1) = 0.94 (Live)
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) = 52.76 kN — Moisture factor (k4) = 1.00
øV = ø*k1*k4*k6*f's*(2/3*A) = 87.01 kN — Temp. factor (k6) = 1.00
øVw = ø*(k1=1)*k4*k6*f's*(2/3*A) = 92.57 kN — Sharing factor (k9) = 1.00
Size modifier (mod.b & s) = 1.00 & 1.00

Deflections

Duration factor (j2) = 2.0

Ireq'd j2.(DL+Ψl.LL) (L/300) =	84.0 x10⁶ mm⁴	< Critical	δDL=	4.6 mm	Span / 932
Ireq'd `LL (L/240) =	12.9 x10⁶ mm⁴		δΨs.LL =	0.9 mm	Span / 4858
Ireq'd WLs (L/180) =	6.9 x10⁶ mm⁴		δWLs =	-0.6 mm	Span / 6821

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

1L1

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(1L1) 2 / 290mm x 42mm Smart LVL15* (Oregon) (Single span)**	
Bending:	**M(dl)* = 9.99kNm (+ve) < øM(dl) = 28.84kNm, M* = 14.80kNm (+ve) < øM = 41.65kNm**	**OK (0.35,0.36)**
Shear:	**V(dl)* = 16.03kN < øV(dl) = 36.93kN, V* = 23.48kN < øV = 51.84kN**	**OK (0.43,0.45)**
Deflection:	**δDL = L/600 (5mm) , δΨs.LL = L/2193 (1mm), δTotal = L/471 (6mm), 1kN mid. δ = 0.2mm**	**OK**
Reactions:	**(1 End) Rdl.max = 8.55kN, Rll.max = 8.81kN, R.max* = 23.48kN**	
	(1 End) Rdl.min = 6.61kN, Rll.min = 7.76kN, R.min* = 19.57kN	
Geometry	(House member affecting ≤ 25m² or secondary building member)	

Category = 1 (1) House, (2) Primary building elements, (3) Important
House = N (Y)es,(N)o
Edge restrained = C (T)ension, (C)ompression, (B)oth
Span (L) = 2700 mm
Lay.t (Top) = 450 mm
Centres (cts) = 3100 mm
Span type = S (S)ingle,(D)ouble

Loadings

Floor area (A) = 8.37 m²
Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50 kPa *	3100 mm +		kN/m =	1.55	kN/m
Wall dead load (wdl) =	0.50 kPa *	2700 mm +		kN/m =	1.35	kN/m
Other dead load (wdl) =	0.40 kPa *	2700 mm +		kN/m =	1.08	kN/m
Include S.Wt =	Y (Y)es,(N)o			S.Wt =	0.15	kN/m
				Σwdl =	4.13	kN/m

Uniform live loads

Floor live load (wll) =	1.50 kPa *	3100 mm +		kN/m =	4.65	kN/m
Partitions (wll) =	0.25 kPa *	2700 mm +		kN/m =	0.68	kN/m
Alternate point live load =	1.80 kN	Distr. to	1 members	Σwll =	5.33	kN/m

Point loads

Dead load (pdl) =	4.02 kN			Position =	700	mm from LHS
Live load (pll) =	2.19 kN			ing PL at support =	N	(Y)es,(N)o

	DL	LL	
GT	4.0	2.2	: L|L
Σ	4.0	2.2	

Short term LL factor (Ψsu) =	0.70	(Ψsp) =	1.00
Long term LL factor (Ψlu) =	0.40	(Ψlp) =	0.60
wdl* = 1.2*wdl+1.5*Ψlu*wll =	8.15 kN/m	M(dl+Ψl.ll)* =	9.99 kNm (Max at 1134mm)
w* = 1.2*wdl+1.5*wll =	12.94 kN/m	M* =	14.80 kNm (Max at 1187mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	6.80 kN	V(dl+Ψl.ll)* =	16.03 kN
p* = 1.2*pdl+1.5*pll =	8.11 kN	V* =	23.48 kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member = 2 / 290mm x 42mm Smart LVL15*
Description = LVL15 seasoned softwood
Design depth (dD) = 290 mm
Design width (dW) = 42 mm
Area (A) = 24360 mm²
Section modulus (Zx) = 1177 x10³ mm³
Stiffness (Ix) = 170.7 x10⁶ mm⁴
Modulus of elasticity (E) = 15300 MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 = 10.75 For top comp. edge restrained - Cl 3.2.3.2(a)
k12d = 1.5-0.05*ρbd*S1 = 0.965 for 10 ≤ ρbd*S1 ≤ 20 - Cl 3.2.4
k12 = 1.5-0.05*ρb*S1 = 0.994 for 10 ≤ ρb*S1 ≤ 20 - Cl 3.2.4
f'b = 46.9 MPa
f's = 4.2 MPa
Material constant (ρbd) = 0.99 (rbd=0.25)
Material constant (ρb) = 0.94 (rb=0.61)

Strength reduction factor (ø) =	0.95	Table 2.1	Duration factor (k1) =	0.80	
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	28.84	kNm	Moisture factor (k4) =	1.00	
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	41.65	kNm	Temp. factor (k6) =	1.00	
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	36.93	kN	Sharing factor (k9) =	1.00	
øV = ø*k1*k4*k6*f's*(2/3*A) =	51.84	kN	Size modifier (mod.b) =	1.00	
			Size modifier (mod.s) =	1.00	

Deflections

Duration factor (j2) = 2.0

Ireq'd j2.(DL+Ψl.LL) (L/300) =	85.4 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	4.5 mm	Span / 600
Ireq'd Ψs.LL (L/300) =	23.4 x10⁶ mm⁴		Ψs.δLL =	1.2 mm	Span / 2193
Ireq'd Total (L/250) =	90.6 x10⁶ mm⁴		δTotal =	5.7 mm	Span / 471
			1kN midspan δ =	0.2 mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

1L2

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(1L2) 2 / 120mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 1.49kNm (+ve) < øM(dl) = 5.74kNm, M* = 1.93kNm (+ve) < øM = 8.30kNm**	**OK (0.26,0.23)**
Shear:	**V(dl)* = 5.38kN < øV(dl) = 15.28kN, V* = 7.00kN < øV = 21.45kN**	**OK (0.35,0.33)**
Deflection:	**δDL = L/886 (1mm) , δΨs.LL = L/2926 (0mm), δTotal = L/680 (1mm), 1kN mid. δ = 0.1mm**	**OK**
Reactions:	**(1 End) Rdl.max = 2.45kN, Rll.max = 2.71kN, R.max* = 7.00kN**	
	(1 End) Rdl.min = 1.95kN, Rll.min = 2.29kN, R.min* = 5.79kN	
Geometry	(House member affecting ≤ 25m² or secondary building member)	

Category = 1 (1) House, (2) Primary building elements, (3) Important
House = N (Y)es,(N)o
Edge restrained = C (T)ension, (C)ompression, (B)oth
Span (L) = 1000 mm
Lay.t (Top) = 1000 mm
Centres (cts) = 450 mm
Span type = S (S)ingle,(D)ouble

Loadings

Floor area (A) = 0.45 m²
Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50 kPa *	450 mm +		kN/m =	0.23	kN/m
Wall dead load (wdl) =	0.50 kPa *	2700 mm +		kN/m =	1.35	kN/m
Other dead load (wdl) =	0.40 kPa *	2700 mm +		kN/m =	1.08	kN/m
Include S.Wt =	Y (Y)es,(N)o			S.Wt =	0.06	kN/m
				Σwdl =	2.72	kN/m

Uniform live loads

Floor live load (wll) =	1.50 kPa *	450 mm +		kN/m =	0.68	kN/m
Partitions (wll) =	0.25 kPa *	2700 mm +		kN/m =	0.68	kN/m
Alternate point live load =	1.80 kN (critical)	Distr. to	1 members	Σwll =	3.60	kN/m

Point loads

	DL	LL	
Large	1.7	1.4	: L|L
Σ	1.7	1.4	

Dead load (pdl) = 1.69 kN
Live load (pll) = 1.40 kN
Position = 647 mm from LHS
ing PL at support = N (Y)es,(N)o

Short term LL factor (Ψsu) =	0.70	(Ψsp) =	1.00
Long term LL factor (Ψlu) =	0.40	(Ψlp) =	0.60
wdl* = 1.2*wdl+1.5*Ψlu*wll =	6.50 kN/m	M(dl+Ψl.ll)* =	1.49 kNm (Max at 647mm)
w* = 1.2*wdl+1.5*wll =	8.66 kN/m	M* =	1.93 kNm (Max at 647mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	3.29 kN	V(dl+Ψl.ll)* =	5.38 kN
p* = 1.2*pdl+1.5*pll =	4.13 kN	V* =	7.00 kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member = 2 / 120mm x 42mm Smart LVL15
Description = LVL15 seasoned softwood
Design depth (dD) = 120 mm
Design width (dW) = 42 mm
Area (A) = 10080 mm²
Section modulus (Zx) = 202 x10³ mm³
Stiffness (Ix) = 12.1 x10⁶ mm⁴
Modulus of elasticity (E) = 15300 MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 = 10.31 For top comp. edge restrained - Cl 3.2.3.2(a)
k12d = 1.5-0.05*ρbd*S1 = 0.943 for 10 ≤ ρbd*S1 ≤ 20 - Cl 3.2.4
k12 = 1.5-0.05*ρb*S1 = 0.972 for 10 ≤ ρb*S1 ≤ 20 - Cl 3.2.4
f'b = 55.7 MPa
f's = 4.2 MPa
Material constant (ρbd) = 1.08 (rbd=0.25)
Material constant (ρb) = 1.03 (rb=0.60)

Strength reduction factor (ø) =	0.95 Table 2.1	Duration factor (k1) =	0.80
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	5.74 kNm	Moisture factor (k4) =	1.00
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	8.30 kNm	Temp. factor (k6) =	1.00
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	15.28 kN	Sharing factor (k9) =	1.00
øV = ø*k1*k4*k6*f's*(2/3*A) =	21.45 kN	Size modifier (mod.b) =	1.00
		Size modifier (mod.s) =	1.00

Deflections

Duration factor (j2) = 2.0

Ireq'd j2.(DL+Ψl.LL) (L/300) =	4.1 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	1.1 mm	Span / 886
Ireq'd Ψs.LL (L/300) =	1.2 x10⁶ mm⁴		Ψs.δLL =	0.3 mm	Span / 2926
Ireq'd Total (L/250) =	4.4 x10⁶ mm⁴		δTotal =	1.5 mm	Span / 680
			1kN midspan δ =	0.1 mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

GL1

T LINTEL V5.03

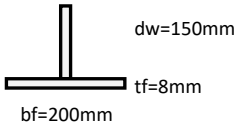
Xstruct

Geometry: (GL1) 150mm x 8mm Pl. Vert., 200mm x 8mm Pl. Horz.
Design: M* = 8.8kNm < øMb(3000,αm=1.13) = 12.8 kNm — **OK (0.69)**
Deflection: δDL = L/703 (4mm), δΨs.LL = L/5535 (1mm), δTotal = L/624 (5mm) — **OK**
Reactions: (Each end) Rdl = 7.9kN, Rll = 1.4kN, R* = 11.7kN

Geometry

Span = Le = 3000 mm

αm = 1.13



Vertical web
Web thickness (tw) = 8 mm
Web depth (dw) = 150 mm
Yield strength = 250 MPa

Horizontal flange
Flange thickness (tf) = 8 mm
Flange width (bf) = 200 mm
Yield strength = 250 MPa

Loading

Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Roof dead load (wdl) =	0.40	kPa *	3000	mm +		kN/m =	1.20 kN/m
Floor dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35 kN/m
Wall dead load (wdl) =	2.10	kPa *	1200	mm +		kN/m =	2.52 kN/m
Other dead load (wdl) =		kPa *		mm +		kN/m =	0.00 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.22 kN/m
						Σwdl =	5.29 kN/m

Uniform live loads

Roof live load (wll) =	0.32	kPa *	3000	mm +		kN/m =	0.96 kN/m
Floor live load (wll) =		kPa *		mm +		kN/m =	0.00 kN/m
Other live load (wll) =		kPa *		mm +		kN/m =	0.00 kN/m
						Σwll =	0.96 kN/m

Point loads
Dead load (Pdl) = kN
Live load (Pll) = kN
Position = 1500 mm from LHS

Horizontal loads
Wall height (wcts) = 0 mm
Ratio Ws/Wu = 0.68
Ult. inward wind load (Wu) = 0.84 kPa
cpe = 0.7 cpi = 0.2 wwl* = 0.00 kN/m
Short term LL (Ψsu) = 0.70 (Ψsp) = 1.00
w* = 1.2*wdl + 1.5*wll = 7.79 kNm Rdl = wdl*L/2 + pdl*(L-pos)/L = 7.9 kN
p* = 1.2*pdl + 1.5*pll = 0.00 kNm Rll = wll*L/2 + pll*(L-pos)/L = 1.4 kN
M* = 8.8 kNm R* = 1.2*Rdl + 1.5*Rll = 11.7 kN
(Max at 1500mm)

Properties

Area =	2800	mm²	Warping constant (Iw) =	0	mm⁶ - Cl H4
Stiffness (Ix) =	6.5	x10⁶ mm⁴	Torsional constant (J) =	59.7	x10³ mm⁴
Stiffness (Iy) =	5.34	x10⁶ mm⁴	Elastic section modulus (Zt) =	54.4	x10³ mm³
Elastic modulus (E) =	200000	MPa - Cl 1.4	Elastic section modulus (Zb) =	172.7	x10³ mm³
Shear modulus (G) =	80000	MPa - Cl 1.4	Min. elastic section modulus (Zmin) =	54.4	x10³ mm³
Elastic (y.top) =	120	mm	Plastic section modulus (S) =	96.2	x10³ mm³
Plastic (yp.top) =	151	mm	Eff. elastic section mod.(Compact) (Zc) =	81.6	x10³ mm³ - Cl 5.2.3

Capacity - Cl 5.6.1.2

Web λs =dw/tw*√(fyw/250) =	18.8	< 22, Non-compact	Cl 5.2.2			λsy =	22
Zex = Zmin+[(λsy-λs)/(λsy-λsp)*(Zc-Zmin)] =	60.7	x10³ mm³ - Cl 5.2.4				λsp =	8
ø =	0.9	Table 3.4					
Msx =	15.2	kNm	øMsx =	13.7	kNm	βx =	-93.9
Moa =	37.9	kNm	αs =	0.826		αm =	1.13
øMbx = αm*αs*øMsx ≤ øMsx =				12.8	kNm - Cl 5.6.1.1(1)		

Deflections

Ireq'd DL (L/500) =	4.6	x10⁶ mm⁴	< Critical	δDL =	4.3 mm	Span / 703
Ireq'd Ψs.LL (L/360) =	0.4	x10⁶ mm⁴		Ψs.δLL =	0.5 mm	Span / 5535
Ireq'd WLs.h (L/250) =	0.0	x10⁶ mm⁴		δWLs.h =	0.0 mm	Span / -
Ireq'd (DL+Ψs.LL) (L/360) =	3.8	x10⁶ mm⁴		δTotal =	4.8 mm	Span / 624
				1kN midspan δ =	0.4 mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

2B1

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(2B1) 2 / 290mm x 42mm Smart LVL15* (Oregon) (Single span)**	
Bending:	**M(dl)* = 4.89kNm (+ve) < øM(dl) = 6.53kNm, M* = 6.68kNm (+ve) < øM = 10.60kNm**	**OK (0.75,0.63)**
Shear:	**V(dl)* = 10.45kN < øV(dl) = 36.93kN, V* = 14.14kN < øV = 51.84kN**	**OK (0.28,0.27)**
Deflection:	**δDL = L/1058 (3mm) , δΨs.LL = L/2604 (1mm), δTotal = L/752 (5mm), 1kN mid. δ = 0.4mm**	**OK**
Reactions:	**(1 End) Rdl.max = 4.09kN, Rll.max = 6.15kN, R.max* = 14.14kN**	
	(1 End) Rdl.min = 1.18kN, Rll.min = 2.45kN, R.min* = 5.10kN	
Geometry	(House member affecting ≤ 25m² or secondary building member)	

Category = 1 (1) House, (2) Primary building elements, (3) Important
House = N (Y)es,(N)o
Edge restrained = C (T)ension, (C)ompression, (B)oth
Span (L) = 3600 mm
Lay.t (Top) = 3600 mm
Centres (cts) = 450 mm
Span type = S (S)ingle,(D)ouble

Loadings

Floor area (A) = 1.62 m²
Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50 kPa *	450 mm +		kN/m =	0.23	kN/m
Wall dead load (wdl) =	kPa *	450 mm +		kN/m =	0.00	kN/m
Other dead load (wdl) =	kPa *	mm +		kN/m =	0.00	kN/m
Include S.Wt =	Y (Y)es,(N)o			S.Wt =	0.15	kN/m
				Σwdl =	0.37	kN/m

Uniform live loads

Floor live load (wll) =	1.50 kPa *	450 mm +		kN/m =	0.68	kN/m
Partitions (wll) =	kPa *	450 mm +		kN/m =	0.00	kN/m
Alternate point live load =	1.80 kN (critical)	Distr. to	1 members	Σwll =	1.00	kN/m

Point loads

Dead load (pdl) = 3.94 kN
Live load (pll) = 5.01 kN

	DL	LL
2B2	3.9	5.0 : L|L
Σ	3.9	5.0

Position = 470 mm from LHS
ing PL at support = N (Y)es,(N)o

Short term LL factor (Ψsu) =	0.70	(Ψsp) =	1.00
Long term LL factor (Ψlu) =	0.40	(Ψlp) =	0.60
wdl* = 1.2*wdl+1.5*Ψlu*wll =	1.35 kN/m	M(dl+Ψl.ll)* =	4.89 kNm (Max at 904mm)
w* = 1.2*wdl+1.5*wll =	1.95 kN/m	M* =	6.68 kNm (Max at 979mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	9.23 kN	V(dl+Ψl.ll)* =	10.45 kN
p* = 1.2*pdl+1.5*pll =	12.24 kN	V* =	14.14 kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member = 2 / 290mm x 42mm Smart LVL15*
Description = LVL15 seasoned softwood
Design depth (dD) = 290 mm
Design width (dW) = 42 mm
Area (A) = 24360 mm²
Section modulus (Zx) = 1177 x10³ mm³
Stiffness (Ix) = 170.7 x10⁶ mm⁴
Modulus of elasticity (E) = 15300 MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 = 30.41 For top comp. edge restrained - Cl 3.2.3.2(a)
k12d = 200/(S1*ρbd)² = 0.219 for ρbd*S1 ≥ 20 - Cl 3.2.4
k12 = 1.5-0.05*ρb*S1 = 0.253 for ρb*S1 ≥ 20 - Cl 3.2.4

f'b = 46.9 MPa
f's = 4.2 MPa
Material constant (ρbd) = 0.99 (rbd=0.25)
Material constant (ρb) = 0.92 (rb=0.82)

Strength reduction factor (ø) =	0.95 Table 2.1	Duration factor (k1) =	0.80
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	6.53 kNm	Moisture factor (k4) =	1.00
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	10.60 kNm	Temp. factor (k6) =	1.00
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	36.93 kN	Sharing factor (k9) =	1.00
øV = ø*k1*k4*k6*f's*(2/3*A) =	51.84 kN	Size modifier (mod.b) =	1.00
		Size modifier (mod.s) =	1.00

Deflections

Duration factor (j2) = 2.0

Ireq'd j2.(DL+Ψl.LL) (L/300) =	48.4 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	3.4 mm	Span / 1058
Ireq'd Ψs.LL (12mm) =	19.7 x10⁶ mm⁴		Ψs.δLL =	1.4 mm	Span / 2604
Ireq'd Total (L/250) =	56.7 x10⁶ mm⁴		δTotal =	4.8 mm	Span / 752
			1kN midspan δ =	0.4 mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

2B2

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(2B2) 2 / 140mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 3.36kNm (+ve) < øM(dl) = 8.04kNm, M* = 5.01kNm (+ve) < øM = 11.28kNm**	**OK (0.42,0.44)**
Shear:	**V(dl)* = 7.94kN < øV(dl) = 17.83kN, V* = 12.24kN < øV = 25.03kN**	**OK (0.45,0.49)**
Deflection:	**δDL = L/421 (3mm) , δΨs.LL = L/1393 (1mm), δTotal = L/323 (4mm), 1kN mid. δ = 0.2mm**	**OK**
Reactions:	**(Each end) Rdl = 3.94kN, Rll = 5.01kN, R* = 12.24kN**	

Geometry

(House member affecting ≤ 25m² or secondary building member)

Category =	1	(1) House, (2) Primary building elements, (3) Important			
House =	N	(Y)es,(N)o	Edge restrained =	C	(T)ension, (C)ompression, (B)oth
Span (L) =	1400	mm	Lay.t (Top) =	450	mm
Centres (cts) =	3600	mm			
Span type =	S	(S)ingle,(D)ouble			

Loadings

Floor area (A) = 5.04 m²

Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50 kPa *	3600 mm +		kN/m =	1.80	kN/m
Wall dead load (wdl) =	0.50 kPa *	2700 mm +		kN/m =	1.35	kN/m
Other dead load (wdl) =	0.40 kPa *	3000 mm +		kN/m =	1.20	kN/m
Include S.Wt =	Y (Y)es,(N)o			S.Wt =	0.07	kN/m
				Σwdl =	4.42	kN/m

Uniform live loads

Floor live load (wll) =	1.50 kPa *	3600 mm +		kN/m =	5.40	kN/m
Partitions (wll) =	0.25 kPa *	3000 mm +		kN/m =	0.75	kN/m
Alternate point live load =	1.80 kN	Distr. to	1 members	Σwll =	6.15	kN/m

Point loads

			DL	LL			
Dead load (pdl) =	1.69 kN	Large	1.7	1.4	: L|L	Position =	700 mm from LHS
Live load (pll) =	1.40 kN	Σ	1.7	1.4		ing PL at support =	N (Y)es,(N)o

Short term LL factor (Ψsu) =	0.70	(Ψsp) =	1.00
Long term LL factor (Ψlu) =	0.40	(Ψlp) =	0.60
wdl* = 1.2*wdl+1.5*Ψlu*wll =	8.99 kN/m	M(dl+Ψl.ll)* =	3.36 kNm (Max at 700mm)
w* = 1.2*wdl+1.5*wll =	14.53 kN/m	M* =	5.01 kNm (Max at 700mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	3.29 kN	V(dl+Ψl.ll)* =	7.94 kN
p* = 1.2*pdl+1.5*pll =	4.13 kN	V* =	12.24 kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	2 / 140mm x 42mm Smart LVL15	Area (A) =	11760 mm²
Description =	LVL15 seasoned softwood	Section modulus (Zx) =	274 x10³ mm³
Design depth (dD) =	140 mm	Stiffness (Ix) =	19.2 x10⁶ mm⁴
Design width (dW) =	42 mm	Modulus of elasticity (E) =	15300 MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 = 7.47 For top comp. edge restrained - Cl 3.2.3.2(a)

k12d =	1.000 for ρbd*S1 ≤ 10 - Cl 3.2.4	f'b =	54.1 MPa
k12 =	1.000 for ρb*S1 ≤ 10 - Cl 3.2.4	f's =	4.2 MPa
		Material constant (ρbd) =	1.07 (rbd=0.25)
Strength reduction factor (ø) =	0.95 Table 2.1	Material constant (ρb) =	1.01 (rb=0.60)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	8.04 kNm	Duration factor (k1) =	0.80
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	11.28 kNm	Moisture factor (k4) =	1.00
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	17.83 kN	Temp. factor (k6) =	1.00
øV = ø*k1*k4*k6*f's*(2/3*A) =	25.03 kN	Sharing factor (k9) =	1.00
		Size modifier (mod.b) =	1.00
		Size modifier (mod.s) =	1.00

Deflections

			Duration factor (j2) =	2.0	
Ireq'd j2.(DL+Ψl.LL) (L/300) =	13.7 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	3.3 mm	Span / 421
Ireq'd Ψs.LL (L/300) =	4.1 x10⁶ mm⁴		Ψs.δLL =	1.0 mm	Span / 1393
Ireq'd Total (L/250) =	14.9 x10⁶ mm⁴		δTotal =	4.3 mm	Span / 323
			1kN midspan δ =	0.2 mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

2B3

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(2B3) 2 / 140mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 4.21kNm (+ve) < øM(dl) = 6.83kNm, M* = 5.18kNm (+ve) < øM = 9.86kNm**	**OK (0.62,0.53)**
Shear:	**V(dl)* = 9.00kN < øV(dl) = 17.83kN, V* = 11.16kN < øV = 25.03kN**	**OK (0.50,0.45)**
Deflection:	**δDL = L/430 (3mm) , δΨs.LL = L/1816 (1mm), δTotal = L/348 (3mm), 1kN mid. δ = 0.1mm**	**OK**
Reactions:	**(Each end) Rdl = 4.80kN, Rll = 3.60kN, R* = 11.16kN**	

Geometry

(House member affecting ≤ 25m² or secondary building member)

Category =	1	(1) House, (2) Primary building elements, (3) Important			
House =	N	(Y)es,(N)o	Edge restrained =	C	(T)ension, (C)ompression, (B)oth
Span (L) =	1200	mm	Lay.t (Top) =	1200	mm
Centres (cts) =	450	mm			
Span type =	S	(S)ingle,(D)ouble			

Loadings

Floor area (A) =	0.54	m²	Live load type =	N	(N)ormal, (S)torage, (M)anual
					AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	450	mm +		kN/m =	0.23 kN/m
Wall dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35 kN/m
Other dead load (wdl) =	0.40	kPa *	4000	mm +		kN/m =	1.60 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.07 kN/m
						Σwdl =	3.25 kN/m

Uniform live loads

Floor live load (wll) =	1.50	kPa *	450	mm +		kN/m =	0.68 kN/m
Partitions (wll) =	0.25	kPa *	4000	mm +		kN/m =	1.00 kN/m
Alternate point live load =	1.80	kN (critical)	Distr. to	1	members	Σwll =	3.00 kN/m

Point loads

Dead load (pdl) =	5.71	kN	Position =	600	mm from LHS
Live load (pll) =	3.59	kN	support =	N	(Y)es,(N)o

	DL	LL	
Large	1.7	1.4 : L|L	
GT	4.0	2.2 : L|L	
Σ	5.7	3.6	

Short term LL factor (Ψsu) =				1.00	
Long term LL factor (Ψlu) =				0.60	
wdl* = 1.2*wdl+1.5*Ψlu*wll =	6.59	kN/m	M(dl+Ψl.ll)* =	4.21	kNm (Max at 600mm)
w* = 1.2*wdl+1.5*wll =	8.39	kN/m	M* =	5.18	kNm (Max at 600mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	10.09	kN	V(dl+Ψl.ll)* =	9.00	kN
p* = 1.2*pdl+1.5*pll =	12.24	kN	V* =	11.16	kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	2 / 140mm x 42mm Smart LVL15		Area (A) =	11760	mm²
Description =	LVL15 seasoned softwood		Section modulus (Zx) =	274	x10³ mm³
Design depth (dD) =	140	mm	Stiffness (Ix) =	19.2	x10⁶ mm⁴
Design width (dW) =	42	mm	Modulus of elasticity (E) =	15300	MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 =	12.20	For top comp. edge restrained - Cl 3.2.3.2(a)			
k12d = 1.5-0.05*ρbd*S1 =	0.850	for 10 ≤ ρbd*S1 ≤ 20 - Cl 3.2.4	f'b =	54.1	MPa
k12 = 1.5-0.05*ρb*S1 =	0.875	for 10 ≤ ρb*S1 ≤ 20 - Cl 3.2.4	f's =	4.2	MPa
			Material constant (ρbd) =	1.07	(rbd=0.25)
Strength reduction factor (ø) =	0.95	Table 2.1	Material constant (ρb) =	1.03	(rb=0.47)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	6.83	kNm	Duration factor (k1) =	0.80	
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	9.86	kNm	Moisture factor (k4) =	1.00	
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	17.83	kN	Temp. factor (k6) =	1.00	
øV = ø*k1*k4*k6*f's*(2/3*A) =	25.03	kN	Sharing factor (k9) =	1.00	
			Size modifier (mod.b) =	1.00	
			Size modifier (mod.s) =	1.00	

Deflections

			Duration factor (j2) =	2.0		
Ireq'd j2.(DL+Ψl.LL) (L/300) =	13.4	x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	2.8 mm	Span / 430
Ireq'd Ψs.LL (L/300) =	3.2	x10⁶ mm⁴		Ψs.δLL =	0.7 mm	Span / 1816
Ireq'd Total (L/250) =	13.8	x10⁶ mm⁴		δTotal =	3.4 mm	Span / 348
				1kN midspan δ =	0.1 mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

2B4

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(2B4) 2 / 300mm x 58mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 17.40kNm (+ve) < øM(dl) = 21.35kNm, M* = 23.00kNm (+ve) < øM = 32.86kNm**	**OK (0.82,0.70)**
Shear:	**V(dl)* = 16.09kN < øV(dl) = 52.76kN, V* = 21.18kN < øV = 74.05kN**	**OK (0.30,0.29)**
Deflection:	**δDL = L/552 (5mm) , δΨs.LL = L/1960 (2mm), δTotal = L/431 (7mm), 1kN mid. δ = 0.1mm**	**OK**
Reactions:	**(1 End) Rdl.max = 8.62kN, Rll.max = 7.23kN, R.max* = 21.18kN**	
	(1 End) Rdl.min = 8.10kN, Rll.min = 6.54kN, R.min* = 19.53kN	

Geometry (House member affecting ≤ 25m² or secondary building member)

Category =	1	(1) House, (2) Primary building elements, (3) Important			
House =	N	(Y)es,(N)o	Edge restrained =	C	(T)ension, (C)ompression, (B)oth
Span (L) =	3000	mm	Lay.t (Top) =	3000	mm
Centres (cts) =	450	mm			
Span type =	S	(S)ingle,(D)ouble			

Loadings

Floor area (A) = 1.35 m²

Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	450	mm +		kN/m =	0.23 kN/m
Wall dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35 kN/m
Other dead load (wdl) =	0.40	kPa *	4000	mm +		kN/m =	1.60 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.21 kN/m
						Σwdl =	3.38 kN/m

Uniform live loads

Floor live load (wll) =	1.50	kPa *	450	mm +		kN/m =	0.68 kN/m
Partitions (wll) =	0.25	kPa *	4000	mm +		kN/m =	1.00 kN/m
Alternate point live load =	1.80	kN	Distr. to	1	members	Σwll =	1.68 kN/m

Point loads

			DL	LL			
Dead load (pdl) =	6.56	kN	2B5	6.6	8.7 : L|L	Position =	1618 mm from LHS
Live load (pll) =	8.75	kN	Σ	6.6	8.7	ing PL at support =	N (Y)es,(N)o

Short term LL factor (Ψsu) =	0.70	(Ψsp) =	1.00
Long term LL factor (Ψlu) =	0.40	(Ψlp) =	0.60
wdl* = 1.2*wdl+1.5*Ψlu*wll =	5.07 kN/m	M(dl+Ψl.ll)* =	17.40 kNm (Max at 1618mm)
w* = 1.2*wdl+1.5*wll =	6.57 kN/m	M* =	23.00 kNm (Max at 1618mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	15.75 kN	V(dl+Ψl.ll)* =	16.09 kN
p* = 1.2*pdl+1.5*pll =	20.99 kN	V* =	21.18 kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	2 / 300mm x 58mm Smart LVL15	Area (A) =	34800 mm²
Description =	LVL15 seasoned softwood	Section modulus (Zx) =	1740 x10³ mm³
Design depth (dD) =	300 mm	Stiffness (Ix) =	261.0 x10⁶ mm⁴
Design width (dW) =	58 mm	Modulus of elasticity (E) =	15300 MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 = 20.45 For top comp. edge restrained - Cl 3.2.3.2(a)
k12d = 200/(S1*ρbd)² = 0.487 for ρbd*S1 ≥ 20 - Cl 3.2.4
k12 = 1.5-0.05*ρb*S1 = 0.534 for 10 ≤ ρb*S1 ≤ 20 - Cl 3.2.4

			f'b =	46.5	MPa
			f's =	4.2	MPa
			Material constant (ρbd) =	0.99	(rbd=0.25)
Strength reduction factor (ø) =	0.95	Table 2.1	Material constant (ρb) =	0.95	(rb=0.55)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	21.35	kNm	Duration factor (k1) =	0.80	
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	32.86	kNm	Moisture factor (k4) =	1.00	
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	52.76	kN	Temp. factor (k6) =	1.00	
øV = ø*k1*k4*k6*f's*(2/3*A) =	74.05	kN	Sharing factor (k9) =	1.00	
			Size modifier (mod.b) =	1.00	
			Size modifier (mod.s) =	1.00	

Deflections

			Duration factor (j2) =	2.0	
Ireq'd j2.(DL+Ψl.LL) (L/300) =	141.9 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	5.4 mm	Span / 552
Ireq'd Ψs.LL (L/300) =	39.9 x10⁶ mm⁴		Ψs.δLL =	1.5 mm	Span / 1960
Ireq'd Total (L/250) =	151.6 x10⁶ mm⁴		δTotal =	7.0 mm	Span / 431
			1kN midspan δ =	0.1 mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

2B5

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(2B5) 2 / 240mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 10.05kNm (+ve) < øM(dl) = 21.24kNm, M* = 15.44kNm (+ve) < øM = 29.81kNm**	**OK (0.47,0.52)**
Shear:	**V(dl)* = 13.54kN < øV(dl) = 30.57kN, V* = 20.99kN < øV = 42.90kN**	**OK (0.44,0.49)**
Deflection:	**δDL = L/376 (7mm) , δΨs.LL = L/1139 (2mm), δTotal = L/283 (9mm), 1kN mid. δ = 0.2mm**	**OK**
Reactions:	**(Each end) Rdl = 6.56kN, Rll = 8.75kN, R* = 20.99kN**	

Geometry

(House member affecting ≤ 25m² or secondary building member)

Category =	1	(1) House, (2) Primary building elements, (3) Important			
House =	N	(Y)es,(N)o	Edge restrained =	C	(T)ension, (C)ompression, (B)oth
Span (L) =	2600	mm	Lay.t (Top) =	450	mm
Centres (cts) =	3100	mm			
Span type =	S	(S)ingle,(D)ouble			

Loadings

Floor area (A) = 8.06 m²

Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	3100	mm +		kN/m =	1.55 kN/m
Wall dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35 kN/m
Other dead load (wdl) =	0.40	kPa *	4000	mm +		kN/m =	1.60 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.12 kN/m
						Σwdl =	4.62 kN/m

Uniform live loads

Floor live load (wll) =	1.50	kPa *	3100	mm +		kN/m =	4.65 kN/m
Partitions (wll) =	0.25	kPa *	4000	mm +		kN/m =	1.00 kN/m
Alternate point live load =	1.80	kN	Distr. to	1	members	Σwll =	5.65 kN/m

Point loads

Dead load (pdl) =	1.11	kN	Position =	1300	mm from LHS
Live load (pll) =	2.80	kN	Shear using PL at support =	N	(Y)es,(N)o

	DL	LL	
Small	1.1	2.8 : 2*L|2*L	
Σ	1.1	2.8	

Short term LL factor (Ψsu) =			1.00	
Long term LL factor (Ψlu) =			0.60	
wdl* = 1.2*wdl+1.5*Ψlu*wll =			10.05	kNm (Max at 1300mm)
w* = 1.2*wdl+1.5*wll =	14.02	kN/m	M* =	15.44 kNm (Max at 1300mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	3.85	kN	V(dl+Ψl.ll)* =	13.54 kN
p* = 1.2*pdl+1.5*pll =	5.53	kN	V* =	20.99 kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	2 / 240mm x 42mm Smart LVL15	Area (A) =	20160 mm²
Description =	LVL15 seasoned softwood	Section modulus (Zx) =	806 x10³ mm³
Design depth (dD) =	240 mm	Stiffness (Ix) =	96.8 x10⁶ mm⁴
Design width (dW) =	42 mm	Modulus of elasticity (E) =	15300 MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 = 9.78 For top comp. edge restrained - Cl 3.2.3.2(a)

k12d =	1.000	for ρbd*S1 ≤ 10 - Cl 3.2.4	f'b =	48.6	MPa
k12 =	1.000	for ρb*S1 ≤ 10 - Cl 3.2.4	f's =	4.2	MPa
			Material constant (ρbd) =	1.01	(rbd=0.25)
Strength reduction factor (ø) =	0.95	Table 2.1	Material constant (ρb) =	0.96	(rb=0.64)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	21.24	kNm	Duration factor (k1) =	0.80	
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	29.81	kNm	Moisture factor (k4) =	1.00	
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	30.57	kN	Temp. factor (k6) =	1.00	
øV = ø*k1*k4*k6*f's*(2/3*A) =	42.90	kN	Sharing factor (k9) =	1.00	
			Size modifier (mod.b) =	1.00	
			Size modifier (mod.s) =	1.00	

Deflections

Duration factor (j2) = 2.0

Ireq'd j2.(DL+Ψl.LL) (L/300) =	77.2 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	6.9 mm	Span / 376
Ireq'd Ψs.LL (L/300) =	25.5 x10⁶ mm⁴		Ψs.δLL =	2.3 mm	Span / 1139
Ireq'd Total (L/250) =	85.5 x10⁶ mm⁴		δTotal =	9.2 mm	Span / 283
			1kN midspan δ =	0.2 mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

2B6

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(2B6) 2 / 190mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 3.61kNm (+ve) < øM(dl) = 13.94kNm, M* = 5.67kNm (+ve) < øM = 19.56kNm**	**OK (0.26,0.29)**
Shear:	**V(dl)* = 8.01kN < øV(dl) = 24.20kN, V* = 12.59kN < øV = 33.96kN**	**OK (0.33,0.37)**
Deflection:	**δDL = L/706 (3mm) , δΨs.LL = L/2446 (1mm), δTotal = L/548 (3mm), 1kN mid. δ = 0.2mm**	**OK**
Reactions:	**(Each end) Rdl = 4.14kN, Rll = 5.09kN, R* = 12.59kN**	

Geometry

(House member affecting ≤ 25m² or secondary building member)

Category =	1	(1) House, (2) Primary building elements, (3) Important			
House =	N	(Y)es,(N)o	Edge restrained =	C	(T)ension, (C)ompression, (B)oth
Span (L) =	1800	mm	Lay.t (Top) =	450	mm
Centres (cts) =	3100	mm			
Span type =	S	(S)ingle,(D)ouble			

Loadings

Floor area (A) = 5.58 m²

Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	3100	mm +		kN/m =	1.55 kN/m
Wall dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35 kN/m
Other dead load (wdl) =	0.40	kPa *	4000	mm +		kN/m =	1.60 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.10 kN/m
						Σwdl =	4.60 kN/m

Uniform live loads

Floor live load (wll) =	1.50	kPa *	3100	mm +		kN/m =	4.65 kN/m
Partitions (wll) =	0.25	kPa *	4000	mm +		kN/m =	1.00 kN/m
Alternate point live load =	1.80	kN	Distr. to	1	members	Σwll =	5.65 kN/m

Point loads

Dead load (pdl) =		kN	Position =	900 mm from LHS
Live load (pll) =		kN	Shear using PL at support =	N (Y)es,(N)o

Short term LL factor (Ψsu) =	0.70	(Ψsp) =	1.00
Long term LL factor (Ψlu) =	0.40	(Ψlp) =	0.60
wdl* = 1.2*wdl+1.5*Ψlu*wll =	8.90 kN/m	M(dl+Ψl.ll)* =	3.61 kNm (Max at 900mm)
w* = 1.2*wdl+1.5*wll =	13.99 kN/m	M* =	5.67 kNm (Max at 900mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	0.00 kN	V(dl+Ψl.ll)* =	8.01 kN
p* = 1.2*pdl+1.5*pll =	0.00 kN	V* =	12.59 kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	2 / 190mm x 42mm Smart LVL15	Area (A) =	15960 mm²
Description =	LVL15 seasoned softwood	Section modulus (Zx) =	505 x10³ mm³
Design depth (dD) =	190 mm	Stiffness (Ix) =	48.0 x10⁶ mm⁴
Design width (dW) =	42 mm	Modulus of elasticity (E) =	15300 MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 = 8.70 For top comp. edge restrained - Cl 3.2.3.2(a)

k12d =	1.000 for ρbd*S1 ≤ 10 - Cl 3.2.4	f'b =	50.9 MPa
k12 =	1.000 for ρb*S1 ≤ 10 - Cl 3.2.4	f's =	4.2 MPa
		Material constant (ρbd) =	1.04 (rbd=0.25)
Strength reduction factor (ø) =	0.95 Table 2.1	Material constant (ρb) =	0.98 (rb=0.61)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	13.94 kNm	Duration factor (k1) =	0.80
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	19.56 kNm	Moisture factor (k4) =	1.00
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	24.20 kN	Temp. factor (k6) =	1.00
øV = ø*k1*k4*k6*f's*(2/3*A) =	33.96 kN	Sharing factor (k9) =	1.00
		Size modifier (mod.b) =	1.00
		Size modifier (mod.s) =	1.00

Deflections

Duration factor (j2) = 2.0

Ireq'd j2.(DL+Ψl.LL) (L/300) =	20.4 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	2.6 mm	Span / 706
Ireq'd Ψs.LL (L/300) =	5.9 x10⁶ mm⁴		Ψs.δLL =	0.7 mm	Span / 2446
Ireq'd Total (L/250) =	21.9 x10⁶ mm⁴		δTotal =	3.3 mm	Span / 548
			1kN midspan δ =	0.2 mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

2B7

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(2B7) 2 / 290mm x 42mm Smart LVL15* (Oregon) (Single span)**	
Bending:	**M(dl)* = 8.26kNm (+ve) < øM(dl) = 28.84kNm, M* = 11.74kNm (+ve) < øM = 41.70kNm**	**OK (0.29,0.28)**
Shear:	**V(dl)* = 19.63kN < øV(dl) = 36.93kN, V* = 27.40kN < øV = 51.84kN**	**OK (0.53,0.53)**
Deflection:	**δDL = L/942 (2mm) , δΨs.LL = L/3444 (1mm), δTotal = L/740 (3mm), 1kN mid. δ = 0.1mm**	**OK**
Reactions:	**(1 End) Rdl.max = 10.38kN, Rll.max = 9.97kN, R.max* = 27.40kN**	
	(1 End) Rdl.min = 6.39kN, Rll.min = 7.04kN, R.min* = 18.22kN	
Geometry	(House member affecting ≤ 25m² or secondary building member)	

Category = 1 (1) House, (2) Primary building elements, (3) Important
House = N (Y)es,(N)o
Edge restrained = C (T)ension, (C)ompression, (B)oth
Span (L) = 2100 mm
Lay.t (Top) = 450 mm
Centres (cts) = 3100 mm
Span type = S (S)ingle,(D)ouble

Loadings

Floor area (A) = 6.51 m²
Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50 kPa *	3100 mm +		kN/m =	1.55	kN/m
Wall dead load (wdl) =	0.50 kPa *	2700 mm +		kN/m =	1.35	kN/m
Other dead load (wdl) =	0.40 kPa *	4100 mm +		kN/m =	1.64	kN/m
Include S.Wt =	Y (Y)es,(N)o			S.Wt =	0.15	kN/m
				Σwdl =	4.69	kN/m

Uniform live loads

Floor live load (wll) =	1.50 kPa *	3100 mm +		kN/m =	4.65	kN/m
Partitions (wll) =	0.25 kPa *	4100 mm +		kN/m =	1.03	kN/m
Alternate point live load =	1.80 kN	Distr. to	1 members	Σwll =	5.68	kN/m

Point loads

	DL	LL	
2B8*	6.9	5.1	: L|L
Σ	6.9	5.1	

Dead load (pdl) = 6.92 kN
Live load (pll) = 5.09 kN
Position = 1655 mm from LHS
ing PL at support = N (Y)es,(N)o

Short term LL factor (Ψsu) =	0.70	(Ψsp) =	1.00
Long term LL factor (Ψlu) =	0.40	(Ψlp) =	0.60
wdl* = 1.2*wdl+1.5*Ψlu*wll =	9.03 kN/m	M(dl+Ψl.ll)* =	8.26 kNm (Max at 1352mm)
w* = 1.2*wdl+1.5*wll =	14.14 kN/m	M* =	11.74 kNm (Max at 1289mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	12.88 kN	V(dl+Ψl.ll)* =	19.63 kN
p* = 1.2*pdl+1.5*pll =	15.94 kN	V* =	27.40 kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member = 2 / 290mm x 42mm Smart LVL15*
Description = LVL15 seasoned softwood
Design depth (dD) = 290 mm
Design width (dW) = 42 mm
Area (A) = 24360 mm²
Section modulus (Zx) = 1177 x10³ mm³
Stiffness (Ix) = 170.7 x10⁶ mm⁴
Modulus of elasticity (E) = 15300 MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 = 10.75 For top comp. edge restrained - Cl 3.2.3.2(a)
k12d = 1.5-0.05*ρbd*S1 = 0.965 for 10 ≤ ρbd*S1 ≤ 20 - Cl 3.2.4
k12 = 1.5-0.05*ρb*S1 = 0.995 for 10 ≤ ρb*S1 ≤ 20 - Cl 3.2.4
f'b = 46.9 MPa
f's = 4.2 MPa
Material constant (ρbd) = 0.99 (rbd=0.25)
Material constant (ρb) = 0.94 (rb=0.63)
Strength reduction factor (ø) = 0.95 Table 2.1
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx = 28.84 kNm
øM = ø*k1*k4*k6*k9*k12*f'b*Zx = 41.70 kNm
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) = 36.93 kN
øV = ø*k1*k4*k6*f's*(2/3*A) = 51.84 kN
Duration factor (k1) = 0.80
Moisture factor (k4) = 1.00
Temp. factor (k6) = 1.00
Sharing factor (k9) = 1.00
Size modifier (mod.b) = 1.00
Size modifier (mod.s) = 1.00

Deflections

Duration factor (j2) = 2.0

Ireq'd j2.(DL+Ψl.LL) (L/300) =	54.4 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	2.2 mm	Span / 942
Ireq'd Ψs.LL (L/300) =	14.9 x10⁶ mm⁴		Ψs.δLL =	0.6 mm	Span / 3444
Ireq'd Total (L/250) =	57.7 x10⁶ mm⁴		δTotal =	2.8 mm	Span / 740
			1kN midspan δ =	0.1 mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

2B8

TIMBER MEMBER V5.12

Xstruct

Beam:	**(2B8) 2 / 300mm x 58mm Smart LVL15 (Oregon)**	
Bending:	**M* = 13.26kNm < øM(0.80) = 36.32kNm**	**OK (0.36)**
Shear:	**V* = 0.03kN < øV(0.80) = 74.05kN**	**OK (0.00)**
Axial:	**No compression, No tension**	
Combined:	**Refer below**	**OK (0.36)**
Deflection:	**δDL = L/911 (3mm), δΨs.LL = L/4053 (1mm), δTotal = L/744 (3mm), 1kN mid. δ = 0.1mm**	**OK**

Geometry

(House member affecting ≤ 25m² or secondary building member) Warning - Dead load only case must be checked

Category = 1 (1) House, (2) Primary building elements, (3) Important
Span (L) = 2600 mm
Strong axis eff. length (Lax) = 450 mm
Edge restrained = C (T)ension, (C)omp.
Weak axis eff. length (Lay) = 2600 mm, (C)ont
Bending (Layb) = 2600 mm
Effective length factor (g13) = 1.00 Studs in framing= 0.9, Restrained both ends in pos.=1.0, Other cases - Table 3.2
Checked dead load only case = N (Y)es,(N)o

Bending & shear at 1640mm from LHS (Max +ve M)

Analysis values = X (M)anual, (L)eft, Position (X) from analysis, (R)ight, (C)ritical

Refer to the analysis output for comb.

Major bending (Mx*) =	13.3 kNm		
Minor bending (My*) =	0.0 kNm	Minor bending (My*) =	0.00 kNm
Shear Force (V*) =	0.0 kN		
Duration (k1) =	0.80 Floor	Compression (Nc*) =	0.00 kN
Long term LL factor (ΨI) =	0.53	Tension (Nt*) =	0.00 kN

Bending and Shear Capacity - Cl 3.2 & Cl 3.2.5

Member =	2 / 300mm x 58mm Smart LVL15	Area (A) =	34800 mm²
Description =	LVL15 seasoned softwood	Section modulus (Zx) =	1740 x10³ mm³
Design depth (dD) =	300 mm	Section modulus (Zy) =	336 x10³ mm³
Design width (dW) =	58 mm	Stiffness (Ix) =	261.0 x10⁶ mm⁴
Strength red. factor (ø) =	0.95 Table 2.1	Modulus of elasticity (E) =	15300 MPa - Cl 8.3

S1=1.25*dD/dW*(Layb/dD)^0.5) = 19.03 for comp. edge restrained - Cl 3.2.3.2
S1y=1.25*dW/dD*(Lax/dW)^0.5) = 0.67 for comp. edge restrained
k12d = 1.5-0.05*ρbd*S1d = 0.556 for 10 ≤ ρbd*S1 ≤ 20 - Cl 3.2.4
k12 = 1.5-0.05*ρb*S = 0.590 - 10 ≤ ρb*S1 ≤ 20 - Cl 3.2.4
k12y = 1.000 for ρb*Sy ≤ 10 - Cl 3.2.4

Strength reduction factor (ø) =	0.95 Table 2.1	f'b =	46.5 MPa
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	24.40 kNm	f's =	4.2 MPa
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	36.32 kNm	Material constant (ρbd) =	0.99 (rbd=0.25)
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	52.76 kN	Material constant (ρb) =	0.96 (rb=0.45)
øV = ø*k1*k4*k6*f's*(2/3*A) =	74.05 kN	Duration factor (k1) =	0.80
øMy(dl) = ø*(k1=0.57)*k4*k6*k9*k12y*f'b*Zy =	8.48 kNm	Factor (k4) =	1.00
øMy = ø*k1*k6*k9*k12y*f'b*Zy =	11.90 kNm	Temp. factor (k6) =	1.00
		Sharing factor (k9) =	1.00
		Size modifier (mod.b) =	1.00
		Size modifier (mod.s) =	1.00

Axial Capacity - Cl 3.3 & Cl 3.4

S3x =min(g13*L/dD & Lax/dD) =	1.5	k12cx =	1.000	for ρc*S3x ≤ 10 - Cl 3.3.3	
S4y = min(g13*L & Lay)/dW =	44.8	k12cy =	0.082	for ρc*S4y ≥ 20 - Cl 3.3.3	
Critical S =	44.8	k12d =	0.082	for ρc*S ≥ 20 - Cl 3.3.3	
		k12 =	0.082	for ρc*S ≥ 20 - Cl 3.3.3	

Strength reduction factor (ø) =	0.95 Table 2.1	Lay =	2600 mm
øNc(dl) = ø*(k1=0.57)*k4*k6*k12cd*f'c*A =	60.0 kN	f'c =	39.0 MPa
øNc = ø*k1*k4*k6*k12c*f'c*A =	84.3 kN	f't =	26.7 MPa
øNt(dl) = ø*(k1=0.57)*k4*k6*f't)*A =	503.5 kN	Temp. factor (k6) =	1.00
øNt = ø*k1*k4*k6*f't*A =	706.7 kN	Size modifier (mod.c) =	1.00
		Size modifier (mod.t) =	1.00

Combined - Cl 3.5.1 & Cl 3.5.2 & Appendix E5

Comp./Bending	Minor buckling =	0.13	**Tension/Bending**	Tension edge =	0.22
	Major buckling =	0.36		Comp. edge =	0.36

Deflections (From Analysis)

Duration factor (j2) = 2.0 Ψs = 0.90

Instantaneous δDL =	1.0 mm at 1320mm from LHS	Span / 2484
Live load δLL =	0.7 mm at 1320mm from LHS	Span / 3651
Permanent δDL = j2*(δDL+ΨI.δLL) =	2.9 mm	Span / 911
Short term Ψs.δLL =	0.6 mm	Span / 4053

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

2B8 (Ana)

ANALYSIS V5.05 Xstruct

Geometry for (2B8): Timber Simple Beam

Description =	2 / 300mm x 58mm Smart LVL15		Ix =	261	x10⁶ mm⁴
Span (L) =	2600	mm	Axis =	X	(X),(Y)
Span type =	S	(S)imple,(E)xt,(I)nt,(C)ant,(P)rop,(F)ixed,(O)ther	Ag =	34800	mm²
Material type =	T	(T)imber,(S)teel,(C)onc.,(SC)comp. steel,(O)ther	Density =	6	kN/m³
House =	N	(Y)es,(N)o	E =	15300	MPa

Loading

Uniform loads (kN/m)

Uniform loads	UDL	Partial 1	Partial 2
Dead load (wdl) =	3.09		
Live load (wll) =	1.58		
Start from LHS (mm) =	0		
End from LHS (mm) =	2600		
S.Wt =	0.21	kN/m	
Ultimate load (w*) =	6.33	0.00	0.00

Point loads (kN)

Point loads	PL 1	PL 2	PL 3
Dead load (pdl) =	0.56	0.56	8.04
Live load (pll) =	1.40	1.40	4.90
Pos. from LHS (mm) =	380	1320	1990
Ultimate load (p*) =	2.77	2.77	16.99

Include S.Wt =	Y	(Y)es,(N)o
Strength loadcase =	C	(D)ead Only,(C)omb.

Live Load type =	Floor	(Timber)
Short term LL (Ψsu) =	0.70	(Ψsp) = 1.00
Long term LL (Ψlu) =	0.40	(Ψlp) = 0.60
Actual LL (Ψsa) =	0.90	(Ψla) = 0.53

	DL	LL
Small	0.6	1.4 : L|L
Σ	0.6	1.4

	DL	LL
GT	4.0	2.2 : L|L
2B9	4.0	2.7 : L|L
Σ	8.0	4.9

Position of resul

1.20*G+1.50*Q analyse

Results at 1640mm from LHS (Max +ve M)

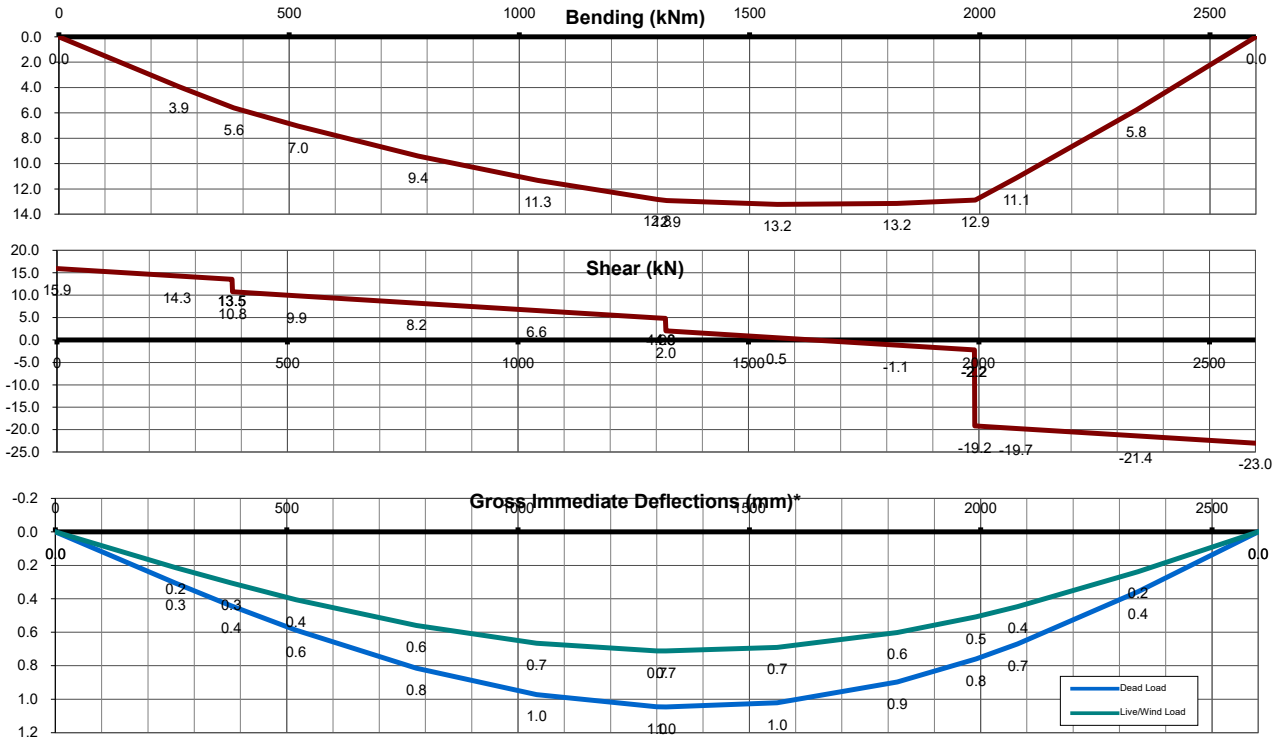
	Left	At x	Right	Max	At	Min	At		
Rdl	6.92		10.80					kN	
Rll	5.09		6.72					kN	
R*	15.94		23.04					kN	
M*	0.00	13.26	0.00	13.26	1640	0.00	0	kNm	
V*	15.94	0.03	-23.04	23.04	2600			kN	Span /
δdl	0.00	0.99	0.00	1.05	1320	0.00	0	mm	2484
δll	0.00	0.38	0.00	0.71	1320	0.00	0	mm	3651
δdl+Ψs*δll	0.00	1.34	0.00	1.69	1320	0.00	0	mm	1540

	DL	LL
Small	0.6	1.4 : L|L
Σ	0.6	1.4

δPll/δTot.ll = 0.669

Graphs

* Deflections are Gross Ig immediate - assessment of long term effects to be considered



XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

2B9

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(2B9) 2 / 190mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 3.71kNm (+ve) < øM(dl) = 13.94kNm, M* = 5.10kNm (+ve) < øM = 19.56kNm**	**OK (0.27,0.26)**
Shear:	**V(dl)* = 6.45kN < øV(dl) = 24.20kN, V* = 8.88kN < øV = 33.96kN**	**OK (0.27,0.26)**
Deflection:	**δDL = L/523 (4mm) , δΨs.LL = L/2819 (1mm), δTotal = L/441 (5mm), 1kN mid. δ = 0.3mm**	**OK**
Reactions:	**(Each end) Rdl = 4.02kN, Rll = 2.70kN, R* = 8.88kN**	

Geometry

(House member affecting ≤ 25m² or secondary building member)

Category =	1	(1) House, (2) Primary building elements, (3) Important			
House =	N	(Y)es,(N)o	Edge restrained =	C	(T)ension, (C)ompression, (B)oth
Span (L) =	2300	mm	Lay.t (Top) =	450	mm
Centres (cts) =	900	mm			
Span type =	S	(S)ingle,(D)ouble			

Loadings

Floor area (A) = 2.07 m²

Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	900	mm +		kN/m =	0.45 kN/m
Wall dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35 kN/m
Other dead load (wdl) =	0.40	kPa *	4000	mm +		kN/m =	1.60 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.10 kN/m
						Σwdl =	3.50 kN/m

Uniform live loads

Floor live load (wll) =	1.50	kPa *	900	mm +		kN/m =	1.35 kN/m
Partitions (wll) =	0.25	kPa *	4000	mm +		kN/m =	1.00 kN/m
Alternate point live load =	1.80	kN	Distr. to	1	members	Σwll =	2.35 kN/m

Point loads

Dead load (pdl) =	kN	Position =	1150 mm from LHS
Live load (pll) =	kN	Shear using PL at support =	N (Y)es,(N)o

Short term LL factor (Ψsu) =	0.70	(Ψsp) =	1.00
Long term LL factor (Ψlu) =	0.40	(Ψlp) =	0.60
wdl* = 1.2*wdl+1.5*Ψlu*wll =	5.60 kN/m	M(dl+Ψl.ll)* =	3.71 kNm (Max at 1150mm)
w* = 1.2*wdl+1.5*wll =	7.72 kN/m	M* =	5.10 kNm (Max at 1150mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	0.00 kN	V(dl+Ψl.ll)* =	6.45 kN
p* = 1.2*pdl+1.5*pll =	0.00 kN	V* =	8.88 kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	2 / 190mm x 42mm Smart LVL15	Area (A) =	15960 mm²
Description =	LVL15 seasoned softwood	Section modulus (Zx) =	505 x10³ mm³
Design depth (dD) =	190 mm	Stiffness (Ix) =	48.0 x10⁶ mm⁴
Design width (dW) =	42 mm	Modulus of elasticity (E) =	15300 MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 = 8.70 For top comp. edge restrained - Cl 3.2.3.2(a)

k12d =	1.000	for ρbd*S1 ≤ 10 - Cl 3.2.4	f'b =	50.9	MPa
k12 =	1.000	for ρb*S1 ≤ 10 - Cl 3.2.4	f's =	4.2	MPa
			Material constant (ρbd) =	1.04	(rbd=0.25)
Strength reduction factor (ø) =	0.95	Table 2.1	Material constant (ρb) =	1.00	(rb=0.46)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	13.94	kNm	Duration factor (k1) =	0.80	
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	19.56	kNm	Moisture factor (k4) =	1.00	
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	24.20	kN	Temp. factor (k6) =	1.00	
øV = ø*k1*k4*k6*f's*(2/3*A) =	33.96	kN	Sharing factor (k9) =	1.00	
			Size modifier (mod.b) =	1.00	
			Size modifier (mod.s) =	1.00	

Deflections

Duration factor (j2) = 2.0

Ireq'd j2.(DL+Ψl.LL) (L/300) =	27.6 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	4.4 mm	Span / 523
Ireq'd Ψs.LL (L/300) =	5.1 x10⁶ mm⁴		Ψs.δLL =	0.8 mm	Span / 2819
Ireq'd Total (L/250) =	27.2 x10⁶ mm⁴		δTotal =	5.2 mm	Span / 441
			1kN midspan δ =	0.3 mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

2B10

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(2B10) 120mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 0.61kNm (+ve) < øM(dl) = 3.04kNm, M* = 0.91kNm (+ve) < øM = 4.27kNm**	**OK (0.20,0.21)**
Shear:	**V(dl)* = 2.23kN < øV(dl) = 7.64kN, V* = 3.31kN < øV = 10.73kN**	**OK (0.29,0.31)**
Deflection:	**δDL = L/1067 (1mm) , δΨs.LL = L/2039 (1mm), δTotal = L/701 (2mm), 1kN mid. δ = 0.3mm**	**OK**
Reactions:	**(Each end) Rdl = 0.51kN, Rll = 1.80kN, R* = 3.31kN**	

Geometry

(House member affecting ≤ 25m² or secondary building member)

Category =	1	(1) House, (2) Primary building elements, (3) Important			
House =	N	(Y)es,(N)o	Edge restrained =	C	(T)ension, (C)ompression, (B)oth
Span (L) =	1100	mm	Lay.t (Top) =	450	mm
Centres (cts) =	1800	mm			
Span type =	S	(S)ingle,(D)ouble			

Loadings

Floor area (A) =	1.98	m²	Live load type =	N	(N)ormal, (S)torage, (M)anual
					AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	1800	mm +		kN/m =	0.90	kN/m
Wall dead load (wdl) =		kPa *		mm +		kN/m =	0.00	kN/m
Other dead load (wdl) =		kPa *		mm +		kN/m =	0.00	kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.03	kN/m
						Σwdl =	0.93	kN/m

Uniform live loads

Floor live load (wll) =	1.50	kPa *	1800	mm +		kN/m =	2.70	kN/m
Partitions (wll) =		kPa *	1800	mm +		kN/m =	0.00	kN/m
Alternate point live load =	1.80	kN (critical)	Distr. to	1	members	Σwll =	3.27	kN/m

Point loads

Dead load (pdl) =		kN	Position =	550	mm from LHS
Live load (pll) =		kN	Shear using PL at support =	N	(Y)es,(N)o

Short term LL factor (Ψsu) =	0.70		(Ψsp) =	1.00	
Long term LL factor (Ψlu) =	0.40		(Ψlp) =	0.60	
wdl* = 1.2*wdl+1.5*Ψlu*wll =	4.06	kN/m	M(dl+Ψl.ll)* =	0.61	kNm (Max at 550mm)
w* = 1.2*wdl+1.5*wll =	6.03	kN/m	M* =	0.91	kNm (Max at 550mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	0.00	kN	V(dl+Ψl.ll)* =	2.23	kN
p* = 1.2*pdl+1.5*pll =	0.00	kN	V* =	3.31	kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	120mm x 42mm Smart LVL15		Area (A) =	5040	mm²
Description =	LVL15 seasoned softwood		Section modulus (Zx) =	101	x10³ mm³
Design depth (dD) =	120	mm	Stiffness (Ix) =	6.0	x10⁶ mm⁴
Design width (dW) =	42	mm	Modulus of elasticity (E) =	15300	MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 =	6.92	For top comp. edge restrained - Cl 3.2.3.2(a)			
k12d =	1.000	for ρbd*S1 ≤ 10 - Cl 3.2.4	f'b =	55.7	MPa
k12 =	1.000	for ρb*S1 ≤ 10 - Cl 3.2.4	f's =	4.2	MPa
			Material constant (ρbd) =	1.08	(rbd=0.25)
Strength reduction factor (ø) =	0.95	Table 2.1	Material constant (ρb) =	1.01	(rb=0.81)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	3.04	kNm	Duration factor (k1) =	0.80	
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	4.27	kNm	Moisture factor (k4) =	1.00	
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	7.64	kN	Temp. factor (k6) =	1.00	
øV = ø*k1*k4*k6*f's*(2/3*A) =	10.73	kN	Sharing factor (k9) =	1.00	
			Size modifier (mod.b) =	1.00	
			Size modifier (mod.s) =	1.00	

Deflections

			Duration factor (j2) =	2.0		
Ireq'd j2.(DL+Ψl.LL) (L/300) =	1.7 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	1.0	mm	Span / 1067
Ireq'd Ψs.LL (L/300) =	0.9 x10⁶ mm⁴		Ψs.δLL =	0.5	mm	Span / 2039
Ireq'd Total (L/250) =	2.2 x10⁶ mm⁴		δTotal =	1.6	mm	Span / 701
			1kN midspan δ =	0.3	mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

2B11

STEEL FLOOR BEAM V5.06

Xstruct

Member:	**(2B11) 200x75PFC (G300)**	
Bending:	**M*(max) = 13.9kNm < øMb(1200,αm=1.30) = 59.7kNm**	**OK (0.23)**
	(Single span)	
Shear:	**V.max*=25.4kN < øVvm = 207.4kN (Web area full depth)**	**OK (0.12)**
Deflection:	**δDL = L/6619 (0mm), δΨs.LL = L/8066 (0mm), δTotal = L/3635 (0mm), 1kN mid. δ = 0.0mm**	**OK**
Precamber:	**Not required**	
Reactions:	**(Each end) Rdl = 10.2kN, Rll = 8.8kN, R* = 25.4kN**	

Geometry

Span (L) = 1200 mm
Centres (cts) = 450 mm
Eff. Len. (Le) = 1200 mm
αm.t = 1.30

Design at = M mm from LHS, (M)ax, (S)eg
Span type = S (S)ingle,(D)ouble
Effective length (Le) = 1200 mm
αm = 1.30

Loadings

Floor area = 0.5 m²
Apply reduction = N (Y)es,(N)o
Floor reduction (Ψa) = 1.00 AS/NZS 1170.1 - Cl 3.4.2
Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50 kPa *	450 mm +		kN/m =	0.23	kN/m
Wall dead load (wdl) =	0.50 kPa *	2700 mm +		kN/m =	1.35	kN/m
Other dead load (wdl) =	0.40 kPa *	1800 mm +		kN/m =	0.72	kN/m
Include S.Wt =	Y (Y)es,(N)o			S.Wt =	0.23	kN/m
				Σwdl =	2.52	kN/m

Uniform live loads

Floor live load (wll) =	1.50 kP			kN/m =	0.68	kN/m
Partitions (wll) =	0.25 kP			kN/m =	0.45	kN/m
Alternate point live load =	1.80 kN (critical)	Distr. to	1 members	Σwll =	3.00	kN/m

	DL	LL	
2B9	4.0	2.7	: L|L
2B12	13.3	11.3	: L|L
Σ	17.3	14.0	

Point loads

Dead load (pdl) = 17.3 kN
Live load (pll) = 14.0 kN
Position = 600 mm from LHS
Shear using PL at support = N (Y)es,(N)o

Short term LL factor (Ψsu) = 0.70
(Ψsp) = 1.00

w* = 1.2*wdl + 1.5*wll = 7.53 kN/m
M* = 13.9 kNm (Max at 600mm)
p* = 1.2*pdl + 1.5*pll = 41.79 kN
V* = 25.4 kN

Capacity

Description = 200x75PFC (G300)
Flange yield (fyf) = 300 MPa
Web yield (fyw) = 320 MPa
Area (Ag) = 2920 mm²
Stiffness (Ix) = 19.1 x10⁶ mm⁴
Stiffness (Iy) = 1.65 x10⁶ mm⁴
ø = 0.9 Table 3.4
Msx = min(fyf,fyw)*Zex = 66.3 kNm - Cl 5.2.1
Positive: Moa.p = 227.1 kNm
Negative: Moa.n = N.A.
αs.t = 0.879

Warping constant (Iw) = 10.5 x10⁹ mm⁶
Torsional constant (J) = 105 x10³ mm⁴
Effective section mod. (Zex) = 221 x10³ mm³
Effective section mod. (Zey) = 46.7 x10³ mm³
Elastic modulus (E) = 200000 MPa - Cl 1.4
Shear modulus (G) = 80000 MPa - Cl 1.4

øMsx = 59.7 kNm
αm.t = 1.30
øMsy = 12.6 kNm - Cl 5.2.1
øMbx.p = 59.7 kNm (=øMsx)

Deflections

Ireq'd DL (L/360) =	1.0 x10⁶ mm⁴		δDL =	0.2 mm	Span / 6619
Ireq'd Ψs.LL (L/360) =	0.9 x10⁶ mm⁴		Ψs.δLL =	0.1 mm	Span / 8066
Ireq'd (DL+Ψs.LL) (L/250) =	1.3 x10⁶ mm⁴	< Critical	δTotal =	0.3 mm	Span / 3635

Max. precamber (0.3%*span) = 4 mm
Precamber 80% of δDL = 0 mm
Min. precamber = 15 mm
Adopted precamber = 0 mm

1kN midspan δ = 0.0 mm

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

2B12

STEEL FLOOR BEAM V5.06

Xstruct

Member:	**(2B12) 250x90PFC (G300)**	
Bending:	**M*(max) = 46.2kNm < øMb(450,αm=1.00) = 113.7kNm**	**OK (0.41)**
	(Single span)	
Shear:	**V.max*=42.4kN < øVvm = 345.6kN (Web area full depth)**	**OK (0.12)**
Deflection:	**δDL = L/1109 (4mm), δΨs.LL = L/1785 (2mm), δTotal = L/684 (6mm), 1kN mid. δ = 0.2mm**	**OK**
Precamber:	**Not required**	
Reactions:	**(1 End) Rdl.max = 18.0kN, Rll.max = 13.9kN, R.max* = 42.4kN**	
	(1 End) Rdl.min = 13.3kN, Rll.min = 11.3kN, R.min* = 32.9kN	

Geometry

Span (L) =	4200	mm	Eff. Len. (Le) =	450	mm
Centres (cts) =	2200	mm	αm.t =	1.00	
Design at =	M	mm from LHS, (M)ax, (S)eg			
Span type =	S	(S)ingle,(D)ouble			
Effective length (Le) =	450	mm			
αm =	1.00				

Loadings

Floor area =	9.2	m²	Live load type =	N	(N)ormal, (S)torage, (M)anual
Apply reduction =	N	(Y)es,(N)o			AS/NZS 1170.0 - Table 4.1
Floor reduction (Ψa) =	1.00	AS/NZS 1170.1 - Cl 3.4.2			

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	2200	mm +		kN/m =	1.10 kN/m
Wall dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35 kN/m
Other dead load (wdl) =	0.40	kPa *	4000	mm +		kN/m =	1.60 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.36 kN/m
						Σwdl =	4.41 kN/m

Uniform live loads

Floor live load (wll) =	1.50	kP				kN/m =	3.30 kN/m
Partitions (wll) =	0.25	kP				kN/m =	1.00 kN/m
Alternate point live load =	1.80	kN	Distr. to	1	members	Σwll =	4.30 kN/m

	DL	LL
GT	4.0	2.2 : L|L
2B13*	8.8	4.9 : L|L
Σ	12.8	7.1

Point loads

Dead load (pdl) =	12.8	kN	Position =	2865	mm from LHS
Live load (pll) =	7.1	kN	Shear using PL at support =	N	(Y)es,(N)o

Short term LL factor (Ψsu) =	0.70	(Ψsp) =	1.00	
w* = 1.2*wdl + 1.5*wll =	11.74 kN/m	M* =	46.2 kNm (Max at 2805mm)	
p* = 1.2*pdl + 1.5*pll =	26.02 kN	V* =	42.4 kN	

Capacity

Description =	250x90PFC (G300)		Warping constant (Iw) =	35.9	x10⁹ mm⁶
Flange yield (fyf) =	300	MPa	Torsional constant (J) =	248	x10³ mm⁴
Web yield (fyw) =	320	MPa	Effective section mod. (Zex) =	421	x10³ mm³
Area (Ag) =	4520	mm²	Effective section mod. (Zey) =	88.7	x10³ mm³
Stiffness (Ix) =	45.1	x10⁶ mm⁴	Elastic modulus (E) =	200000	MPa - Cl 1.4
Stiffness (Iy) =	3.64	x10⁶ mm⁴	Shear modulus (G) =	80000	MPa - Cl 1.4
ø =	0.9	Table 3.4			
Msx = min(fyf,fyw)*Zex =	126.3	kNm - Cl 5.2.1	øMsx =	113.7	kNm
				øMsy =	23.9 kNm - Cl 5.2.1
Positive: Moa.p =	3622.2	kNm	αs.t = 1.000	αm.t = 1.00	øMbx.p = 113.7 kNm
Negative: Moa.n =	N.A.				

Deflections (δ ±2.5% with off-centre PL)

Ireq'd DL (L/360) =	14.6	x10⁶ mm⁴	δDL =	3.8 mm	Span / 1109
Ireq'd Ψs.LL (L/360) =	9.1	x10⁶ mm⁴	Ψs.δLL =	2.4 mm	Span / 1785
Ireq'd (DL+Ψs.LL) (L/250) =	16.5	x10⁶ mm⁴ < Critical	δTotal =	6.1 mm	Span / 684

Max. precamber (0.3%*span) =	13 mm	Min. precamber =	15 mm
Precamber 80% of δDL =	3 mm	Adopted precamber =	0 mm
		1kN midspan δ =	0.2 mm

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

2B13

STEEL MEMBER V5.14

Xstruct

Section: **(2B13) 200x75PFC (G300)**
Bending: **Mx* = 18.9kNm < øMb(4500,αm=1.30) = 33.8kNm, øMb(αm=1) = 26.0kNm** **OK (0.56)**
No minor bending
Shear: **Vx* = 0.019kN < øVvm = 207.4kN (Web area full depth)** **OK (0.00)**
No minor shear
Compression: **No compression**

Tension: **No tension**

Torsion: **No torsion**

Deflection: **δDL = L/903 (5mm), δΨs.LL = L/1967 (2mm), δTotal= L/619 (7mm) at 2150mm from LHS** **OK**

Bending & Shear at 2165mm from LHS (Max +ve M) - Section 5

Max. restraint (2.5% flange force) = 2.5 kN

(M* to include first order amplification as required - Cl 4.4.2)

Analysis values = X (M)anual, (L)eft, Position (X) from analysis, (R)ight, (C)ritical

Refer to the analysis output

Analysis Axis = X (X),(Y)

Major bending (Mx*) =	18.9	kNm			
Minor bending (My*) =	0.000	kNm	Minor bending (My*) =	0	kNm
Shear Force (Vx*) =	0.019	kN	Torsion (Mz*) =	0	kNm
Shear Force (Vy*) =	0.000	kN			
Effective length factor (ke) =	Calc		Shear Force (Vy*) =	0	kN
ke = (kt=1.00)*(kl=1.00)*(kr=1.00) =	1.00	(From Le Tab)	Span / Segment Length (L) =	4500	mm
Effective length (Le = L*ke) =	4500	mm	Moment modification factor (αm) =	1.30	
ø =	0.9	Table 3.4			
øMsx =	59.7	kNm	Bending (x) =	OK (0.56)	
øMbx(αm=1) =	26.0	kNm			
øMbx =	33.8	kNm	Shear =	OK (0.00)	
øMsyL =	12.6	kNm	øMsyR =	13.3 kNm	
øVv =	207.4	kN			
øVvm =	207.4	kN	Ix =	19.1	$x10^6$ mm^4
øMz =	1.42	kNm	S.Wt =	0.230	kN/m

Compression - Section 6 (No compression)

Axial compression (Nc*) =	0.0	kN	Axial compression (Nc*) =	0	kN
Major axis length (Lx) =	10000	mm	Eff. X length factor (kex) =	1.00	
Minor axis length (Ly) =	1500	mm	Eff. Y length factor (key) =	1.00	
Braced or Sway member =	S	(B)raced, (S)way			
			Major axis effective length (Lex) =	10000	mm
øNs =	788.4	kN	Minor axis effective length (Ley) =	1500	mm
øNcx(kex=1.00) =	252.5	kN			
In-Plane øNcx(kex=1.00) =	252.5	kN			
øNcy(key=1.00) =	540.8	kN			
In-Plane øNcy(key=1.00) =	540.8	kN			
øNc =	252.5	kN			

Tension - Section 7 (No tension)

Axial tension (Nt*) =	0.0	kN	Axial tension (Nt*) =	0	kN
kt =	1.00	Table 7.3.2			
øNt =	788.4	kN			

Combined

øMrxt =	59.7	kNm	øMixt =	59.7	kNm	øMoxt =	33.8	kNm
øMrxc =	59.7	kNm	øMixc =	59.7	kNm	øMoxc =	33.8	kNm
øMryt =	12.6	kNm	øMiyc =	12.6	kNm	øMtx =	33.8	kNm
øMryc =	12.6	kNm				øMcx =	33.8	kNm

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

2B13 (Ana)

ANALYSIS V5.05

Xstruct

Geometry for (2B13): Steel Simple Beam

Description =	200x75PFC (G300)		Ix =	19.1	x10⁶ mm⁴
Span (L) =	4300	mm	Axis =	X	(X),(Y)
Span type =	S	(S)imple,(E)xt,(I)nt,(C)ant,(P)rop,(F)ixed,(O)ther	Ag =	2920	mm²
Material type =	S	(T)imber,(S)teel,(C)onc.,(SC)comp. steel,(O)ther	Density =	78.6	kN/m³
			E =	200000	MPa

Loading

Uniform loads (kN/m)

Uniform loads	UDL	Partial 1	Partial 2
Dead load (wdl) =	3.09		
Live load (wll) =	1.58		
Start from LHS (mm) =	0		
End from LHS (mm) =	4300		
S.Wt =	0.23	kN/m	
Ultimate load (w*) =	6.35	0.00	0.00

Point loads (kN)

Point loads	PL 1	PL 2	PL 3
Dead load (pdl) =	1.69	2.69	
Live load (pll) =	1.40	3.20	
Pos. from LHS (mm) =	950	3750	
Ultimate load (p*) =	4.13	8.03	0.00

Live Load type =	Floor	(Steel)	
Short term LL (Ψsu) =	0.70	(Ψsp) =	1.00
Long term LL (Ψlu) =	0.40	(Ψlp) =	0.60
Actual LL (Ψsa) =	0.80	(Ψla) =	0.47

Include S.Wt = Y (Y)es,(N)o
Strength loadcase = C (D)ead Only,(C)omb.

	DL	LL
Large	1.7	1.4 : L|L
T1	1.0	1.8 : L|L
Σ	2.7	3.2

Results at 2165mm from LHS (Max +ve M)

Position of result (x) = 2165 mm

1.20*G+1.50*Q analysed

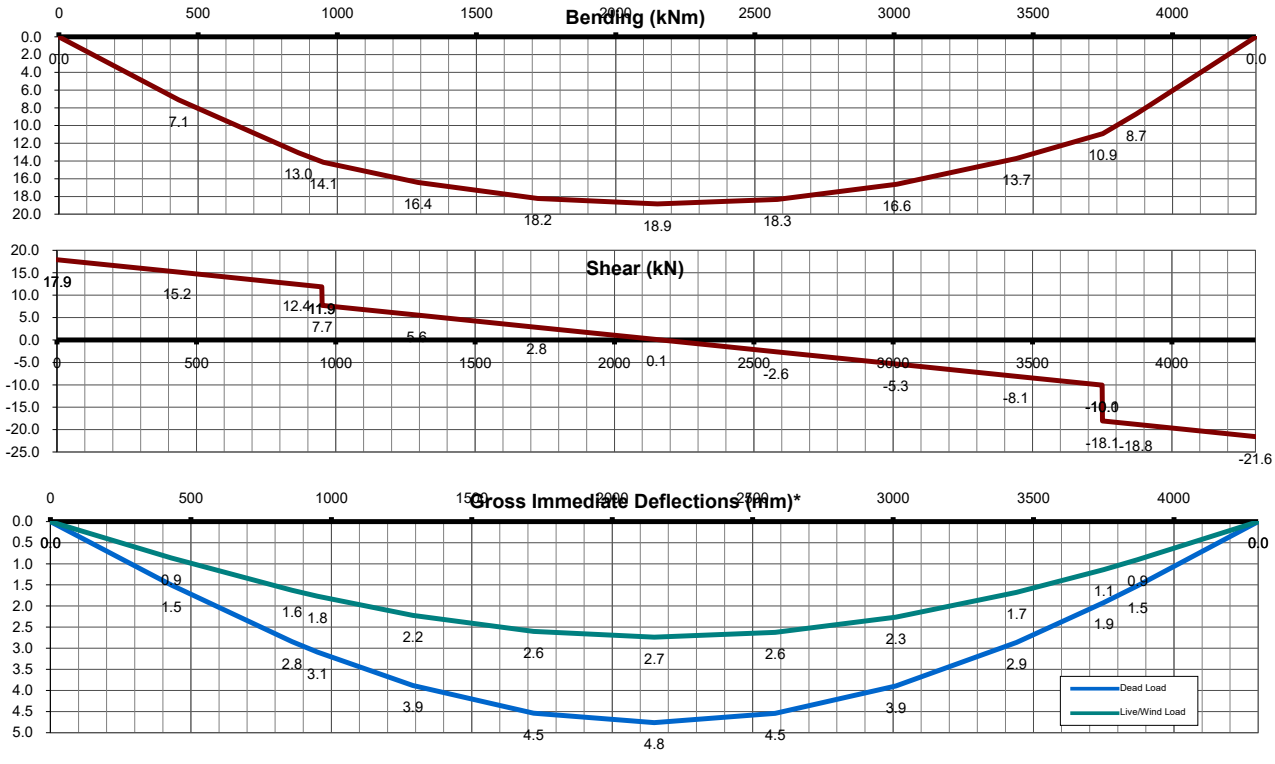
	Left	At x	Right	Max	At	Min	At	Units	
Rdl	8.80		9.86					kN	
Rll	4.90		6.50					kN	
R*	17.90		21.57					kN	
M*	0.00	18.85	0.00	18.85	2165	0.00	0	kNm	
V*	17.90	0.02	-21.57	21.57	4300			kN	Span /
δdl	0.00	4.76	0.00	4.76	2150	0.00	0	mm	903
δll	0.00	2.74	0.00	2.74	2150	0.00	0	mm	1570
δdl+Ψs*δll	0.00	6.95	0.00	6.95	2150	0.00	0	mm	619

	DL	LL
Large	1.7	1.4 : L|L
Σ	1.7	1.4

δPll/δTot.ll = 0.328

Graphs

* Deflections are Gross Ig immediate - assessment of long term effects to be considered



XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

2B14

STEEL MEMBER V5.14

Xstruct

Section:	**(2B14) 250x90PFC (G300)**	
Bending:	**Mx* = 24.0kNm < øMb(4500,αm=1.30) = 73.7kNm, øMb(αm=1) = 56.7kNm**	**OK (0.32)**
	No minor bending	
Shear:	**Vx* = 0.009kN < øVvm = 345.6kN (Web area full depth)**	**OK (0.00)**
	No minor shear	
Compression:	**No compression**	
Tension:	**No tension**	
Torsion:	**No torsion**	
Deflection:	**δDL = L/1605 (3mm), δΨs.LL = L/2558 (2mm), δTotal= L/986 (5mm) at 2400mm from LHS**	**OK**

Bending & Shear at 1240mm from LHS (Max +ve M) - Section 5

Max. restraint (2.5% flange force) = 2.5 kN

(M* to include first order amplification as required - Cl 4.4.2)

Analysis values = X (M)anual, (L)eft, Position (X) from analysis, (R)ight, (C)ritical

Refer to the analysis output

Analysis Axis = X (X),(Y)

Major bending (Mx*) =	24.0	kNm			
Minor bending (My*) =	0.000	kNm	Minor bending (My*) =	0	kNm
Shear Force (Vx*) =	0.009	kN	Torsion (Mz*) =	0	kNm
Shear Force (Vy*) =	0.000	kN			
Effective length factor (ke) =	Calc		Shear Force (Vy*) =	0	kN
ke = (kt=1.00)*(kl=1.00)*(kr=1.00) =	1.00	(From Le Tab)	Span / Segment Length (L) =	4500	mm
Effective length (Le = L*ke) =	4500	mm	Moment modification factor (αm) =	1.30	
ø =	0.9	Table 3.4			
øMsx =	113.7	kNm	Bending (x) =	OK (0.32)	
øMbx(αm=1) =	56.7	kNm			
øMbx =	73.7	kNm	Shear =	OK (0.00)	
øMsyL =	23.9	kNm	øMsyR =	24.0 kNm	
øVv =	345.6	kN			
øVvm =	345.6	kN	Ix =	45.1	x10⁶ mm⁴
øMz =	2.68	kNm	S.Wt =	0.355	kN/m

Compression - Section 6 (No compression)

Axial compression (Nc*) =	0.0	kN	Axial compression (Nc*) =	0	kN
Major axis length (Lx) =	10000	mm	Eff. X length factor (kex) =	1.00	
Minor axis length (Ly) =	1500	mm	Eff. Y length factor (key) =	1.00	
Braced or Sway member =	S	(B)raced, (S)way			
			Major axis effective length (Lex) =	10000	mm
øNs =	1220.4	kN	Minor axis effective length (Ley) =	1500	mm
øNcx(kex=1.00) =	527.7	kN			
In-Plane øNcx(kex=1.00) =	527.7	kN			
øNcy(key=1.00) =	926.9	kN			
In-Plane øNcy(key=1.00) =	926.9	kN			
øNc =	527.7	kN			

Tension - Section 7 (No tension)

Axial tension (Nt*) =	0.0	kN	Axial tension (Nt*) =	0	kN
kt =	1.00	Table 7.3.2			
øNt =	1220.4	kN			

Combined

øMrxt =	113.7 kNm	øMixt =	113.7 kNm	øMoxt =	73.7 kNm
øMrxc =	113.7 kNm	øMixc =	113.7 kNm	øMoxc =	73.7 kNm
øMryt =	23.9 kNm	øMiyc =	23.9 kNm	øMtx =	73.7 kNm
øMryc =	23.9 kNm			øMcx =	73.7 kNm

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

2B14 (Ana)

ANALYSIS V5.05 Xstruct

Geometry for (2B14): Steel Simple Beam

Description =	250x90PFC (G300)		Ix =	45.1	x10⁶ mm⁴
Span (L) =	4800	mm	Axis =	X	(X),(Y)
Span type =	S	(S)imple,(E)xt,(I)nt,(C)ant,(P)rop,(F)ixed,(O)ther	Ag =	4520	mm²
Material type =	S	(T)imber,(S)teel,(C)onc.,(SC)comp. steel,(O)ther	Density =	78.6	kN/m³
			E =	200000	MPa

Loading

Uniform loads (kN/m)

Uniform loads	UDL	Partial 1	Partial 2
Dead load (wdl) =	0.98		
Live load (wll) =	0.65		
Start from LHS (mm) =	0		
End from LHS (mm) =	4800		
S.Wt =	0.36	kN/m	
Ultimate load (w*) =	2.58	0.00	0.00

Point loads (kN)

Point loads	PL 1	PL 2	PL 3
Dead load (pdl) =	17.99	5.98	
Live load (pll) =	13.87	4.75	
Pos. from LHS (mm) =	518	4265	
Ultimate load (p*) =	42.39	14.30	0.00

Include S.Wt =		Y	(Y)es,(N)o
Strength loadcase =		C	(D)ead Only,(C)omb.

Live Load type =	Floor	(Steel)		
Short term LL (Ψsu) =	0.70	(Ψsp) =	1.00	
Long term LL (Ψlu) =	0.40	(Ψlp) =	0.60	
Actual LL (Ψsa) =	0.93	(Ψla) =	0.55	

	DL	LL	
2B12	18.0	13.9	: M|M
Σ	18.0	13.9	

Results at 1240mm from LHS (Max +ve M)

Position of result (x) = 1240 mm

1.20*G+1.50*Q analysed

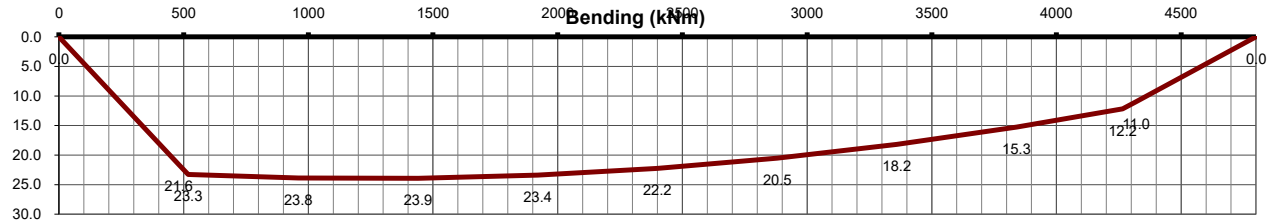
	Left	At x	Right	Max	At	Min	At	Units	
Rdl	19.92		10.46					kN	
Rll	14.46		7.28					kN	
R*	45.60		23.47					kN	
M*	0.00	23.95	0.00	23.95	1240	0.00	0	kNm	
V*	45.60	0.01	-23.47	45.60	0			kN	Span /
δdl	0.00	2.36	0.00	2.99	2400	0.00	0	mm	1605
δll	0.00	1.62	0.00	2.03	2400	0.00	0	mm	2369
δdl+Ψs*δll	0.00	3.86	0.00	4.87	2400	0.00	0	mm	986

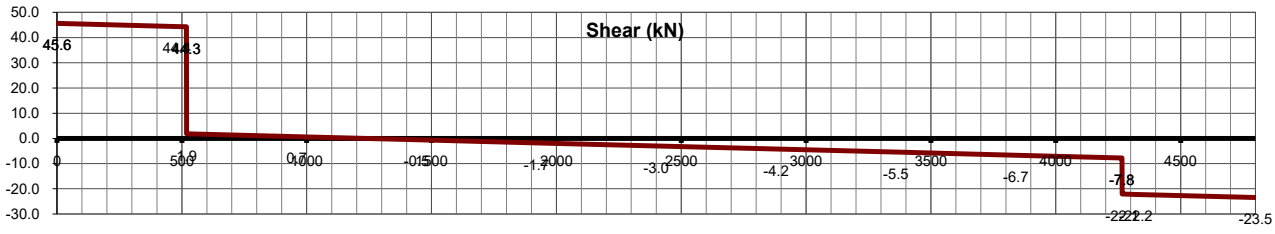
	DL	LL	
2B15	5.0	2.9	: L|L
T1	1.0	1.8	: L|L
Σ	6.0	4.7	

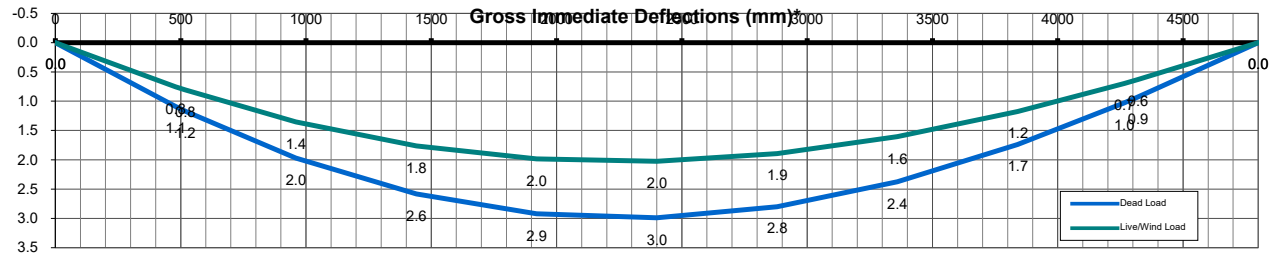
δPll/δTot.ll = 0.754

Graphs

* Deflections are Gross Ig immediate - assessment of long term effects to be considered







XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

2B15

TIMBER ROOF BEAM V5.10

Xstruct

Beam:	**(2B15) 2 / 300mm x 58mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 6.40kNm (+ve) < øM(dl) = 14.89kNm, M* = 8.79kNm (+ve) < øM = 26.13kNm**	**OK (0.43,0.34)**
	Mw* = 0.00kNm (-ve) < øMw = 30.94kNm	**OK (0.00)**
Shear:	**V(dl)* = 6.92kN < øV(dl) = 52.76kN, V* = 10.95kN < øV = 87.01kN**	**OK (0.13,0.13)**
	Vw* = 2.82kN < øVw = 92.57kN	**OK (0.03)**
Deflection:	**δDL = L/932 (5mm) , δΨs.LL = L/4858 (1mm), δWLs = L/6821 (-1mm)**	**OK**
Reactions:	**(1 End) Rdl.max = 4.98kN, Rll.max = 2.95kN, Rwl.max* = -1.79kN, R.dn.max* = 10.40kN, R.up.max* = -2.70kN (Down)**	
	(1 End) Rdl.min = 4.26kN, Rll.min = 1.65kN, Rwl.min* = -1.79kN, R.dn.min* = 7.59kN, R.up.min* = -2.05kN (Down)	

Geometry

(House member affecting ≤ 25m² or secondary building member)

Category =	1 (1) House, (2) Primary building elements, (3) Important			House =	N (Y)es,(N)o
Span (L) =	4300 mm		Edge restrained (down) =	C	(T)ension,(C)ompression,(B)oth
Centres (cts) =	900 mm		Lay.t (Top) =	4300	mm
Span type =	S (S)ingle,(D)ouble				

Loadings

Roof area (A) =	3.87 m²		Apply wind reduction =	Y	(Y)es,(N)o
LL = 1.8/A+0.12 ≥ 0.25 =	0.59 kPa		Roof reduction (Ka) =	1.00	AS/NZS 1170.2, Table 5.4
			Ratio Ws/Wu =	0.68	(Refer wind analysis)

Uniform dead loads

Roof dead load (wdl) =	0.40	kPa *	900	mm +		kN/m =	0.36 kN/m
Other dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.21 kN/m
						Σwdl =	1.92 kN/m

Uniform live loads

Roof live load (wll) =	0.59	kPa *	900	mm +		kN/m =	0.53 kN/m
Other live load (wll) =		kPa *	900	mm +		kN/m =	0.00 kN/m
Alternate point live load =	1.40	kN (critical)	Distr. to	1	members	Σwll =	0.65 kN/m

Uniform wind loads

Ult. wind load (Wu) =	0.84	kPa *	900	mm		
Cp,e =	0.9	Cp,i =	0.2		Σwwl* =	-0.83 kN/m (up)

Point loads

Dead load (pdl) =	1.00	kN			tion =	600	mm from LHS
Live load (pll) =	1.80	kN			port =	Y	(Y)es,(N)o
Wind load (pwl*) =		kN (-ve up)					

	DL	LL	WLu	
T1	1.0	1.8	-	: L|L|-
Σ	1.0	1.8	0.0	

w(dl)* = 1.35*wdl =	2.59 kN/m	M(dl)* =	6.40 kNm (Max at 2077mm)
w* = 1.2*wdl + 1.5*wll =	3.28 kN/m	M* =	8.79 kNm (Max at 1984mm)
w.up* = 0.9*wdl + wwl* =	-0.90 kN/m (down)	Mw.dn* =	0.00 kNm
p(dl)* = 1.35*pdl =	1.35 kN	V(dl)* =	6.92 kN
p* = 1.2*pdl+1.5*pll =	3.90 kN	V* =	10.95 kN
p.up* = 0.9*pdl + pwl* =	-0.90 kN (down)	Vw.up* =	2.82 kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	2 / 300mm x 58mm Smart LVL15		Area (A) =	34800	mm²
Description =	LVL15 seasoned softwood		Section modulus (Zx) =	1740	x10³ mm³
Design depth (dD) =	300 mm		Stiffness (Ix) =	261.0	x10⁶ mm⁴
Design width (dW) =	58 mm		Modulus of elasticity (E) =	15300	MPa - Cl 8.3
S1d = 1.25*dD/dW*(Lay.t/dD)^0.5 =	24.48	For top comp. edge restrained - Cl 3.2.3.2(a)			
S1ud = 1.25*dD/dW*(Lay.t/dD)^0.5 =	24.48	For top comp. edge restrained - Cl 3.2.3.2(a)			
k12d = 200/(S1d*pbd)² =	0.340	for ρbd*S1d ≥ 20 - Cl 3.2.4			
k12 = 200/(S1d*ρb)² =	0.361	for ρb*S1d ≥ 20 - Cl 3.2.4	f'b =	46.5	MPa
k12u = 200/(S1u*ρbu)² =	0.402	for ρbu*S1u ≥ 20 - Cl 3.2.4	f's =	4.2	MPa
Strength reduction factor (ø) =	0.95	Table 2.1	Material constant (ρbd) =	0.99	(rbd=0.25)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	14.89	kNm	Material constant (ρb) =	0.96	(rb=0.42)
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	26.13	kNm	Stress reversal (ρbu) =	0.91	(rbu=1.00)
øMw = ø*(k1=1)*k4*k6*k9*k12u*f'b*Zx =	30.94	kNm	Duration factor (k1) =	0.94	(Live)
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	52.76	kN	Moisture factor (k4) =	1.00	
øV = ø*k1*k4*k6*f's*(2/3*A) =	87.01	kN	Temp. factor (k6) =	1.00	
øVw = ø*(k1=1)*k4*k6*f's*(2/3*A) =	92.57	kN	Sharing factor (k9) =	1.00	
			Size modifier (mod.b & s) =	1.00	& 1.00

Deflections

			Duration factor (j2) =	2.0		
Ireq'd j2.(DL+Ψl.LL) (L/300) =	84.0 x10⁶ mm⁴	< Critical	δDL=	4.6	mm	Span / 932
Ireq'd `LL (L/240) =	12.9 x10⁶ mm⁴		δΨs.LL =	0.9	mm	Span / 4858
Ireq'd WLs (L/180) =	6.9 x10⁶ mm⁴		δWLs =	-0.6	mm	Span / 6821

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

GL2

T LINTEL V5.03

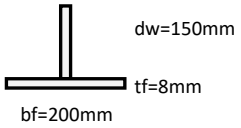
Xstruct

Geometry: (GL2) 150mm x 8mm Pl. Vert., 200mm x 8mm Pl. Horz.
Design: M* = 8.8kNm < øMb(3000,αm=1.13) = 12.8 kNm — **OK (0.69)**
Deflection: δDL = L/703 (4mm), δΨs.LL = L/5535 (1mm), δTotal = L/624 (5mm) — **OK**
Reactions: (Each end) Rdl = 7.9kN, Rll = 1.4kN, R* = 11.7kN

Geometry

Span = Le = 3000 mm

αm = 1.13



Vertical web			Horizontal flange		
Web thickness (tw) =	8	mm	Flange thickness (tf) =	8	mm
Web depth (dw) =	150	mm	Flange width (bf) =	200	mm
Yield strength =	250	MPa	Yield strength =	250	MPa

Loading

Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Roof dead load (wdl) =	0.40	kPa *	3000	mm +		kN/m =	1.20	kN/m
Floor dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35	kN/m
Wall dead load (wdl) =	2.10	kPa *	1200	mm +		kN/m =	2.52	kN/m
Other dead load (wdl) =		kPa *		mm +		kN/m =	0.00	kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.22	kN/m
						Σwdl =	5.29	kN/m

Uniform live loads

Roof live load (wll) =	0.32	kPa *	3000	mm +		kN/m =	0.96	kN/m
Floor live load (wll) =		kPa *		mm +		kN/m =	0.00	kN/m
Other live load (wll) =		kPa *		mm +		kN/m =	0.00	kN/m
						Σwll =	0.96	kN/m

Point loads

Dead load (Pdl) = kN — Position = 1500 mm from LHS
Live load (Pll) = kN

Horizontal loads

Wall height (wcts) = 0 mm — Ratio Ws/Wu = 0.68
Ult. inward wind load (Wu) = 0.84 kPa
cpe = 0.7 — cpi = 0.2 — wwl* = 0.00 kN/m
Short term LL (Ψsu) = 0.70 — (Ψsp) = 1.00
w* = 1.2*wdl + 1.5*wll = 7.79 kNm — Rdl = wdl*L/2 + pdl*(L-pos)/L = 7.9 kN
p* = 1.2*pdl + 1.5*pll = 0.00 kNm — Rll = wll*L/2 + pll*(L-pos)/L = 1.4 kN
M* = 8.8 kNm (Max at 1500mm) — R* = 1.2*Rdl + 1.5*Rll = 11.7 kN

Properties

Area =	2800	mm²	Warping constant (Iw) =	0	mm⁶ - Cl H4
Stiffness (Ix) =	6.5	x10⁶ mm⁴	Torsional constant (J) =	59.7	x10³ mm⁴
Stiffness (Iy) =	5.34	x10⁶ mm⁴	Elastic section modulus (Zt) =	54.4	x10³ mm³
Elastic modulus (E) =	200000	MPa - Cl 1.4	Elastic section modulus (Zb) =	172.7	x10³ mm³
Shear modulus (G) =	80000	MPa - Cl 1.4	Min. elastic section modulus (Zmin) =	54.4	x10³ mm³
Elastic (y.top) =	120	mm	Plastic section modulus (S) =	96.2	x10³ mm³
Plastic (yp.top) =	151	mm	Eff. elastic section mod.(Compact) (Zc) =	81.6	x10³ mm³ - Cl 5.2.3

Capacity - Cl 5.6.1.2

Web λs =dw/tw*√(fyw/250) =	18.8	< 22, Non-compact	Cl 5.2.2			λsy =	22
Zex = Zmin+[(λsy-λs)/(λsy-λsp)*(Zc-Zmin)] =	60.7	x10³ mm³ - Cl 5.2.4				λsp =	8
ø =	0.9	Table 3.4					
Msx =	15.2	kNm	øMsx =	13.7	kNm	βx =	-93.9
Moa =	37.9	kNm	αs =	0.826		αm =	1.13
øMbx = αm*αs*øMsx ≤ øMsx =				12.8	kNm - Cl 5.6.1.1(1)		

Deflections

Ireq'd DL (L/500) =	4.6	x10⁶ mm⁴	< Critical	δDL =	4.3	mm	Span / 703
Ireq'd Ψs.LL (L/360) =	0.4	x10⁶ mm⁴		Ψs.δLL =	0.5	mm	Span / 5535
Ireq'd WLs.h (L/250) =	0.0	x10⁶ mm⁴		δWLs.h =	0.0	mm	Span / -
Ireq'd (DL+Ψs.LL) (L/360) =	3.8	x10⁶ mm⁴		δTotal =	4.8	mm	Span / 624
				1kN midspan δ =	0.4	mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

RL1

TIMBER ROOF BEAM V5.10

Xstruct

Beam:	**(RL1) 240mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 1.87kNm (+ve) < øM(dl) = 8.49kNm, M* = 3.35kNm (+ve) < øM = 14.61kNm**	**OK (0.22,0.23)**
	Mw* = 1.06kNm (-ve) < øMw = 15.26kNm	**OK (0.07)**
Shear:	**V(dl)* = 7.50kN < øV(dl) = 15.28kN, V* = 12.06kN < øV = 25.20kN**	**OK (0.49,0.48)**
	Vw* = 1.63kN < øVw = 26.81kN	**OK (0.06)**
Deflection:	**δDL = L/925 (3mm) , δΨs.LL = L/2726 (1mm), δWLs = L/1703 (-2mm)**	**OK**
Reactions:	**(1 End) Rdl.max = 5.32kN, Rll.max = 3.46kN, Rwl.max* = -3.37kN, R.dn.max* = 11.58kN, R.up.max* = -1.42kN (Down)**	
	(1 End) Rdl.min = 1.78kN, Rll.min = 1.53kN, Rwl.min* = -3.37kN, R.dn.min* = 4.43kN, R.up.min* = 1.77kN	

Geometry

(House member affecting ≤ 25m² or secondary building member)

Category = 1 (1) House, (2) Primary building elements, (3) Important — House = N (Y)es,(N)o
Span (L) = 2700 mm — Edge restrained (down) = C (T)ension,(C)ompression,(B)oth
Centres (cts) = 2700 mm — Lay.t (Top) = 900 mm
Span type = S (S)ingle,(D)ouble

Loadings

Roof area (A) = 7.29 m² — Apply wind reduction = Y (Y)es,(N)o
LL = 1.8/A+0.12 ≥ 0.25 = 0.37 kPa — Roof reduction (Ka) = 1.00 AS/NZS 1170.2, Table 5.4
Ratio Ws/Wu = 0.68 (Refer wind analysis)

Uniform dead loads

Roof dead load (wdl) =	0.40 kPa *	2700 mm +		kN/m =	1.08 kN/m
Other dead load (wdl) =	kPa *	2700 mm +		kN/m =	0.00 kN/m
Include S.Wt =	Y (Y)es,(N)o			S.Wt =	0.06 kN/m
				Σwdl =	1.14 kN/m

Uniform live loads

Roof live load (wll) =	0.37 kPa *	2700 mm +		kN/m =	0.99 kN/m
Other live load (wll) =	kPa *	2700 mm +		kN/m =	0.00 kN/m
Alternate point live load =	1.40 kN (critical)	Distr. to	1 members	Σwll =	1.04 kN/m

Uniform wind loads

Ult. wind load (Wu) = 0.84 kPa * — 2700 mm
Cp,e = 0.9 — Cp,i = 0.2 — Σwwl* = -2.49 kN/m (up)

Point loads

	DL	LL	WLu	
GT	4.0	2.2	-7.8	: L|L|L
Extra	0.0	0.0	7.8	:
Σ	4.0	2.2	0.0	

Dead load (pdl) = 4.02 kN — ition = 2540 mm from LHS
Live load (pll) = 2.19 kN — port = Y (Y)es,(N)o
Wind load (pwl*) = kN

w(dl)* = 1.35*wdl =	1.54 kN/m	M(dl)* =	1.87 kNm (Max at 1559mm)
w* = 1.2*wdl + 1.5*wll =	2.92 kN/m	M* =	3.35 kNm (Max at 1514mm)
w.up* = 0.9*wdl + wwl* =	1.47 kN/m (up)	Mw.up* =	1.06 kNm (Max at 1204mm)
p(dl)* = 1.35*pdl =	5.43 kN	V(dl)* =	7.50 kN
p* = 1.2*pdl+1.5*pll =	8.11 kN	V* =	12.06 kN
p.up* = 0.9*pdl + pwl* =	-3.62 kN (down)	Vw.up* =	1.63 kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member = 240mm x 42mm Smart LVL15 — Area (A) = 10080 mm²
Description = LVL15 seasoned softwood — Section modulus (Zx) = 403 x10³ mm³
Design depth (dD) = 240 mm — Stiffness (Ix) = 48.4 x10⁶ mm⁴
Design width (dW) = 42 mm — Modulus of elasticity (E) = 15300 MPa - Cl 8.3

S1d = 1.25*dD/dW*(Lay.t/dD)^0.5 = 13.83 For top comp. edge restrained - Cl 3.2.3.2(a)
S1u = (dD/dW)^1.35*(Lay.t/dD)^0.25 = 14.64 For top tension edge restrained in uplift - Cl 3.2.3.2(a)
k12d = 1.5-0.05*ρbd*S1d = 0.800 for 10 ≤ ρbd*S1d ≤ 20 - Cl 3.2.4
k12 = 1.5-0.05*ρb*S1d = 0.834 for 10 ≤ ρb*S1d ≤ 20 - Cl 3.2.4 — f'b = 48.6 MPa
k12u = 1.5-0.05*ρbu*S1u = 0.819 for 10 ≤ ρbu*S1u ≤ 20 - Cl 3.2.4 — f's = 4.2 MPa

Strength reduction factor (ø) =	0.95 Table 2.1	Material constant (ρbd) =	1.01 (rbd=0.25)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	8.49 kNm	Material constant (ρb) =	0.96 (rb=0.57)
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	14.61 kNm	Stress reversal (ρbu) =	0.93 (rbu=1.00)
øMw = ø*(k1=1)*k4*k6*k9*k12u*f'b*Zx =	15.26 kNm	Duration factor (k1) =	0.94 (Live)
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	15.28 kN	Moisture factor (k4) =	1.00
øV = ø*k1*k4*k6*f's*(2/3*A) =	25.20 kN	Temp. factor (k6) =	1.00
øVw = ø*(k1=1)*k4*k6*f's*(2/3*A) =	26.81 kN	Sharing factor (k9) =	1.00
		Size modifier (mod.b & s) =	1.00 & 1.00

Deflections

Duration factor (j2) = 2.0

Ireq'd j2.(DL+Ψl.LL) (L/300) =	15.7 x10⁶ mm⁴	< Critical	δDL=	2.9 mm	Span / 925
Ireq'd `LL (L/240) =	4.3 x10⁶ mm⁴		δΨs.LL =	1.0 mm	Span / 2726
Ireq'd WLs (L/180) =	5.1 x10⁶ mm⁴		δWLs =	-1.6 mm	Span / 1703

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

3B4

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(3B4) 2 / 300mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 15.08kNm (+ve) < øM(dl) = 30.42kNm, M* = 21.71kNm (+ve) < øM = 43.92kNm**	**OK (0.50,0.49)**
Shear:	**V(dl)* = 19.67kN < øV(dl) = 38.21kN, V* = 28.80kN < øV = 53.63kN**	**OK (0.51,0.54)**
Deflection:	**δDL = L/426 (7mm) , δΨs.LL = L/1562 (2mm), δTotal = L/335 (9mm), 1kN mid. δ = 0.2mm**	**OK**
Reactions:	**(1 End) Rdl.max = 10.38kN, Rll.max = 10.90kN, R.max* = 28.80kN**	
	(1 End) Rdl.min = 8.72kN, Rll.min = 9.82kN, R.min* = 25.20kN	
Geometry	(House member affecting ≤ 25m² or secondary building member)	

Category = 1 (1) House, (2) Primary building elements, (3) Important
House = N (Y)es,(N)o
Edge restrained = C (T)ension, (C)ompression, (B)oth
Span (L) = 2900 mm
Lay.t (Top) = 450 mm
Centres (cts) = 3300 mm
Span type = S (S)ingle,(D)ouble

Loadings

Floor area (A) = 9.57 m²
Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50 kPa *	3300 mm +		kN/m =	1.65	kN/m
Wall dead load (wdl) =	0.50 kPa *	2700 mm +		kN/m =	1.35	kN/m
Other dead load (wdl) =	0.40 kPa *	4000 mm +		kN/m =	1.60	kN/m
Include S.Wt =	Y (Y)es,(N)o			S.Wt =	0.15	kN/m
				Σwdl =	4.75	kN/m

Uniform live loads

Floor live load (wll) =	1.50 kPa *	3300 mm +		kN/m =	4.95	kN/m
Partitions (wll) =	0.25 kPa *	4000 mm +		kN/m =	1.00	kN/m
Alternate point live load =	1.80 kN	Distr. to	1 members	Σwll =	5.95	kN/m

Point loads

Dead load (pdl) = 5.32 kN
Live load (pll) = 3.46 kN
Position = 1900 mm from LHS
Shear using PL at support = N (Y)es,(N)o

Short term LL factor (Ψsu) =	0.70		(Ψsp) =	1.00	
Long term LL factor (Ψlu) =				0.60	
wdl* = 1.2*wdl+1.5*Ψlu*wll =				15.08	kNm (Max at 1803mm)
w* = 1.2*wdl+1.5*wll =	14.63	kN/m	M* =	21.71	kNm (Max at 1723mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	9.50	kN	V(dl+Ψl.ll)* =	19.67	kN
p* = 1.2*pdl+1.5*pll =	11.58	kN	V* =	28.80	kN

	DL	LL
RL1	5.3	3.5 : M|M
Σ	5.3	3.5

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member = 2 / 300mm x 42mm Smart LVL15
Description = LVL15 seasoned softwood
Design depth (dD) = 300 mm
Design width (dW) = 42 mm
Area (A) = 25200 mm²
Section modulus (Zx) = 1260 x10³ mm³
Stiffness (Ix) = 189.0 x10⁶ mm⁴
Modulus of elasticity (E) = 15300 MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 = 10.94 For top comp. edge restrained - Cl 3.2.3.2(a)
k12d = 1.5-0.05*ρbd*S1 = 0.958 for 10 ≤ ρbd*S1 ≤ 20 - Cl 3.2.4
k12 = 1.5-0.05*ρb*S1 = 0.986 for 10 ≤ ρb*S1 ≤ 20 - Cl 3.2.4
f'b = 46.5 MPa
f's = 4.2 MPa
Material constant (ρbd) = 0.99 (rbd=0.25)
Material constant (ρb) = 0.94 (rb=0.59)
Strength reduction factor (ø) = 0.95 Table 2.1
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx = 30.42 kNm
øM = ø*k1*k4*k6*k9*k12*f'b*Zx = 43.92 kNm
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) = 38.21 kN
øV = ø*k1*k4*k6*f's*(2/3*A) = 53.63 kN
Duration factor (k1) = 0.80
Moisture factor (k4) = 1.00
Temp. factor (k6) = 1.00
Sharing factor (k9) = 1.00
Size modifier (mod.b) = 1.00
Size modifier (mod.s) = 1.00

Deflections

Duration factor (j2) = 2.0

Ireq'd j2.(DL+Ψl.LL) (L/300) =	133.1 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	6.8 mm	Span / 426
Ireq'd Ψs.LL (L/300) =	36.3 x10⁶ mm⁴		Ψs.δLL =	1.9 mm	Span / 1562
Ireq'd Total (L/250) =	141.1 x10⁶ mm⁴		δTotal =	8.7 mm	Span / 335
			1kN midspan δ =	0.2 mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

3B2

STEEL FLOOR BEAM V5.06

Xstruct

Member:	**(3B2) 200x75PFC (G300)**	
Bending:	**M*(max) = 37.6kNm < øMb(450,αm=1.00) = 59.7kNm**	**OK (0.63)**
	(Single span)	
Shear:	**V.max*=33.8kN < øVvm = 207.4kN (Web area full depth)**	**OK (0.16)**
Deflection:	**δDL = L/756 (5mm), δΨs.LL = L/951 (4mm), δTotal = L/421 (9mm), 1kN mid. δ = 0.3mm**	**OK**
Precamber:	**Not required**	
Reactions:	**(Each end) Rdl = 11.8kN, Rll = 13.0kN, R* = 33.8kN**	

Geometry

Span (L) =	3800	mm	Eff. Len. (Le) =	450	mm
Centres (cts) =	3300	mm	αm.t =	1.00	
Design at =	M	mm from LHS, (M)ax, (S)eg			
Span type =	S	(S)ingle,(D)ouble			
Effective length (Le) =	450	mm			
αm =	1.00				

Loadings

Floor area =	12.5	m²	Live load type =	N	(N)ormal, (S)torage, (M)anual		
Apply reduction =	N	(Y)es,(N)o			AS/NZS 1170.0 - Table 4.1		
Floor reduction (Ψa) =	1.00	AS/NZS 1170.1 - Cl 3.4.2					

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	3300	mm +		kN/m =	1.65	kN/m
Wall dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35	kN/m
Other dead load (wdl) =	0.40	kPa *	4000	mm +		kN/m =	1.60	kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.23	kN/m
						Σwdl =	4.83	kN/m

Uniform live loads

Floor live load (wll) =	1.50	kPa * Ψa *	3300	mm +		kN/m =	4.95	kN/m
Partitions (wll) =	0.25	kPa *	4000	mm +		kN/m =	1.00	kN/m
Alternate point live load =	1.80	kN	Distr. to	1	members	Σwll =	5.95	kN/m

Point loads

Dead load (pdl) =	5.3	kN	Position =	1900	mm from LHS
Live load (pll) =	3.5	kN	Shear using PL at support =	N	(Y)es,(N)o

	DL	LL	
RL1	5.3	3.5	: M|M
Σ	5.3	3.5	

Short term LL factor (Ψsu) = 0.70 (Ψsp) = 1.00

w* = 1.2*wdl + 1.5*wll = 14.7… M* = 37.6 kNm (Max at 1900mm)

p* = 1.2*pdl + 1.5*pll = 11.58 kN V* = 33.8 kN

Capacity

Description =	200x75PFC (G300)		Warping constant (Iw) =	10.5	x10⁹ mm⁶
Flange yield (fyf) =	300	MPa	Torsional constant (J) =	105	x10³ mm⁴
Web yield (fyw) =	320	MPa	Effective section mod. (Zex) =	221	x10³ mm³
Area (Ag) =	2920	mm²	Effective section mod. (Zey) =	46.7	x10³ mm³
Stiffness (Ix) =	19.1	x10⁶ mm⁴	Elastic modulus (E) =	200000	MPa - Cl 1.4
Stiffness (Iy) =	1.65	x10⁶ mm⁴	Shear modulus (G) =	80000	MPa - Cl 1.4
ø =	0.9	Table 3.4			
Msx = min(fyf,fyw)*Zex =	66.3	kNm - Cl 5.2.1	øMsx =	59.7	kNm
				øMsy =	12.6	kNm - Cl 5.2.1
Positive: Moa.p =	1334.7	kNm	αs.t = 1.000	αm.t = 1.00	øMbx.p =	59.7	kNm
Negative: Moa.n =	N.A.				

Deflections

Ireq'd DL (L/360) =	9.1	x10⁶ mm⁴	δDL =	5.0	mm	Span / 756
Ireq'd Ψs.LL (L/360) =	7.2	x10⁶ mm⁴	Ψs.δLL =	4.0	mm	Span / 951
Ireq'd (DL+Ψs.LL) (L/250) =	11.3	x10⁶ mm⁴ < Critical	δTotal =	9.0	mm	Span / 421

Max. precamber (0.3%*span) =	11 mm	Min. precamber =	15 mm
Precamber 80% of δDL =	4 mm	Adopted precamber =	0 mm

1kN midspan δ = 0.3 mm

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

3B3

STEEL FLOOR BEAM V5.06

Xstruct

Member:	**(3B3) 310UB46.2 (G300)**	
Bending:	**M*(max) = 97.1kNm < øMb(5000,αm=1.30) = 126.9kNm**	**OK (0.77)**
	(Single span)	
Shear:	**V.max*=53.5kN < øVvm = 355.4kN (Web area full depth)**	**OK (0.15)**
Deflection:	**δDL = L/1171 (4mm), δΨs.LL = L/1437 (3mm), δTotal = L/645 (8mm), 1kN mid. δ = 0.1mm**	**OK**
Precamber:	**Not required**	
Reactions:	**(1 End) Rdl.max = 22.0kN, Rll.max = 18.1kN, R.max* = 53.5kN**	
	(1 End) Rdl.min = 18.4kN, Rll.min = 14.2kN, R.min* = 43.5kN	

Geometry

Span (L) =	5000	mm	Eff. Len. (Le) =	5000	mm
Centres (cts) =	450	mm	αm.t =	1.30	
Design at =	M	mm from LHS, (M)ax, (S)eg			
Span type =	S	(S)ingle,(D)ouble			
Effective length (Le) =	5000	mm			
αm =	1.30				

Loadings

Floor area = 2.3 m² | Live load type = N (N)ormal, (S)torage, (M)anual
Apply reduction = N (Y)es,(N)o | AS/NZS 1170.0 - Table 4.1
Floor reduction (Ψa) = 1.00 AS/NZS 1170.1 - Cl 3.4.2

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	450	mm +		kN/m =	0.23 kN/m
Wall dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35 kN/m
Other dead load (wdl) =	0.40	kPa *	4000	mm +		kN/m =	1.60 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.47 kN/m
						Σwdl =	3.64 kN/m

Uniform live loads

Floor live load (wll) =	1.50	kPa * Ψa *	450	mm +		kN/m =	0.68 kN/m
Partitions (wll) =	0.25	kPa *	4000	mm +		kN/m =	1.00 kN/m
Alternate point live load =	1.80	kN	Distr. to	1	members	Σwll =	1.68 kN/m

Point loads

Dead load (pdl) = 22.2 kN | Position = 2900 mm from LHS
Live load (pll) = 23.9 kN | Shear using PL at support = N (Y)es,(N)o

	DL	LL	
3B2	11.8	13.0	: L|L
3B4	10.4	10.9	: R|R
Σ	22.2	23.9	

Short term LL factor (Ψsu) = 0.70 | Ψsp) = 1.00
w* = 1.2*wdl + 1.5*wll = 6.88 | M* = 97.1 kNm (Max at 2900mm)
p* = 1.2*pdl + 1.5*pll = 62.55 kN | V* = 53.5 kN

Capacity

Description =	310UB46.2 (G300)		Warping constant (Iw) =	197	x10⁹ mm⁶
Flange yield (fyf) =	300	MPa	Torsional constant (J) =	233	x10³ mm⁴
Web yield (fyw) =	320	MPa	Effective section mod. (Zex) =	729	x10³ mm³
Area (Ag) =	5930	mm²	Effective section mod. (Zey) =	163	x10³ mm³
Stiffness (Ix) =	100.0	x10⁶ mm⁴	Elastic modulus (E) =	200000	MPa - Cl 1.4
Stiffness (Iy) =	9.01	x10⁶ mm⁴	Shear modulus (G) =	80000	MPa - Cl 1.4
ø =	0.9	Table 3.4			
Msx = min(fyf,fyw)*Zex =	218.7	kNm - Cl 5.2.1	øMsx =	196.8	kNm
Positive: Moa.p =	156.0	kNm	αs.t = 0.496	αm.t = 1.30	
Negative: Moa.n =	N.A.				

øMsy = 44.0 kNm - Cl 5.2.1
øMbx.p = 126.9 kNm

Deflections (δ ±2.5% with off-centre PL)

Ireq'd DL (L/360) =	30.7	x10⁶ mm⁴	δDL =	4.3 mm	Span / 1171
Ireq'd Ψs.LL (L/360) =	25.1	x10⁶ mm⁴	Ψs.δLL =	3.5 mm	Span / 1437
Ireq'd (DL+Ψs.LL) (L/250) =	38.7	x10⁶ mm⁴ < Critical	δTotal =	7.7 mm	Span / 645

Max. precamber (0.3%*span) = 15 mm | Min. precamber = 15 mm
Precamber 80% of δDL = 3 mm | Adopted precamber = 0 mm

1kN midspan δ = 0.1 mm

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

3B1

STEEL FLOOR BEAM V5.06

Xstruct

Member:	**(3B1) 300x90PFC (G300)**	
Bending:	**M*(max) = 61.8kNm < øMb(5000,αm=1.30) = 84.2kNm**	**OK (0.73)**
	(Single span)	
Shear:	**V.max*=36.6kN < øVvm = 414.7kN (Web area full depth)**	**OK (0.09)**
Deflection:	**δDL = L/1231 (4mm), δΨs.LL = L/1713 (3mm), δTotal = L/716 (7mm), 1kN mid. δ = 0.2mm**	**OK**
Precamber:	**Not required**	
Reactions:	**(1 End) Rdl.max = 15.8kN, Rll.max = 11.7kN, R.max* = 36.6kN**	
	(1 End) Rdl.min = 13.9kN, Rll.min = 9.7kN, R.min* = 31.2kN	

Geometry

Span (L) =	5000	mm	Eff. Len. (Le) =	5000	mm
Centres (cts) =	450	mm	αm.t =	1.30	
Design at =	M	mm from LHS, (M)ax, (S)eg			
Span type =	S	(S)ingle,(D)ouble			
Effective length (Le) =	5000	mm			
αm =	1.30				

Loadings

Floor area =	2.3	m²	Live load type =	N	(N)ormal, (S)torage, (M)anual
Apply reduction =	N	(Y)es,(N)o			AS/NZS 1170.0 - Table 4.1
Floor reduction (Ψa) =	1.00	AS/NZS 1170.1 - Cl 3.4.2			

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	450	mm +		kN/m =	0.23 kN/m
Wall dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35 kN/m
Other dead load (wdl) =	0.40	kPa *	4000	mm +		kN/m =	1.60 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.40 kN/m
						Σwdl =	3.58 kN/m

Uniform live loads

Floor live load (wll) =	1.50	kPa * Ψa *	450	mm +		kN/m =	0.68 kN/m
Partitions (wll) =	0.25	kPa *	4000	mm +		kN/m =	1.00 kN/m
Alternate point live load =	1.80	kN	Distr. to	1	members	Σwll =	1.68 kN/m

Point loads

Dead load (pdl) =	11.8	kN	Position =	2900	mm from LHS
Live load (pll) =	13.0	kN	Shear using PL at support =	N	(Y)es,(N)o

	DL	LL	
3B2	11.8	13.0	: L|L
Σ	11.8	13.0	

Short term LL factor (Ψsu) =			(Ψsp) =	1.00	
w* = 1.2*wdl + 1.5*wll =	[illegible]	kN/m	M* =	61.8	kNm (Max at 2900mm)
p* = 1.2*pdl + 1.5*pll =	33.76	kN	V* =	36.6	kN

Capacity

Description =	300x90PFC (G300)		Warping constant (Iw) =	58.1	x10⁹ mm⁶
Flange yield (fyf) =	300	MPa	Torsional constant (J) =	304	x10³ mm⁴
Web yield (fyw) =	320	MPa	Effective section mod. (Zex) =	564	x10³ mm³
Area (Ag) =	5110	mm²	Effective section mod. (Zey) =	82.3	x10³ mm³
Stiffness (Ix) =	72.4	x10⁶ mm⁴	Elastic modulus (E) =	200000	MPa - Cl 1.4
Stiffness (Iy) =	4.04	x10⁶ mm⁴	Shear modulus (G) =	80000	MPa - Cl 1.4
ø =	0.9	Table 3.4			
Msx = min(fyf,fyw)*Zex =	169.2	kNm - Cl 5.2.1	øMsx =	152.3	kNm
Positive: Moa.p =	96.0	kNm	αs.t = 0.425	αm.t = 1.30	øMsy = 22.2 kNm - Cl 5.2.1
Negative: Moa.n =	N.A.				øMbx.p = 84.2 kNm

Deflections (δ ±2.5% with off-centre PL)

Ireq'd DL (L/360) =	21.2	x10⁶ mm⁴	δDL =	4.1 mm	Span / 1231
Ireq'd Ψs.LL (L/360) =	15.2	x10⁶ mm⁴	Ψs.δLL =	2.9 mm	Span / 1713
Ireq'd (DL+Ψs.LL) (L/250) =	25.3	x10⁶ mm⁴ < Critical	δTotal =	7.0 mm	Span / 716

Max. precamber (0.3%*span) =	15 mm	Min. precamber =	15 mm
Precamber 80% of δDL =	3 mm	Adopted precamber =	0 mm
		1kN midspan δ =	0.2 mm

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

3B5

STEEL FLOOR BEAM V5.06

Xstruct

Member:	**(3B5) 300x90PFC (G300)**	
Bending:	**M*(max) = 70.4kNm < øMb(450,αm=1.00) = 152.3kNm**	**OK (0.46)**
	(Single span)	
Shear:	**V.max*=52.4kN < øVvm = 414.7kN (Web area full depth)**	**OK (0.13)**
Deflection:	**δDL = L/1020 (5mm), δΨs.LL = L/1292 (4mm), δTotal = L/570 (9mm), 1kN mid. δ = 0.2mm**	**OK**
Precamber:	**Not required**	
Reactions:	**(1 End) Rdl.max = 18.9kN, Rll.max = 19.8kN, R.max* = 52.4kN**	
	(1 End) Rdl.min = 16.3kN, Rll.min = 18.0kN, R.min* = 46.5kN	

Geometry

Span (L) =	5400	mm	Eff. Len. (Le) =	450	mm
Centres (cts) =	3300	mm	αm.t =	1.00	
Design at =	M	mm from LHS, (M)ax, (S)eg			
Span type =	S	(S)ingle,(D)ouble			
Effective length (Le) =	450	mm			
αm =	1.00				

Loadings

Floor area =	17.8	m²	Live load type =	N	(N)ormal, (S)torage, (M)anual		
Apply reduction =	N	(Y)es,(N)o			AS/NZS 1170.0 - Table 4.1		
Floor reduction (Ψa) =	1.00	AS/NZS 1170.1 - Cl 3.4.2					

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	3300	mm +		kN/m =	1.65	kN/m
Wall dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35	kN/m
Other dead load (wdl) =	0.40	kPa *	4500	mm +		kN/m =	1.80	kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.40	kN/m
						Σwdl =	5.20	kN/m

Uniform live loads

Floor live load (wll) =	1.50	kPa * Ψa *	3300	mm +		kN/m =	4.95	kN/m
Partitions (wll) =	0.25	kPa *	4500	mm +		kN/m =	1.13	kN/m
Alternate point live load =	1.80	kN	Distr. to	1	members	Σwll =	6.08	kN/m

Point loads

Dead load (pdl) =	7.1	kN	Position =	1700	mm from LHS
Live load (pll) =	5.0	kN	Support =	N	(N)es,(N)o

	DL	LL	
RL1	1.8	1.5	: L|L
RL1	5.3	3.5	: R|R
Σ	7.1	5.0	

Short term LL factor (Ψsu) =	0		(Ψsp) =	1.00	
w* = 1.2*wdl + 1.5*wll =	15.35	kN/m	M* =	70.4	kNm (Max at 2372mm)
p* = 1.2*pdl + 1.5*pll =	16.01	kN	V* =	52.4	kN

Capacity

Description =	300x90PFC (G300)		Warping constant (Iw) =	58.1	x10⁹ mm⁶
Flange yield (fyf) =	300	MPa	Torsional constant (J) =	304	x10³ mm⁴
Web yield (fyw) =	320	MPa	Effective section mod. (Zex) =	564	x10³ mm³
Area (Ag) =	5110	mm²	Effective section mod. (Zey) =	82.3	x10³ mm³
Stiffness (Ix) =	72.4	x10⁶ mm⁴	Elastic modulus (E) =	200000	MPa - Cl 1.4
Stiffness (Iy) =	4.04	x10⁶ mm⁴	Shear modulus (G) =	80000	MPa - Cl 1.4
ø =	0.9	Table 3.4			
Msx = min(fyf,fyw)*Zex =	169.2	kNm - Cl 5.2.1	øMsx =	152.3	kNm
				øMsy =	22.2 kNm - Cl 5.2.1
Positive: Moa.p =	4823.0	kNm	αs.t = 1.000	αm.t = 1.00	øMbx.p = 152.3 kNm
Negative: Moa.n =	N.A.				

Deflections (δ ±2.5% with off-centre PL)

Ireq'd DL (L/360) =	25.6	x10⁶ mm⁴	δDL =	5.3 mm	Span / 1020
Ireq'd Ψs.LL (L/360) =	20.2	x10⁶ mm⁴	Ψs.δLL =	4.2 mm	Span / 1292
Ireq'd (DL+Ψs.LL) (L/250) =	31.8	x10⁶ mm⁴ < Critical	δTotal =	9.5 mm	Span / 570

Max. precamber (0.3%*span) =	16 mm	Min. precamber =	15 mm
Precamber 80% of δDL =	4 mm	Adopted precamber =	0 mm
		1kN midspan δ =	0.2 mm

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

3B6

STEEL FLOOR BEAM V5.06

Xstruct

Member:	**(3B6) 250UC72.9 (G300)**	
Bending:	**M*(max) = 110.9kNm < øMb(6000,αm=1.30) = 238.9kNm**	**OK (0.46)**
	(Single span)	
Shear:	**V.max*=48.7kN < øVvm = 377.5kN (Web area full depth)**	**OK (0.13)**
Deflection:	**δDL = L/907 (7mm), δΨs.LL = L/1257 (5mm), δTotal = L/527 (11mm), 1kN mid. δ = 0.2mm**	**OK**
Precamber:	**Not required**	
Reactions:	**(1 End) Rdl.max = 21.5kN, Rll.max = 15.3kN, R.max* = 48.7kN**	
	(1 End) Rdl.min = 20.9kN, Rll.min = 14.6kN, R.min* = 46.9kN	

Geometry

Span (L) = 6000 mm
Centres (cts) = 450 mm
Eff. Len. (Le) = 6000 mm
αm.t = 1.30

Design at = M mm from LHS, (M)ax, (S)eg
Span type = S (S)ingle,(D)ouble
Effective length (Le) = 6000 mm
αm = 1.30

Loadings

Floor area = 2.7 m²
Apply reduction = N (Y)es,(N)o
Floor reduction (Ψa) = 1.00 AS/NZS 1170.1 - Cl 3.4.2
Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	450	mm +		kN/m =	0.23 kN/m
Wall dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35 kN/m
Other dead load (wdl) =	0.40	kPa *	4000	mm +		kN/m =	1.60 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.73 kN/m
						Σwdl =	3.91 kN/m

Uniform live loads

Floor live load (wll) =	1.50	kPa * Ψa *	450	mm +		kN/m =	0.68 kN/m
Partitions (wll) =	0.25	kPa *	4000	mm +		kN/m =	1.00 kN/m
Alternate point live load =	1.80	kN	Distr. to	1	members	Σwll =	1.68 kN/m

Point loads

Dead load (pdl) = 18.9 kN
Live load (pll) = 19.8 kN
Position = 2900 mm from LHS
Shear using PL at support = N (Y)es,(N)o

	DL	LL	
3B5	18.9	19.8	: M|M
Σ	18.9	19.8	

Short term LL factor (Ψsu) = [illegible] (Ψsp) = 1.00
w* = 1.2*wdl + 1.5*wll = [illegible] kN/m
p* = 1.2*pdl + 1.5*pll = 52.43 kN
M* = 110.9 kNm (Max at 2900mm)
V* = 48.7 kN

Capacity

Description = 250UC72.9 (G300)
Flange yield (fyf) = 300 MPa
Web yield (fyw) = 320 MPa
Area (Ag) = 9320 mm²
Stiffness (Ix) = 114.0 x10⁶ mm⁴
Stiffness (Iy) = 38.80 x10⁶ mm⁴
ø = 0.9 Table 3.4
Msx = min(fyf,fyw)*Zex = 295.8 kNm - Cl 5.2.1
Positive: Moa.p = 405.8 kNm
Negative: Moa.n = N.A.

Warping constant (Iw) = 557 x10⁹ mm⁶
Torsional constant (J) = 586 x10³ mm⁴
Effective section mod. (Zex) = 986 x10³ mm³
Effective section mod. (Zey) = 454 x10³ mm³
Elastic modulus (E) = 200000 MPa - Cl 1.4
Shear modulus (G) = 80000 MPa - Cl 1.4

αs.t = 0.690
øMsx = 266.2 kNm
αm.t = 1.30
øMsy = 122.6 kNm - Cl 5.2.1
øMbx.p = 238.9 kNm

Deflections (δ ±2.5% with off-centre PL)

Ireq'd DL (L/360) =	45.3 x10⁶ mm⁴		δDL =	6.6 mm	Span / 907
Ireq'd Ψs.LL (L/360) =	32.7 x10⁶ mm⁴		Ψs.δLL =	4.8 mm	Span / 1257
Ireq'd (DL+Ψs.LL) (L/250) =	54.1 x10⁶ mm⁴	< Critical	δTotal =	11.4 mm	Span / 527

Max. precamber (0.3%*span) = 18 mm
Precamber 80% of δDL = 5 mm
Min. precamber = 15 mm
Adopted precamber = 0 mm

1kN midspan δ = 0.2 mm

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

3B7

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(3B7) 2 / 120mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 0.89kNm (+ve) < øM(dl) = 5.74kNm, M* = 1.16kNm (+ve) < øM = 8.29kNm**	**OK (0.16,0.14)**
Shear:	**V(dl)* = 3.56kN < øV(dl) = 15.28kN, V* = 4.64kN < øV = 21.45kN**	**OK (0.23,0.22)**
Deflection:	**δDL = L/1432 (1mm) , δΨs.LL = L/4935 (0mm), δTotal = L/1110 (1mm), 1kN mid. δ = 0.1mm**	**OK**
Reactions:	**(Each end) Rdl = 1.62kN, Rll = 1.80kN, R* = 4.64kN**	

Geometry

(House member affecting ≤ 25m² or secondary building member)

Category =	1	(1) House, (2) Primary building elements, (3) Important			
House =	N	(Y)es,(N)o	Edge restrained =	C	(T)ension, (C)ompression, (B)oth
Span (L) =	1000	mm	Lay.t (Top) =	1000	mm
Centres (cts) =	450	mm			
Span type =	S	(S)ingle,(D)ouble			

Loadings

Floor area (A) =	0.45	m²	Live load type =	N	(N)ormal, (S)torage, (M)anual
					AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	450	mm +		kN/m =	0.23 kN/m
Wall dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35 kN/m
Other dead load (wdl) =	0.40	kPa *	4000	mm +		kN/m =	1.60 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.06 kN/m
						Σwdl =	3.24 kN/m

Uniform live loads

Floor live load (wll) =	1.50	kPa *	450	mm +		kN/m =	0.68 kN/m
Partitions (wll) =	0.25	kPa *	4000	mm +		kN/m =	1.00 kN/m
Alternate point live load =	1.80	kN (critical)	Distr. to	1	members	Σwll =	3.60 kN/m

Point loads

Dead load (pdl) =		kN	Position =	500	mm from LHS
Live load (pll) =		kN	Shear using PL at support =	N	(Y)es,(N)o

Short term LL factor (Ψsu) =	0.70		(Ψsp) =	1.00	
Long term LL factor (Ψlu) =	0.40		(Ψlp) =	0.60	
wdl* = 1.2*wdl+1.5*Ψlu*wll =	7.12	kN/m	M(dl+Ψl.ll)* =	0.89	kNm (Max at 500mm)
w* = 1.2*wdl+1.5*wll =	9.28	kN/m	M* =	1.16	kNm (Max at 500mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	0.00	kN	V(dl+Ψl.ll)* =	3.56	kN
p* = 1.2*pdl+1.5*pll =	0.00	kN	V* =	4.64	kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	2 / 120mm x 42mm Smart LVL15		Area (A) =	10080	mm²
Description =	LVL15 seasoned softwood		Section modulus (Zx) =	202	x10³ mm³
Design depth (dD) =	120	mm	Stiffness (Ix) =	12.1	x10⁶ mm⁴
Design width (dW) =	42	mm	Modulus of elasticity (E) =	15300	MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 =	10.31	For top comp. edge restrained - Cl 3.2.3.2(a)			
k12d = 1.5-0.05*ρbd*S1 =	0.943	for 10 ≤ ρbd*S1 ≤ 20 - Cl 3.2.4	f'b =	55.7	MPa
k12 = 1.5-0.05*ρb*S1 =	0.971	for 10 ≤ ρb*S1 ≤ 20 - Cl 3.2.4	f's =	4.2	MPa
			Material constant (ρbd) =	1.08	(rbd=0.25)
Strength reduction factor (ø) =	0.95	Table 2.1	Material constant (ρb) =	1.03	(rb=0.58)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	5.74	kNm	Duration factor (k1) =	0.80	
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	8.29	kNm	Moisture factor (k4) =	1.00	
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	15.28	kN	Temp. factor (k6) =	1.00	
øV = ø*k1*k4*k6*f's*(2/3*A) =	21.45	kN	Sharing factor (k9) =	1.00	
			Size modifier (mod.b) =	1.00	
			Size modifier (mod.s) =	1.00	

Deflections

			Duration factor (j2) =	2.0	
Ireq'd j2.(DL+Ψl.LL) (L/300) =	2.5 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	0.7 mm	Span / 1432
Ireq'd Ψs.LL (L/300) =	0.7 x10⁶ mm⁴		Ψs.δLL =	0.2 mm	Span / 4935
Ireq'd Total (L/250) =	2.7 x10⁶ mm⁴		δTotal =	0.9 mm	Span / 1110
			1kN midspan δ =	0.1 mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

3B8

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(3B8) 2 / 190mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 3.26kNm (+ve) < øM(dl) = 6.72kNm, M* = 4.26kNm (+ve) < øM = 9.96kNm**	**OK (0.49,0.43)**
Shear:	**V(dl)* = 5.67kN < øV(dl) = 24.20kN, V* = 7.40kN < øV = 33.96kN**	**OK (0.23,0.22)**
Deflection:	**δDL = L/588 (4mm) , δΨs.LL = L/3955 (1mm), δTotal = L/512 (4mm), 1kN mid. δ = 0.3mm**	**OK**
Reactions:	**(Each end) Rdl = 3.76kN, Rll = 1.93kN, R* = 7.40kN**	

Geometry

(House member affecting ≤ 25m² or secondary building member)

Category =	1	(1) House, (2) Primary building elements, (3) Important			
House =	N	(Y)es,(N)o	Edge restrained =	C	(T)ension, (C)ompression, (B)oth
Span (L) =	2300	mm	Lay.t (Top) =	2300	mm
Centres (cts) =	450	mm			
Span type =	S	(S)ingle,(D)ouble			

Loadings

Floor area (A) = 1.04 m²

Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	450	mm +		kN/m =	0.23 kN/m
Wall dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35 kN/m
Other dead load (wdl) =	0.40	kPa *	4000	mm +		kN/m =	1.60 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.10 kN/m
						Σwdl =	3.27 kN/m

Uniform live loads

Floor live load (wll) =	1.50	kPa *	450	mm +		kN/m =	0.68 kN/m
Partitions (wll) =	0.25	kPa *	4000	mm +		kN/m =	1.00 kN/m
Alternate point live load =	1.80	kN	Distr. to	1	members	Σwll =	1.68 kN/m

Point loads

Dead load (pdl) =	kN	Position =	1150 mm from LHS
Live load (pll) =	kN	Shear using PL at support =	N (Y)es,(N)o

Short term LL factor (Ψsu) =	0.70	(Ψsp) =	1.00	
Long term LL factor (Ψlu) =	0.40	(Ψlp) =	0.60	
wdl* = 1.2*wdl+1.5*Ψlu*wll =	4.93 kN/m	M(dl+Ψl.ll)* =	3.26	kNm (Max at 1150mm)
w* = 1.2*wdl+1.5*wll =	6.44 kN/m	M* =	4.26	kNm (Max at 1150mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	0.00 kN	V(dl+Ψl.ll)* =	5.67 kN	
p* = 1.2*pdl+1.5*pll =	0.00 kN	V* =	7.40 kN	

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	2 / 190mm x 42mm Smart LVL15	Area (A) =	15960 mm²
Description =	LVL15 seasoned softwood	Section modulus (Zx) =	505 x10³ mm³
Design depth (dD) =	190 mm	Stiffness (Ix) =	48.0 x10⁶ mm⁴
Design width (dW) =	42 mm	Modulus of elasticity (E) =	15300 MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 = 19.67 For top comp. edge restrained - Cl 3.2.3.2(a)
k12d = 200/(S1*ρbd)² = 0.482 for ρbd*S1 ≥ 20 - Cl 3.2.4
k12 = 1.5-0.05*ρb*S1 = 0.509 for 10 ≤ ρb*S1 ≤ 20 - Cl 3.2.4

			f'b =	50.9	MPa
			f's =	4.2	MPa
			Material constant (ρbd) =	1.04	(rbd=0.25)
Strength reduction factor (ø) =	0.95	Table 2.1	Material constant (ρb) =	1.01	(rb=0.39)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	6.72	kNm	Duration factor (k1) =	0.80	
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	9.96	kNm	Moisture factor (k4) =	1.00	
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	24.20	kN	Temp. factor (k6) =	1.00	
øV = ø*k1*k4*k6*f's*(2/3*A) =	33.96	kN	Sharing factor (k9) =	1.00	
			Size modifier (mod.b) =	1.00	
			Size modifier (mod.s) =	1.00	

Deflections

			Duration factor (j2) =	2.0		
Ireq'd j2.(DL+Ψl.LL) (L/300) =	24.5 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	3.9	mm	Span / 588
Ireq'd Ψs.LL (L/300) =	3.6 x10⁶ mm⁴		Ψs.δLL =	0.6	mm	Span / 3955
Ireq'd Total (L/250) =	23.4 x10⁶ mm⁴		δTotal =	4.5	mm	Span / 512
			1kN midspan δ =	0.3	mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

3B10

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(3B10) 2 / 240mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 8.49kNm (+ve) < øM(dl) = 21.24kNm, M* = 12.02kNm (+ve) < øM = 29.81kNm**	**OK (0.40,0.40)**
Shear:	**V(dl)* = 15.93kN < øV(dl) = 30.57kN, V* = 22.87kN < øV = 42.90kN**	**OK (0.52,0.53)**
Deflection:	**δDL = L/538 (4mm) , δΨs.LL = L/1976 (1mm), δTotal = L/423 (5mm), 1kN mid. δ = 0.1mm**	**OK**
Reactions:	**(1 End) Rdl.max = 8.42kN, Rll.max = 8.51kN, R.max* = 22.87kN**	
	(1 End) Rdl.min = 6.39kN, Rll.min = 7.19kN, R.min* = 18.46kN	
Geometry	(House member affecting ≤ 25m² or secondary building member)	

Category = 1 (1) House, (2) Primary building elements, (3) Important
House = N (Y)es,(N)o
Edge restrained = C (T)ension, (C)ompression, (B)oth
Span (L) = 2100 mm
Lay.t (Top) = 450 mm
Centres (cts) = 3300 mm
Span type = S (S)ingle,(D)ouble

Loadings

Floor area (A) = 6.93 m²
Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50 kPa *	3300 mm +		kN/m =	1.65	kN/m
Wall dead load (wdl) =	0.50 kPa *	2700 mm +		kN/m =	1.35	kN/m
Other dead load (wdl) =	0.40 kPa *	3500 mm +		kN/m =	1.40	kN/m
Include S.Wt =	Y (Y)es,(N)o			S.Wt =	0.12	kN/m
				Σwdl =	4.52	kN/m

Uniform live loads

Floor live load (wll) =	1.50 kPa *	3300 mm +		kN/m =	4.95	kN/m
Partitions (wll) =	0.25 kPa *	3500 mm +		kN/m =	0.88	kN/m
Alternate point live load =	1.80 kN	Distr. to	1 members	Σwll =	5.83	kN/m

Point loads

	DL	LL
RL1	5.3	3.5 : M|M
Σ	5.3	3.5

Dead load (pdl) = 5.32 kN
Live load (pll) = 3.46 kN
Position = 650 mm from LHS
ing PL at support = N (Y)es,(N)o

Short term LL factor (Ψsu) =	0.70	(Ψsp) =	1.00
Long term LL factor (Ψlu) =	0.40	(Ψlp) =	0.60
wdl* = 1.2*wdl+1.5*Ψlu*wll =	8.92 kN/m	M(dl+Ψl.ll)* =	8.49 kNm (Max at 720mm)
w* = 1.2*wdl+1.5*wll =	14.16 kN/m	M* =	12.02 kNm (Max at 797mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	9.50 kN	V(dl+Ψl.ll)* =	15.93 kN
p* = 1.2*pdl+1.5*pll =	11.58 kN	V* =	22.87 kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member = 2 / 240mm x 42mm Smart LVL15
Description = LVL15 seasoned softwood
Design depth (dD) = 240 mm
Design width (dW) = 42 mm
Area (A) = 20160 mm²
Section modulus (Zx) = 806 x10³ mm³
Stiffness (Ix) = 96.8 x10⁶ mm⁴
Modulus of elasticity (E) = 15300 MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 = 9.78 For top comp. edge restrained - Cl 3.2.3.2(a)
k12d = 1.000 for ρbd*S1 ≤ 10 - Cl 3.2.4
k12 = 1.000 for ρb*S1 ≤ 10 - Cl 3.2.4
f'b = 48.6 MPa
f's = 4.2 MPa
Material constant (ρbd) = 1.01 (rbd=0.25)
Strength reduction factor (ø) = 0.95 Table 2.1
Material constant (ρb) = 0.96 (rb=0.59)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx = 21.24 kNm
Duration factor (k1) = 0.80
øM = ø*k1*k4*k6*k9*k12*f'b*Zx = 29.81 kNm
Moisture factor (k4) = 1.00
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) = 30.57 kN
Temp. factor (k6) = 1.00
øV = ø*k1*k4*k6*f's*(2/3*A) = 42.90 kN
Sharing factor (k9) = 1.00
Size modifier (mod.b) = 1.00
Size modifier (mod.s) = 1.00

Deflections

Duration factor (j2) = 2.0

Ireq'd j2.(DL+Ψl.LL) (L/300) =	54.0 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	3.9 mm	Span / 538
Ireq'd Ψs.LL (L/300) =	14.7 x10⁶ mm⁴		Ψs.δLL =	1.1 mm	Span / 1976
Ireq'd Total (L/250) =	57.2 x10⁶ mm⁴		δTotal =	5.0 mm	Span / 423
			1kN midspan δ =	0.1 mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

3B9

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(3B9) 2 / 190mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 2.90kNm (+ve) < øM(dl) = 10.65kNm, M* = 3.72kNm (+ve) < øM = 15.79kNm**	**OK (0.27,0.24)**
Shear:	**V(dl)* = 19.52kN < øV(dl) = 24.20kN, V* = 25.06kN < øV = 33.96kN**	**OK (0.81,0.74)**
Deflection:	**δDL = L/1440 (1mm) , δΨs.LL = L/4973 (0mm), δTotal = L/1117 (1mm), 1kN mid. δ = 0.0mm**	**OK**
Reactions:	**(1 End) Rdl.max = 9.33kN, Rll.max = 9.24kN, R.max* = 25.06kN**	
	(1 End) Rdl.min = 3.02kN, Rll.min = 2.86kN, R.min* = 7.91kN	
Geometry	(House member affecting ≤ 25m² or secondary building member)	

Category = 1 (1) House, (2) Primary building elements, (3) Important
House = N (Y)es,(N)o
Edge restrained = C (T)ension, (C)ompression, (B)oth
Span (L) = 1200 mm
Lay.t (Top) = 1200 mm
Centres (cts) = 450 mm
Span type = S (S)ingle,(D)ouble

Loadings

Floor area (A) = 0.54 m²
Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50 kPa *	450 mm +		kN/m =	0.23	kN/m
Wall dead load (wdl) =	0.50 kPa *	2700 mm +		kN/m =	1.35	kN/m
Other dead load (wdl) =	0.40 kPa *	4000 mm +		kN/m =	1.60	kN/m
Include S.Wt =	Y (Y)es,(N)o			S.Wt =	0.10	kN/m
				Σwdl =	3.27	kN/m

Uniform live loads

Floor live load (wll) =	1.50 kPa *	450 mm +		kN/m =	0.68	kN/m
Partitions (wll) =	0.25 kPa *	4000 mm +		kN/m =	1.00	kN/m
Alternate point live load =	1.80 kN (critical)	Distr. to	1 members	Σwll =	3.00	kN/m

Point loads

Dead load (pdl) = 8.42 kN
Live load (pll) = 8.51 kN
Position = 1050 mm from LHS
Shear using PL at support = N (Y)es,(N)o

	DL	LL	
3B10	8.4	8.5	: L|L
Σ	8.4	8.5	

Short term LL factor (Ψsu) =			1.00	
Long term LL factor (Ψlu) =			0.60	
wdl* = 1.2*wdl+1.5*Ψlu*wll =	[illegible] kN/m	M(dl+Ψl.ll) =	2.90	kNm (Max at 935mm)
w* = 1.2*wdl+1.5*wll =	8.42 kN/m	M* =	3.72	kNm (Max at 939mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	17.76 kN	V(dl+Ψl.ll)* =	19.52	kN
p* = 1.2*pdl+1.5*pll =	22.87 kN	V* =	25.06	kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member = 2 / 190mm x 42mm Smart LVL15
Description = LVL15 seasoned softwood
Design depth (dD) = 190 mm
Design width (dW) = 42 mm
Area (A) = 15960 mm²
Section modulus (Zx) = 505 x10³ mm³
Stiffness (Ix) = 48.0 x10⁶ mm⁴
Modulus of elasticity (E) = 15300 MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 = 14.21 For top comp. edge restrained - Cl 3.2.3.2(a)
k12d = 1.5-0.05*ρbd*S1 = 0.764 for 10 ≤ ρbd*S1 ≤ 20 - Cl 3.2.4
k12 = 1.5-0.05*ρb*S1 = 0.807 for 10 ≤ ρb*S1 ≤ 20 - Cl 3.2.4
f'b = 50.9 MPa
f's = 4.2 MPa
Material constant (ρbd) = 1.04 (rbd=0.25)
Material constant (ρb) = 0.97 (rb=0.67)

Strength reduction factor (ø) =	0.95	Table 2.1	
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	10.65	kNm	
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	15.79	kNm	
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	24.20	kN	
øV = ø*k1*k4*k6*f's*(2/3*A) =	33.96	kN	

Duration factor (k1) = 0.80
Moisture factor (k4) = 1.00
Temp. factor (k6) = 1.00
Sharing factor (k9) = 1.00
Size modifier (mod.b) = 1.00
Size modifier (mod.s) = 1.00

Deflections

Duration factor (j2) = 2.0

Ireq'd j2.(DL+Ψl.LL) (L/300) =	10.0 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	0.8 mm	Span / 1440
Ireq'd Ψs.LL (L/300) =	2.9 x10⁶ mm⁴		Ψs.δLL =	0.2 mm	Span / 4973
Ireq'd Total (L/250) =	10.7 x10⁶ mm⁴		δTotal =	1.1 mm	Span / 1117
			1kN midspan δ =	0.0 mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

3B11

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(3B11) 2 / 190mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 7.88kNm (+ve) < øM(dl) = 13.94kNm, M* = 10.93kNm (+ve) < øM = 19.56kNm**	**OK (0.57,0.56)**
Shear:	**V(dl)* = 12.75kN < øV(dl) = 24.20kN, V* = 18.51kN < øV = 33.96kN**	**OK (0.53,0.54)**
Deflection:	**δDL = L/361 (5mm) , δΨs.LL = L/1352 (1mm), δTotal = L/285 (6mm), 1kN mid. δ = 0.2mm**	**OK**
Reactions:	**(Each end) Rdl = 6.71kN, Rll = 6.97kN, R* = 18.51kN**	

Geometry

(House member affecting ≤ 25m² or secondary building member)

Category =	1	(1) House, (2) Primary building elements, (3) Important			
House =	N	(Y)es,(N)o	Edge restrained =	C	(T)ension, (C)ompression, (B)oth
Span (L) =	1800	mm	Lay.t (Top) =	450	mm
Centres (cts) =	3300	mm			
Span type =	S	(S)ingle,(D)ouble			

Loadings

Floor area (A) = 5.94 m²

Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	3300	mm +		kN/m =	1.65 kN/m
Wall dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35 kN/m
Other dead load (wdl) =	0.40	kPa *	3500	mm +		kN/m =	1.40 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.10 kN/m
						Σwdl =	4.50 kN/m

Uniform live loads

Floor live load (wll) =	1.50	kPa *	3300	mm +		kN/m =	4.95 kN/m
Partitions (wll) =	0.25	kPa *	3500	mm +		kN/m =	0.88 kN/m
Alternate point live load =	1.80	kN	Distr. to	1	members	Σwll =	5.83 kN/m

Point loads

Dead load (pdl) =	5.32	kN	RL1	DL 5.3	LL 3.5 : M|M	Position =	900 mm from LHS
Live load (pll) =	3.46	kN	Σ	5.3	3.5	ing PL at support =	N (Y)es,(N)o

Short term LL factor (Ψsu) =	0.70		(Ψsp) =	1.00	
Long term LL factor (Ψlu) =	0.40		(Ψlp) =	0.60	
wdl* = 1.2*wdl+1.5*Ψlu*wll =	8.89	kN/m	M(dl+Ψl.ll)* =	7.88	kNm (Max at 900mm)
w* = 1.2*wdl+1.5*wll =	14.13	kN/m	M* =	10.93	kNm (Max at 900mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	9.50	kN	V(dl+Ψl.ll)* =	12.75	kN
p* = 1.2*pdl+1.5*pll =	11.58	kN	V* =	18.51	kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	2 / 190mm x 42mm Smart LVL15		Area (A) =	15960	mm²
Description =	LVL15 seasoned softwood		Section modulus (Zx) =	505	x10³ mm³
Design depth (dD) =	190	mm	Stiffness (Ix) =	48.0	x10⁶ mm⁴
Design width (dW) =	42	mm	Modulus of elasticity (E) =	15300	MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 = 8.70 For top comp. edge restrained - Cl 3.2.3.2(a)

k12d =	1.000	for ρbd*S1 ≤ 10 - Cl 3.2.4	f'b =	50.9	MPa
k12 =	1.000	for ρb*S1 ≤ 10 - Cl 3.2.4	f's =	4.2	MPa
			Material constant (ρbd) =	1.04	(rbd=0.25)
Strength reduction factor (ø) =	0.95	Table 2.1	Material constant (ρb) =	0.99	(rb=0.54)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	13.94	kNm	Duration factor (k1) =	0.80	
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	19.56	kNm	Moisture factor (k4) =	1.00	
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	24.20	kN	Temp. factor (k6) =	1.00	
øV = ø*k1*k4*k6*f's*(2/3*A) =	33.96	kN	Sharing factor (k9) =	1.00	
			Size modifier (mod.b) =	1.00	
			Size modifier (mod.s) =	1.00	

Deflections

			Duration factor (j2) =	2.0	
Ireq'd j2.(DL+Ψl.LL) (L/300) =	39.9 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	5.0 mm	Span / 361
Ireq'd Ψs.LL (L/300) =	10.7 x10⁶ mm⁴		Ψs.δLL =	1.3 mm	Span / 1352
Ireq'd Total (L/250) =	42.1 x10⁶ mm⁴		δTotal =	6.3 mm	Span / 285
			1kN midspan δ =	0.2 mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

3B13

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(3B13) 120mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 0.63kNm (+ve) < øM(dl) = 3.04kNm, M* = 0.93kNm (+ve) < øM = 4.27kNm**	**OK (0.21,0.22)**
Shear:	**V(dl)* = 2.30kN < øV(dl) = 7.64kN, V* = 3.38kN < øV = 10.73kN**	**OK (0.30,0.32)**
Deflection:	**δDL = L/1026 (1mm) , δΨs.LL = L/2039 (1mm), δTotal = L/683 (2mm), 1kN mid. δ = 0.3mm**	**OK**
Reactions:	**(Each end) Rdl = 0.57kN, Rll = 1.80kN, R* = 3.38kN**	

Geometry

(House member affecting ≤ 25m² or secondary building member)

Category =	1	(1) House, (2) Primary building elements, (3) Important			
House =	N	(Y)es,(N)o	Edge restrained =	C	(T)ension, (C)ompression, (B)oth
Span (L) =	1100	mm	Lay.t (Top) =	450	mm
Centres (cts) =	2000	mm			
Span type =	S	(S)ingle,(D)ouble			

Loadings

Floor area (A) =	2.20	m²	Live load type =	N	(N)ormal, (S)torage, (M)anual
					AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	2000	mm +		kN/m =	1.00 kN/m
Wall dead load (wdl) =		kPa *	2000	mm +		kN/m =	0.00 kN/m
Other dead load (wdl) =		kPa *		mm +		kN/m =	0.00 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.03 kN/m
						Σwdl =	1.03 kN/m

Uniform live loads

Floor live load (wll) =	1.50	kPa *	2000	mm +		kN/m =	3.00 kN/m
Partitions (wll) =		kPa *	2000	mm +		kN/m =	0.00 kN/m
Alternate point live load =	1.80	kN (critical)	Distr. to	1	members	Σwll =	3.27 kN/m

Point loads

Dead load (pdl) =		kN	Position =	550	mm from LHS
Live load (pll) =		kN	Shear using PL at support =	N	(Y)es,(N)o

Short term LL factor (Ψsu) =	0.70		(Ψsp) =	1.00	
Long term LL factor (Ψlu) =	0.40		(Ψlp) =	0.60	
wdl* = 1.2*wdl+1.5*Ψlu*wll =	4.18	kN/m	M(dl+Ψl.ll)* =	0.63	kNm (Max at 550mm)
w* = 1.2*wdl+1.5*wll =	6.15	kN/m	M* =	0.93	kNm (Max at 550mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	0.00	kN	V(dl+Ψl.ll)* =	2.30	kN
p* = 1.2*pdl+1.5*pll =	0.00	kN	V* =	3.38	kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	120mm x 42mm Smart LVL15		Area (A) =	5040	mm²
Description =	LVL15 seasoned softwood		Section modulus (Zx) =	101	x10³ mm³
Design depth (dD) =	120	mm	Stiffness (Ix) =	6.0	x10⁶ mm⁴
Design width (dW) =	42	mm	Modulus of elasticity (E) =	15300	MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 =	6.92	For top comp. edge restrained - Cl 3.2.3.2(a)			
k12d =	1.000	for ρbd*S1 ≤ 10 - Cl 3.2.4	f'b =	55.7	MPa
k12 =	1.000	for ρb*S1 ≤ 10 - Cl 3.2.4	f's =	4.2	MPa
			Material constant (ρbd) =	1.08	(rbd=0.25)
Strength reduction factor (ø) =	0.95	Table 2.1	Material constant (ρb) =	1.01	(rb=0.80)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	3.04	kNm	Duration factor (k1) =	0.80	
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	4.27	kNm	Moisture factor (k4) =	1.00	
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	7.64	kN	Temp. factor (k6) =	1.00	
øV = ø*k1*k4*k6*f's*(2/3*A) =	10.73	kN	Sharing factor (k9) =	1.00	
			Size modifier (mod.b) =	1.00	
			Size modifier (mod.s) =	1.00	

Deflections

			Duration factor (j2) =	2.0		
Ireq'd j2.(DL+Ψl.LL) (L/300) =	1.8 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	1.1	mm	Span / 1026
Ireq'd Ψs.LL (L/300) =	0.9 x10⁶ mm⁴		Ψs.δLL =	0.5	mm	Span / 2039
Ireq'd Total (L/250) =	2.2 x10⁶ mm⁴		δTotal =	1.6	mm	Span / 683
			1kN midspan δ =	0.3	mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

3B12

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(3B12) 2 / 120mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 0.83kNm (+ve) < øM(dl) = 5.74kNm, M* = 1.12kNm (+ve) < øM = 8.35kNm**	**OK (0.14,0.13)**
Shear:	**V(dl)* = 5.25kN < øV(dl) = 15.28kN, V* = 7.36kN < øV = 21.45kN**	**OK (0.34,0.34)**
Deflection:	**δDL = L/1568 (1mm) , δΨs.LL = L/4293 (0mm), δTotal = L/1149 (1mm), 1kN mid. δ = 0.1mm**	**OK**
Reactions:	**(1 End) Rdl.max = 1.74kN, Rll.max = 3.51kN, R.max* = 7.36kN**	
	(1 End) Rdl.min = 1.23kN, Rll.min = 1.89kN, R.min* = 4.32kN	
Geometry	(House member affecting ≤ 25m² or secondary building member)	

Category = 1 (1) House, (2) Primary building elements, (3) Important
House = N (Y)es,(N)o
Edge restrained = C (T)ension, (C)ompression, (B)oth
Span (L) = 1000 mm
Lay.t (Top) = 1000 mm
Centres (cts) = 2000 mm
Span type = S (S)ingle,(D)ouble

Loadings

Floor area (A) = 2.00 m²
Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50 kPa *	2000 mm +		kN/m =	1.00	kN/m
Wall dead load (wdl) =	0.50 kPa *	2700 mm +		kN/m =	1.35	kN/m
Other dead load (wdl) =	kPa *	mm +		kN/m =	0.00	kN/m
Include S.Wt =	Y (Y)es,(N)o			S.Wt =	0.06	kN/m
				Σwdl =	2.41	kN/m

Uniform live loads

Floor live load (wll) =	1.50 kPa *	2000 mm +		kN/m =	3.00	kN/m
Partitions (wll) =	kPa *	2000 mm +		kN/m =	0.00	kN/m
Alternate point live load =	1.80 kN (critical)	Distr. to	1 members	Σwll =	3.60	kN/m

Point loads

Dead load (pdl) = 0.57 kN
Live load (pll) = 1.80 kN

	DL	LL	
3B13	0.6	1.8	: L|L
Σ	0.6	1.8	

Position = 50 mm from LHS
ing PL at support = N (Y)es,(N)o

Short term LL factor (Ψsu) =	0.70	(Ψsp) =	1.00
Long term LL factor (Ψlu) =	0.40	(Ψlp) =	0.60
wdl* = 1.2*wdl+1.5*Ψlu*wll =	6.13 kN/m	M(dl+Ψl.ll)* =	0.83 kNm (Max at 481mm)
w* = 1.2*wdl+1.5*wll =	8.29 kN/m	M* =	1.12 kNm (Max at 480mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	2.30 kN	V(dl+Ψl.ll)* =	5.25 kN
p* = 1.2*pdl+1.5*pll =	3.38 kN	V* =	7.36 kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member = 2 / 120mm x 42mm Smart LVL15
Description = LVL15 seasoned softwood
Design depth (dD) = 120 mm
Design width (dW) = 42 mm
Area (A) = 10080 mm²
Section modulus (Zx) = 202 x10³ mm³
Stiffness (Ix) = 12.1 x10⁶ mm⁴
Modulus of elasticity (E) = 15300 MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 = 10.31 For top comp. edge restrained - Cl 3.2.3.2(a)
k12d = 1.5-0.05*ρbd*S1 = 0.943 for 10 ≤ ρbd*S1 ≤ 20 - Cl 3.2.4
k12 = 1.5-0.05*ρb*S1 = 0.977 for 10 ≤ ρb*S1 ≤ 20 - Cl 3.2.4
f'b = 55.7 MPa
f's = 4.2 MPa
Material constant (ρbd) = 1.08 (rbd=0.25)
Material constant (ρb) = 1.01 (rb=0.72)

Strength reduction factor (ø) =	0.95 Table 2.1	Duration factor (k1) =	0.80
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	5.74 kNm	Moisture factor (k4) =	1.00
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	8.35 kNm	Temp. factor (k6) =	1.00
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	15.28 kN	Sharing factor (k9) =	1.00
øV = ø*k1*k4*k6*f's*(2/3*A) =	21.45 kN	Size modifier (mod.b) =	1.00
		Size modifier (mod.s) =	1.00

Deflections

Duration factor (j2) = 2.0

Ireq'd j2.(DL+Ψl.LL) (L/300) =	2.3 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	0.6 mm	Span / 1568
Ireq'd Ψs.LL (L/300) =	0.8 x10⁶ mm⁴		Ψs.δLL =	0.2 mm	Span / 4293
Ireq'd Total (L/250) =	2.6 x10⁶ mm⁴		δTotal =	0.9 mm	Span / 1149
			1kN midspan δ =	0.1 mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

3B14

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(3B14) 2 / 300mm x 58mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 12.29kNm (+ve) < øM(dl) = 43.85kNm, M* = 19.42kNm (+ve) < øM = 61.55kNm**	**OK (0.28,0.32)**
Shear:	**V(dl)* = 14.89kN < øV(dl) = 52.76kN, V* = 23.54kN < øV = 74.05kN**	**OK (0.28,0.32)**
Deflection:	**δDL = L/615 (5mm) , δΨs.LL = L/2093 (2mm), δTotal = L/475 (7mm), 1kN mid. δ = 0.2mm**	**OK**
Reactions:	**(Each end) Rdl = 7.60kN, Rll = 9.61kN, R* = 23.54kN**	

Geometry

(House member affecting ≤ 25m² or secondary building member)

Category =	1	(1) House, (2) Primary building elements, (3) Important			
House =	N	(Y)es,(N)o	Edge restrained =	C	(T)ension, (C)ompression, (B)oth
Span (L) =	3300	mm	Lay.t (Top) =	450	mm
Centres (cts) =	3300	mm			
Span type =	S	(S)ingle,(D)ouble			

Loadings

Floor area (A) = 10.89 m²

Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	3300	mm +		kN/m =	1.65 kN/m
Wall dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35 kN/m
Other dead load (wdl) =	0.40	kPa *	3500	mm +		kN/m =	1.40 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.21 kN/m
						Σwdl =	4.61 kN/m

Uniform live loads

Floor live load (wll) =	1.50	kPa *	3300	mm +		kN/m =	4.95 kN/m
Partitions (wll) =	0.25	kPa *	3500	mm +		kN/m =	0.88 kN/m
Alternate point live load =	1.80	kN	Distr. to	1	members	Σwll =	5.83 kN/m

Point loads

Dead load (pdl) =	kN	Position =	900 mm from LHS
Live load (pll) =	kN	Shear using PL at support =	N (Y)es,(N)o

Short term LL factor (Ψsu) =	0.70	(Ψsp) =	1.00
Long term LL factor (Ψlu) =	0.40	(Ψlp) =	0.60
wdl* = 1.2*wdl+1.5*Ψlu*wll =	9.03 kN/m	M(dl+Ψl.ll)* =	12.29 kNm (Max at 1650mm)
w* = 1.2*wdl+1.5*wll =	14.27 kN/m	M* =	19.42 kNm (Max at 1650mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	0.00 kN	V(dl+Ψl.ll)* =	14.89 kN
p* = 1.2*pdl+1.5*pll =	0.00 kN	V* =	23.54 kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	2 / 300mm x 58mm Smart LVL15	Area (A) =	34800 mm²
Description =	LVL15 seasoned softwood	Section modulus (Zx) =	1740 x10³ mm³
Design depth (dD) =	300 mm	Stiffness (Ix) =	261.0 x10⁶ mm⁴
Design width (dW) =	58 mm	Modulus of elasticity (E) =	15300 MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 = 7.92 For top comp. edge restrained - Cl 3.2.3.2(a)

k12d =	1.000	for ρbd*S1 ≤ 10 - Cl 3.2.4	f'b =	46.5	MPa
k12 =	1.000	for ρb*S1 ≤ 10 - Cl 3.2.4	f's =	4.2	MPa
			Material constant (ρbd) =	0.99	(rbd=0.25)
Strength reduction factor (ø) =	0.95	Table 2.1	Material constant (ρb) =	0.94	(rb=0.61)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	43.85	kNm	Duration factor (k1) =	0.80	
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	61.55	kNm	Moisture factor (k4) =	1.00	
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	52.76	kN	Temp. factor (k6) =	1.00	
øV = ø*k1*k4*k6*f's*(2/3*A) =	74.05	kN	Sharing factor (k9) =	1.00	
			Size modifier (mod.b) =	1.00	
			Size modifier (mod.s) =	1.00	

Deflections

			Duration factor (j2) =	2.0	
Ireq'd j2.(DL+Ψl.LL) (L/300) =	127.3 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	5.4 mm	Span / 615
Ireq'd Ψs.LL (L/300) =	37.4 x10⁶ mm⁴		Ψs.δLL =	1.6 mm	Span / 2093
Ireq'd Total (L/250) =	137.3 x10⁶ mm⁴		δTotal =	6.9 mm	Span / 475
			1kN midspan δ =	0.2 mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

GL3

PFC & ANGLE V5.06

Xstruct

Geometry: (GL3) 230x75PFC (G300) + 150x90(v)x10UA (flush bottom)
Design: M* = 24.1kNm < øMb(2500,αm=1.13) = 94.7kNm — **OK (0.25)**
Deflection: δDL = L/857 (6mm), δΨs.LL = L/12427 (0mm), δTotal = L/802 (6mm), 1kN mid. δ = 0.3mm — **OK**
Reactions: (Each End) Rdl = 14.3kN, Rll = 1.4kN, R* = 19.3kN

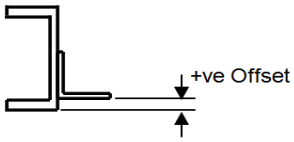
Geometry

Warning - Torsional rotation to be verified (not considered)

Span (L) = 5000 mm
Effective length (Le) = 2500 mm - Cl 5.6.3
αm = 1.13
Design at = M mm from LHS, (M)ax, (S)eg

Effective length (Le) = 2500 mm
αm = 1.13

PFC = 230x75PFC (G300)
Angle = 150x90(v)x10UA
Long leg vertical = N (Y)es,(N)o
Offset from bottom = 0 mm (flush bottom)



Loading

Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Roof dead load (wdl) =	0.40	kPa *	1700	mm +		kN/m =	0.68	kN/m
Floor dead load (wdl) =		kPa *		mm +		kN/m =	0.00	kN/m
Wall dead load (wdl) =		kPa *		mm +		kN/m =	0.00	kN/m
Other dead load (wdl) =	2.10	kPa *	2200	mm +		kN/m =	4.62	kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.42	kN/m
						Σwdl =	5.72	kN/m

Uniform live loads

Roof live load (wll) =	0.33	kPa *	1700	mm +		kN/m =	0.56	kN/m
Floor live load (wll) =	1.50	kPa *	0	mm +		kN/m =	0.00	kN/m
Other live load (wll) =		kPa *		mm +		kN/m =	0.00	kN/m
						Σwll =	0.56	kN/m

Point loads

Dead load (pdl) = kN
Live load (pll) = kN
Position = 2500 mm from LHS

Short term LL factor (Ψsu) = 0.70
(Ψsp) = 1.00

w* = 1.35*wdl = 7.73 kNm
p* = 1.2*pdl + 1.5*pll = 0.00 kNm
Max M* at = 2500 mm
M* = 24.1 kNm

Rdl = 14.3 kN
Rll = 1.4 kN
R* = 19.3 kN

Properties - Combined

Area (Ag) =	5400 mm²	Warping constant (Iw) =	0.0 mm⁶ (App. H4)
Yield (fyc=min(fyf,fyw,afy)) =	300 MPa	Torsional constant (J) =	181.0 x10³ mm⁴
Stiffness (Ix) =	39.9 x10⁶ mm⁴	Elastic modulus (Zt) =	259.9 x10³ mm³
Stiffness (Iy) =	13.73 x10⁶ mm⁴	Elastic modulus (Zb) =	522.7 x10³ mm³
Elastic (y.top) =	153.6 mm	Min. elastic modulus (Zmin) =	259.9 x10³ mm³
Elastic (x.left) =	82.0 mm	Plastic modulus (S) =	490.9 x10³ mm³
Plastic (yp.top) =	198.6 mm	Effective modulus (Zex) =	389.9 x10³ mm³
Elastic modulus (E) =	200000 MPa - Cl 1.4		
Shear modulus (G) =	80000 MPa - Cl 1.4	ø =	0.9 Table 3.4

Capacity - Cl 5.6.1.1

Msx = fyc*Zex = 117.0 kNm - Cl 5.2.1
øMsx = 105.3 kNm
Moa = 250.6 kNm
αs = 0.796
αm = 1.13
øMbx = αm*αs*øMsx ≤ øMsx = 94.7 kNm

Deflections

Ireq'd DL (10mm max) =	23.3 x10⁶ mm⁴		δDL =	5.8 mm	Span / 857
Ireq'd Ψs.LL (10mm max) =	1.6 x10⁶ mm⁴	< Critical	Ψs.δLL =	0.4 mm	Span / 12427
Ireq'd (DL+Ψs.LL) (10mm max) =	24.9 x10⁶ mm⁴	< Critical	δTotal =	6.2 mm	Span / 802
			1kN midspan δ =	0.3 mm	

Wall:	**(RW1 500) 600mm high, 5.0kPa surcharge (Drained)**	
Loads:	**Surcharge = 5.00kPa, Drained**	
Steel Upright:	**100UC14.8 (G300) (Galv.)**	
	M* = 1.21kNm < øM = 21.43kNm, V* = 4.92kN < øVvm = 83.81kN	**OK (0.06,0.06)**
	δ(dl)=ht/12597 (0.0mm), δ(dl+Ψl.ll)=ht/5341 (0.1mm)	**OK**
Timber Upright:	**Not Applicable**	

Footing:	**M*o = 6.77kNm < øMr = 7.08kNm**	**OK (0.96)**
Sleepers:	**75mm x 200mm F7 KD Pine** (Weak) (Single layer sleepers)**	
	M(dl)* = 0.34kNm < øM(dl) = 1.35kNm, M* = 0.33kNm < øM = 1.35kNm	**OK (0.25,0.25)**
	Critical sleeper layer is 3 from top of sleeper wall bending about weak axis	
	δ(dl)=L/845 (1.4mm) on layer 3, δ(dl+Ψl.ll)=L/589 (2.0mm) on layer 3	**OK**

Geometry

Pier depth/diameter ratio = 3.6

Wall assumed fully drained

Geometry Retaining height must be a multiple of the sleeper vertical dimension (600mm)

Retaining height (ht) =	600	mm
Post centres (cts) =	1200	mm
Upright =	S	(T)imber,(S)teel,(B)oth
Concrete sleepers =	N	(Y)es,(N)o
Risk class =	B	(A),(B),(C) - Moderate damage and loss of services - Table 1.1
Backfill type =	1	Class(1), Class(2), (U)ncontrolled, (I)n-situ - Table 5.1(A)

Soil parameters (behind wall)

Internal friction (ø) =	25	° (0° ≤ ø ≤ 45°)
Incline (β) =	0	° (0° ≤ β ≤ 45°) 1 in 0.0
Soil weight (γs) =	23.0	kN/m³
Cohesion (c) =	0	kPa

Footing - Cohesionless

Total footing depth (d) =	1600	mm (From surface)
Ignore top (ig) =	0	mm
Footing diameter (dia) =	450	mm
Soil cohesion (cf) =	0	kPa (0 for cohensionless)
Soil internal friction (øf) =	25	° (0° < ø ≤ 45°)
Design cf*=cf*Φuc(=0.7) =	0.0	kPa insitu material
Design øf*=øf*Φuc(=0.85) =	21.3	° insitu material
Soil weight (γsf) =	23.0	kN/m³
Live Load duration =	Permanent	
Long term LL factor (Ψl) =	1.00	AS 1170.0 Table 4.1
Duration factor (k1) =	0.57	

Sleepers Minor axis bending

Sleeper depth (dSD) =	75	mm (Horz. dimension)
Sleeper width (dSW) =	200	mm (Vert. dimension)
Max number of layers =	3	(600mm high)

Design loads - Appendix J & Section 4 - AS4678

Min. surcharge =	5.0	kPa - Table 4.1
Water height (hw) =	0.0	mm (Drained)
Surcharge (s) =	5.0	kPa
Dead only factor =	1.35	(1.35)
Earth factor =	1.25	(1.25)
Live load factor =	1.50	(1.50 - 0.0 for stabilising effect)
Stabilising factor =	0.80	AS4678 - Appendix J2

Additional upright overturning

Thrust (Va) =	0.00	kN/upright
Overturning (Ma) =	0.00	kNm/upright
Load factor =	1.50	
Long term LL factor (Ψlo) =	0.40	
Va* =	0.00	kN/upright
Ma* =	0.00	kNm/upright

(Thrust/moment applied at the top of the wall)

Material design factors - Section 5

Φuc =	0.90	c*=c*Φuc =	0.0	kPa	Cl 5.2.1		
Φuo =	0.95	ø* =	23.9	°	Cl 5.2.2	ø* =	0.417 rad

Design factor (Φn) =	1.00	Table 5.2			
Ka =	0.423	(Rankine)	Depth of tension zone =	0	mm
Kp =	2.362	(Rankine)	Acting soil height (ha) =	600	mm

Design moment in upright (about top of footing, per m of wall)

	Pressure	Thrust	Thrust*	Lever arm	Mw	Mw*	Comments
	kPa	kN/m	kN/m	mm	kNm/m	kNm/m	(At wall base)
Soil = Ka*γs*ha =	5.84	1.75	2.19	200	0.35	0.44	Max. pressure at base
Surcharge = Ka*s =	2.12	1.27	1.91	300	0.38	0.57	Uniform pressure dist.
Additional =		0.00	0.00	600	0.00	0.00	
Total =		**3.02**	**4.10**		**0.73**	**1.01**	

Total thrust (Vw) = 3.02 kN/m
Total ult. thrust (Vw*) = 4.10 kN/m
Total ult. thrust (Vw*/Φn) = 4.10 kNm/m

Total moment (Mw) = 0.73 kNm/m
Total ult. moment (Mw*) = 1.01 kNm/m
Total ult. moment (Mw*/Φn) = 1.01 kNm/m
Ultimate factor = 1.38

Sleeper design - AS1720.1 Section 3

Double sleepers at layer = 0 (Single layer sleepers)
Double sleepers laminated = N (Y)es,(N)o
Total layers = 3

Critical layer for design = 3
Critical layer centroid depth = 500
w(dl)*= 1.89 kN/m
M(dl)*/Φn = 0.34 kNm/m

Critical layer for design = 3
Critical layer centroid depth = 500 mm
w*= 1.85 kN/m
M*/Φn = 0.33 kNm/m

Area (A) = 15000 mm²
Section modulus (Zy) = 188 x10³mm³
Stiffness (Iy) = 7.0 x10⁶mm⁴
Modulus of elasticity (E) = 7900 MPa

Description = 75mm x 200mm F7 KD Pine
Design depth (dD) = 75 mm
Design width (dW) = 200 mm

Capacity factor (ø) = 0.7 Table 2.1 - Category 2
Duration factor (k1) = 0.57
Stability factor (k12) = 1.00
f'b = 18.0 MPa

Moisture factor (k4) = 1.00
Temp. factor (k6) = 1.00
Sharing factor (k9) = 1.00
Size modifier (mod.b) = 1.00

øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12*f'b*Z = 1.35 kNm OK (0.25)
øM = ø*k1*k4*k6*k9*k12*f'b*Z = 1.35 kNm OK (0.25)
j2 = 3.00
Deflection horizontal j2*δ(dl) = 1.4 mm span / 845 At layer 3
δ(ll) = 0.6 mm span / 1943 At layer 1
Long term deflection horizontal δ(dl+Ψl.ll) = 2.0 mm span / 589 At layer 3

Steel upright design - AS4100 Section 5

V* = Vw*.*cts/Φn = 4.92 kN
M* = Mw*.*cts/Φn = 1.21 kNm

Capacity factor (ø) = 0.9 Table 3.4
Warping constant (Iw) = 2.3 x10⁹mm⁶
Torsional constant (J) = 34.9 x10³mm⁴
Effective section mod. (Zex) = 74.4 x10³mm³
Effective section mod. (Zey) = 34.4 x10³mm³
Modulus of elasticity (Es) = 200000 MPa - Cl 1.4

Description = 100UC14.8 (G300)
Flange yield (fyf) = 320 MPa
Area (Ag) = 1890 mm²
Stiffness (Ix) = 3.18 x10⁶ mm⁴
Shear modulus (G) = 80000 MPa - Cl 1.4

Msx = 23.8 kNm - Cl 5.2 øMsx = 21.4 kNm OK (0.06)
øVv = øVu = 83.8 kN
øVvm = 83.8 kN øVvm = øVv OK (0.06)

Deflection horizontal at top δ(dl) = 0.0 mm ht / 12597
δ(LL) = 0.1 mm ht / 9271
δ(ll) (other) = 0.0 mm ht / 0
Total δ(ll) = 0.1 mm ht / 9271
Total deflection horizontal δ(dl+Ψl.ll) = 0.1 mm ht / 5341

Timber upright design - AS1720.1 Section 3 (Not Applicable)

Footing design [ASD] - Cohesionless Shear included in footing

Footing geometry			**Upright reactions**		
Total footing depth (d) =	1600	mm	V* =	4.92	kN
Ignore depth (ig) =	0	mm	M* =	1.21	kNm
Design depth (D=d-ig) =	1600	mm			
Rotation depth (rD=D-D*(1-1/√2)) =	1131	mm	**Overturning moment**		
Footing diameter (dia) =	450	mm			
			M*o = M* + V*.* (ig + rD) =	6.77	kNm

Soil parameters (footing)			
Internal friction (ø*) =	0.4	rad	
Ka =	0.47	(Rankine)	
Kp =	2.14	(Rankine)	
øMr = (Kp-Ka)*γsf*dia*D³/10 =	7.1	kNm	OK (0.96)

Horizontal bearing		
Equiv. Kp-Ka = K* = (Kp-Ka)*(Mo*/øMr) =	1.60	
Ult. bearing BP* (hinge) = K* *γ*0.707*D =	41.6	kPa (Horizontal)
Ult. bearing BP* (base) = K* *γ*D =	58.8	kPa (Horizontal)

Wall:	**(RW1 1000) 1000mm high, 5.0kPa surcharge (Drained)**	
Loads:	**Surcharge = 5.00kPa, Drained**	
Steel Upright:	**150UC23.4 (G300) (Galv.)**	
	M* = 2.89kNm < øM = 50.69kNm, V* = 7.41kN < øVvm = 160.22kN	**OK (0.06,0.05)**
	δ(dl)=ht/9703 (0.1mm), δ(dl+Ψl.ll)=ht/5345 (0.2mm)	**OK**
Timber Upright:	**Not Applicable**	

Footing:	**M*o = 13.37kNm < øMr = 13.82kNm**	**OK (0.97)**
Sleepers:	**75mm x 200mm F7 KD Pine** (Weak) (Single layer sleepers)**	
	M(dl)* = 0.24kNm < øM(dl) = 1.35kNm, M* = 0.23kNm < øM = 1.35kNm	**OK (0.17,0.17)**
	Critical sleeper layer is 5 from top of sleeper wall bending about weak axis	
	δ(dl)=L/1584 (0.5mm) on layer 5, δ(dl+Ψl.ll)=L/1276 (0.6mm) on layer 5	**OK**

Geometry

Pier depth/diameter ratio = 4.4

Wall assumed fully drained

Geometry Retaining height must be a multiple of the sleeper vertical dimension (1000mm)

Retaining height (ht) =	1000	mm
Post centres (cts) =	800	mm
Upright =	S	(T)imber,(S)teel,(B)oth
Concrete sleepers =	N	(Y)es,(N)o
Risk class =	B	(A),(B),(C) - Moderate damage and loss of services - Table 1.1
Backfill type =	1	Class(1), Class(2), (U)ncontrolled, (I)n-situ - Table 5.1(A)

Soil parameters (behind wall)

Internal friction (ø) =	25	° (0° ≤ ø ≤ 45°)
Incline (β) =	0	° (0° ≤ β ≤ 45°) 1 in 0.0
Soil weight (γs) =	23.0	kN/m³
Cohesion (c) =	0	kPa

Footing - Cohesionless

Total footing depth (d) =	2000	mm (From surface)
Ignore top (ig) =	0	mm
Footing diameter (dia) =	450	mm
Soil cohesion (cf) =	0	kPa (0 for cohensionless)
Soil internal friction (øf) =	25	° (0° < ø ≤ 45°)
Design cf*=cf*Φuc(=0.7) =	0.0	kPa insitu material
Design øf*=øf*Φuc(=0.85) =	21.3	° insitu material
Soil weight (γsf) =	23.0	kN/m³
Live Load duration =	Permanent	
Long term LL factor (Ψl) =	1.00	AS 1170.0 Table 4.1
Duration factor (k1) =	0.57	

Sleepers Minor axis bending

Sleeper depth (dSD) =	75	mm (Horz. dimension)
Sleeper width (dSW) =	200	mm (Vert. dimension)
Max number of layers =	5	(1000mm high)

Design loads - Appendix J & Section 4 - AS4678

Min. surcharge =	5.0	kPa - Table 4.1
Water height (hw) =	0.0	mm (Drained)
Surcharge (s) =	5.0	kPa
Dead only factor =	1.35	(1.35)
Earth factor =	1.25	(1.25)
Live load factor =	1.50	(1.50 - 0.0 for stabilising effect)
Stabilising factor =	0.80	AS4678 - Appendix J2

Additional upright overturning

Thrust (Va) =	0.00	kN/upright
Overturning (Ma) =	0.00	kNm/upright
Load factor =	1.50	
Long term LL factor (Ψlo) =	0.40	
Va* =	0.00	kN/upright
Ma* =	0.00	kNm/upright

(Thrust/moment applied at the top of the wall)

Material design factors - Section 5

Φuc =	0.90	c*=c*Φuc =	0.0	kPa	Cl 5.2.1		
Φuo =	0.95	ø* =	23.9	°	Cl 5.2.2	ø* =	0.417 rad

Design factor (Φn) =	1.00	Table 5.2			
Ka =	0.423	(Rankine)	Depth of tension zone =	0	mm
Kp =	2.362	(Rankine)	Acting soil height (ha) =	1000	mm

Design moment in upright (about top of footing, per m of wall)

	Pressure	Thrust	Thrust*	Lever arm	Mw	Mw*	Comments
	kPa	kN/m	kN/m	mm	kNm/m	kNm/m	(At wall base)
Soil = Ka*γs*ha =	9.74	4.87	6.09	333	1.62	2.03	Max. pressure at base
Surcharge = Ka*s =	2.12	2.12	3.18	500	1.06	1.59	Uniform pressure dist.
Additional =		0.00	0.00	1000	0.00	0.00	
Total =		**6.99**	**9.26**		**2.68**	**3.62**	

Total thrust (Vw) =	6.99 kN/m	Total moment (Mw) =	2.68 kNm/m
Total ult. thrust (Vw*) =	9.26 kN/m	Total ult. moment (Mw*) =	3.62 kNm/m
Total ult. thrust (Vw*/Φn) =	**9.26 kNm/m**	**Total ult. moment (Mw*/Φn) =**	**3.62 kNm/m**
		Ultimate factor =	1.35

Sleeper design - AS1720.1 Section 3

Double sleepers at layer =	0	(Single layer sleepers)
Double sleepers laminated =	N	(Y)es,(N)o
Total layers =	5	

Critical layer for design =	5	Critical layer for design =	5
Critical layer centroid depth =	900	Critical layer centroid depth =	900 mm
w(dl)*=	2.94 kN/m	w*=	2.83 kN/m
M(dl)*/Φn =	0.24 kNm/m	M*/Φn =	0.23 kNm/m
		Area (A) =	15000 mm²
Description =	75mm x 200mm F7 KD Pine	Section modulus (Zy) =	188 x10³mm³
Design depth (dD) =	75 mm	Stiffness (Iy) =	7.0 x10⁶mm⁴
Design width (dW) =	200 mm	Modulus of elasticity (E) =	7900 MPa

Capacity factor (ø) =	0.7	Table 2.1 - Category 2	
Duration factor (k1) =	0.57	Moisture factor (k4) =	1.00
Stability factor (k12) =	1.00	Temp. factor (k6) =	1.00
f'b =	18.0 MPa	Sharing factor (k9) =	1.00
		Size modifier (mod.b) =	1.00
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12*f'b*Z =	1.35 kNm	OK (0.17)	
øM = ø*k1*k4*k6*k9*k12*f'b*Z =	1.35 kNm	OK (0.17)	
j2 =	3.00		
Deflection horizontal j2*δ(dl) =	0.5 mm	span / 1584	At layer 5
δ(ll) =	0.1 mm	span / 6559	At layer 1
Long term deflection horizontal δ(dl+Ψl.ll) =	0.6 mm	span / 1276	At layer 5

Steel upright design - AS4100 Section 5

V* = Vw*.*cts/Φn =	7.41 kN		
M* = Mw*.*cts/Φn =	2.89 kNm		
		Capacity factor (ø) =	0.9 Table 3.4
Description =	150UC23.4 (G300)	Warping constant (Iw) =	21.1 x10⁹mm⁶
Flange yield (fyf) =	320 MPa	Torsional constant (J) =	50.2 x10³mm⁴
Area (Ag) =	2980 mm²	Effective section mod. (Zex) =	176 x10³mm³
Stiffness (Ix) =	12.6 x10⁶ mm⁴	Effective section mod. (Zey) =	73.5 x10³mm³
Shear modulus (G) =	80000 MPa - Cl 1.4	Modulus of elasticity (Es) =	200000 MPa - Cl 1.4

Msx =	56.3 kNm - Cl 5.2	øMsx =	50.7 kNm	OK (0.06)
øVv = øVu =	160.2 kN			
øVvm =	160.2 kN	øVvm = øVv		OK (0.05)

Deflection horizontal at top δ(dl) =	0.1 mm	ht / 9703
δ(LL) =	0.1 mm	ht / 11902
δ(ll) (other) =	0.0 mm	ht / 0
Total δ(ll) =	0.1 mm	ht / 11902
Total deflection horizontal δ(dl+Ψl.ll) =	0.2 mm	ht / 5345

Timber upright design - AS1720.1 Section 3 (Not Applicable)

Footing design [ASD] - Cohesionless Shear included in footing

Footing geometry			**Upright reactions**		
Total footing depth (d) =	2000	mm	V* =	7.41	kN
Ignore depth (ig) =	0	mm	M* =	2.89	kNm
Design depth (D=d-ig) =	2000	mm			
Rotation depth (rD=D-D*(1-1/√2)) =	1414	mm	**Overturning moment**		
Footing diameter (dia) =	450	mm			
			M*o = M* + V*.* (ig + rD) =	13.37	kNm

Soil parameters (footing)			
Internal friction (ø*) =	0.4	rad	
Ka =	0.47	(Rankine)	
Kp =	2.14	(Rankine)	
øMr = (Kp-Ka)*γsf*dia*D³/10 =	13.8	kNm	OK (0.97)

Horizontal bearing		
Equiv. Kp-Ka = K* = (Kp-Ka)*(Mo*/øMr) =	1.62	
Ult. bearing BP* (hinge) = K* *γ*0.707*D =	52.5	kPa (Horizontal)
Ult. bearing BP* (base) = K* *γ*D =	74.3	kPa (Horizontal)

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

RW1 1500

SLEEPER WALLS V5.10

Xstruct

Wall:	**(RW1 1500) 1500mm high, 5.0kPa surcharge (Drained)**	
Loads:	**Surcharge = 5.00kPa, Drained**	
Steel Upright:	**150UC23.4 (G300) (Galv.)**	
	M* = 8.34kNm < øM = 50.69kNm, V* = 14.77kN < øVvm = 160.22kN	**OK (0.16,0.09)**
	δ(dl)=ht/1917 (0.8mm), δ(dl+ΨI.ll)=ht/1242 (1.2mm)	**OK**
Timber Upright:	**Not Applicable**	

Footing:	**M*o = 34.44kNm < øMr = 35.99kNm**	**OK (0.96)**
Sleepers:	**75mm x 200mm F5 KD Pine** (Weak) (Single layer sleepers)**	
	M(dl)* = 0.36kNm < øM(dl) = 1.05kNm, M* = 0.34kNm < øM = 1.05kNm	**OK (0.34,0.33)**
	Critical sleeper layer is 8 from top of sleeper wall bending about weak axis	
	δ(dl)=L/830 (1.0mm) on layer 8, δ(dl+ΨI.ll)=L/725 (1.1mm) on layer 8	**OK**

Geometry

Pier depth/diameter ratio = 4.2

Wall assumed fully drained

Geometry Error - Retaining height must be a multiple of the sleeper vertical dimension (1400mm)

Retaining height (ht) =	1500	mm
Post centres (cts) =	800	mm
Upright =	S	(T)imber,(S)teel,(B)oth
Concrete sleepers =	N	(Y)es,(N)o
Risk class =	B	(A),(B),(C) - Moderate damage and loss of services - Table 1.1
Backfill type =	1	Class(1), Class(2), (U)ncontrolled, (I)n-situ - Table 5.1(A)

Soil parameters (behind wall)

Internal friction (ø) =	25	° (0° ≤ ø ≤ 45°)
Incline (β) =	0	° (0° ≤ β ≤ 45°) 1 in 0.0
Soil weight (γs) =	23.0	kN/m³
Cohesion (c) =	0	kPa

Footing - Cohesionless

Total footing depth (d) =	2500	mm (From surface)
Ignore top (ig) =	0	mm
Footing diameter (dia) =	600	mm
Soil cohesion (cf) =	0	kPa (0 for cohensionless)
Soil internal friction (øf) =	25	° (0° < ø ≤ 45°)
Design cf*=cf*Φuc(=0.7) =	0.0	kPa insitu material
Design øf*=øf*Φuc(=0.85) =	21.3	° insitu material
Soil weight (γsf) =	23.0	kN/m³
Live Load duration =	Permanent	
Long term LL factor (ΨI) =	1.00	AS 1170.0 Table 4.1
Duration factor (k1) =	0.57	

Sleepers Minor axis bending

Sleeper depth (dSD) =	75	mm (Horz. dimension)
Sleeper width (dSW) =	200	mm (Vert. dimension)
Max number of layers =	8	(1600mm high)

Design loads - Appendix J & Section 4 - AS4678

Min. surcharge =	5.0	kPa - Table 4.1
Water height (hw) =	0.0	mm (Drained)
Surcharge (s) =	5.0	kPa
Dead only factor =	1.35	(1.35)
Earth factor =	1.25	(1.25)
Live load factor =	1.50	(1.50 - 0.0 for stabilising effect)
Stabilising factor =	0.80	AS4678 - Appendix J2

Additional upright overturning

Thrust (Va) =	0.00	kN/upright
Overturning (Ma) =	0.00	kNm/upright
Load factor =	1.50	
Long term LL factor (Ψlo) =	0.40	
Va* =	0.00	kN/upright
Ma* =	0.00	kNm/upright

(Thrust/moment applied at the top of the wall)

Material design factors - Section 5

Φuc =	0.90	c*=c*Φuc =	0.0	kPa	Cl 5.2.1		
Φuo =	0.95	ø* =	23.9	°	Cl 5.2.2	ø* =	0.417 rad

Design factor (Φn) =	1.00	Table 5.2			
Ka =	0.423	(Rankine)	Depth of tension zone =	0	mm
Kp =	2.362	(Rankine)	Acting soil height (ha) =	1500	mm

Design moment in upright (about top of footing, per m of wall)

	Pressure	Thrust	Thrust*	Lever arm	Mw	Mw*	Comments
	kPa	kN/m	kN/m	mm	kNm/m	kNm/m	(At wall base)
Soil = Ka*γs*ha =	14.61	10.96	13.70	500	5.48	6.85	Max. pressure at base
Surcharge = Ka*s =	2.12	3.18	4.76	750	2.38	3.57	Uniform pressure dist.
Additional =		0.00	0.00	1500	0.00	0.00	
Total =		**14.13**	**18.46**		**7.86**	**10.42**	

Total thrust (Vw) = 14.13 kN/m
Total ult. thrust (Vw*) = 18.46 kN/m
Total ult. thrust (Vw*/Φn) = 18.46 kNm/m

Total moment (Mw) = 7.86 kNm/m
Total ult. moment (Mw*) = 10.42 kNm/m
Total ult. moment (Mw*/Φn) = 10.42 kNm/m
Ultimate factor = 1.33

Sleeper design - AS1720.1 Section 3

Double sleepers at layer = 0 (Single layer sleepers)
Double sleepers laminated = N (Y)es,(N)o
Total layers = 8

Critical layer for design = 8
Critical layer centroid depth = 1500
w(dl)*= 4.52 kN/m
M(dl)*/Φn = 0.36 kNm/m

Critical layer for design = 8
Critical layer centroid depth = 1500 mm
w*= 4.29 kN/m
M*/Φn = 0.34 kNm/m

Description = 75mm x 200mm F5 KD Pine
Design depth (dD) = 75 mm
Design width (dW) = 200 mm

Area (A) = 15000 mm²
Section modulus (Zy) = 188 x10³mm³
Stiffness (Iy) = 7.0 x10⁶mm⁴
Modulus of elasticity (E) = 6900 MPa

Capacity factor (ø) = 0.7 Table 2.1 - Category 2
Duration factor (k1) = 0.57
Stability factor (k12) = 1.00
f'b = 14.0 MPa

Moisture factor (k4) = 1.00
Temp. factor (k6) = 1.00
Sharing factor (k9) = 1.00
Size modifier (mod.b) = 1.00

øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12*f'b*Z = 1.05 kNm OK (0.34)
øM = ø*k1*k4*k6*k9*k12*f'b*Z = 1.05 kNm OK (0.33)
j2 = 3.00
Deflection horizontal j2*δ(dl) = 1.0 mm span / 830 At layer 8
δ(ll) = 0.1 mm span / 5729 At layer 1
Long term deflection horizontal δ(dl+Ψl.ll) = 1.1 mm span / 725 At layer 8

Steel upright design - AS4100 Section 5

V* = Vw*.*cts/Φn = 14.77 kN
M* = Mw*.*cts/Φn = 8.34 kNm

Capacity factor (ø) = 0.9 Table 3.4
Description = 150UC23.4 (G300)
Flange yield (fyf) = 320 MPa
Area (Ag) = 2980 mm²
Stiffness (Ix) = 12.6 x10⁶ mm⁴
Shear modulus (G) = 80000 MPa - Cl 1.4

Warping constant (Iw) = 21.1 x10⁹mm⁶
Torsional constant (J) = 50.2 x10³mm⁴
Effective section mod. (Zex) = 176 x10³mm³
Effective section mod. (Zey) = 73.5 x10³mm³
Modulus of elasticity (Es) = 200000 MPa - Cl 1.4

Msx = 56.3 kNm - Cl 5.2 øMsx = 50.7 kNm OK (0.16)
øVv = øVu = 160.2 kN
øVvm = 160.2 kN øVvm = øVv OK (0.09)

Deflection horizontal at top δ(dl) = 0.8 mm ht / 1917
δ(LL) = 0.4 mm ht / 3527
δ(ll) (other) = 0.0 mm ht / 0
Total δ(ll) = 0.4 mm ht / 3527
Total deflection horizontal δ(dl+Ψl.ll) = 1.2 mm ht / 1242

Timber upright design - AS1720.1 Section 3 (Not Applicable)

Footing design [ASD] - Cohesionless Shear included in footing

Footing geometry			**Upright reactions**		
Total footing depth (d) =	2500	mm	V* =	14.77	kN
Ignore depth (ig) =	0	mm	M* =	8.34	kNm
Design depth (D=d-ig) =	2500	mm			
Rotation depth (rD=D-D*(1-1/√2)) =	1768	mm	**Overturning moment**		
Footing diameter (dia) =	600	mm			
			M*o = M* + V*.* (ig + rD) =	34.44	kNm

Soil parameters (footing)			
Internal friction (ø*) =	0.4	rad	
Ka =	0.47	(Rankine)	
Kp =	2.14	(Rankine)	
øMr = (Kp-Ka)*γsf*dia*D³/10 =	36.0	kNm	OK (0.96)

Horizontal bearing		
Equiv. Kp-Ka = K* = (Kp-Ka)*(Mo*/øMr) =	1.60	
Ult. bearing BP* (hinge) = K* *γ*0.707*D =	64.9	kPa (Horizontal)
Ult. bearing BP* (base) = K* *γ*D =	91.8	kPa (Horizontal)

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

3B2 (Alt)

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(3B2 (Alt)) 2 / 400mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 25.87kNm (+ve) < øM(dl) = 45.02kNm, M* = 37.51kNm (+ve) < øM = 65.27kNm**	**OK (0.57,0.57)**
Shear:	**V(dl)* = 22.48kN < øV(dl) = 48.26kN, V* = 33.70kN < øV = 67.74kN**	**OK (0.47,0.50)**
Deflection:	**δDL = L/466 (8mm) , δΨs.LL = L/1706 (2mm), δTotal = L/366 (10mm), 1kN mid. δ = 0.2mm**	**OK**
Reactions:	**(Each end) Rdl = 11.78kN, Rll = 13.04kN, R* = 33.70kN**	

Geometry

(House member affecting > 25m² or primary building member)

Category =	2	(1) House, (2) Primary building elements, (3) Important			
House =	N	(Y)es,(N)o	Edge restrained =	C	(T)ension, (C)ompression, (B)oth
Span (L) =	3800	mm	Lay.t (Top) =	450	mm
Centres (cts) =	3300	mm			
Span type =	S	(S)ingle,(D)ouble			

Loadings

Floor area (A) =	12.54	m²	Live load type =	N	(N)ormal, (S)torage, (M)anual
					AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	3300	mm +		kN/m =	1.65 kN/m
Wall dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35 kN/m
Other dead load (wdl) =	0.40	kPa *	4000	mm +		kN/m =	1.60 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.20 kN/m
						Σwdl =	4.80 kN/m

Uniform live loads

Floor live load (wll) =	1.50	kPa *	3300	mm +		kN/m =	4.95 kN/m
Partitions (wll) =	0.25	kPa *	4000	mm +		kN/m =	1.00 kN/m
Alternate point live load =	1.80	kN	Distr. to	1	members	Σwll =	5.95 kN/m

Point loads

Dead load (pdl) =	5.32 kN	Position =	1900	mm from LHS
Live load (pll) =	3.46 kN	Shear using PL at support =	N	(Y)es,(N)o

Short term LL factor (Ψsu) =	0.70	(Ψsp) =	1.00	
Long term LL factor (Ψlu) =	0.40	(Ψlp) =	0.60	
wdl* = 1.2*wdl+1.5*Ψlu*wll =	9.33 kN/m	M(dl+Ψl.ll)* =	25.87	kNm (Max at 1900mm)
w* = 1.2*wdl+1.5*wll =	14.69 kN/m	M* =	37.51	kNm (Max at 1900mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	9.50 kN	V(dl+Ψl.ll)* =	22.48	kN
p* = 1.2*pdl+1.5*pll =	11.58 kN	V* =	33.70	kN

	DL	LL	
RL1	5.3	3.5	: M|M
Σ	5.3	3.5	

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	2 / 400mm x 42mm Smart LVL15	Area (A) =	33600 mm²
Description =	LVL15 seasoned softwood	Section modulus (Zx) =	2240 x10³ mm³
Design depth (dD) =	400 mm	Stiffness (Ix) =	448.0 x10⁶ mm⁴
Design width (dW) =	42 mm	Modulus of elasticity (E) =	15300 MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 =	12.63	For top comp. edge restrained - Cl 3.2.3.2(a)		
k12d = 1.5-0.05*ρbd*S1 =	0.891	for 10 ≤ ρbd*S1 ≤ 20 - Cl 3.2.4	f'b =	44.0 MPa
k12 = 1.5-0.05*ρb*S1 =	0.920	for 10 ≤ ρb*S1 ≤ 20 - Cl 3.2.4	f's =	4.2 MPa
			Material constant (ρbd) =	0.96 (rbd=0.25)
Strength reduction factor (ø) =	0.9	Table 2.1	Material constant (ρb) =	0.92 (rb=0.56)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	45.02	kNm	Duration factor (k1) =	0.80
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	65.27	kNm	Moisture factor (k4) =	1.00
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	48.26	kN	Temp. factor (k6) =	1.00
øV = ø*k1*k4*k6*f's*(2/3*A) =	67.74	kN	Sharing factor (k9) =	1.00
			Size modifier (mod.b) =	1.00
			Size modifier (mod.s) =	1.00

Deflections

			Duration factor (j2) =	2.0		
Ireq'd j2.(DL+Ψl.LL) (L/300) =	288.5 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	8.2	mm	Span / 466
Ireq'd Ψs.LL (12mm) =	83.2 x10⁶ mm⁴		Ψs.δLL =	2.2	mm	Span / 1706
Ireq'd Total (L/250) =	306.1 x10⁶ mm⁴		δTotal =	10.4	mm	Span / 366
			1kN midspan δ =	0.2	mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

C1

STEEL COLUMN V5.07

Xstruct

Member:	**(C1) 89 x 6.0 SHS (G350)# (Cap plate connection)**	
Compression:	**Nc* = 66.2kN < øNc = 203.8kN**	**OK (0.32)**
Bending:	**Mx* = 2.9kNm < øMb(4000,αm=1.75) = 17.8kNm**	**OK (0.17)**
	No minor bending	
Combined:	**In-plane = 0.49, Out-of-plane = 0.49**	**OK (0.49)**

Geometry

Column length (L) =	4000	mm	L = Lb = Lx = Ly =	Y	(Y)es,(N)o
Compression:					
Major axis length (Lx) =	4000	mm			
Minor axis length (Ly) =	4000	mm			
Effective length X factor (kex) =	1.00	Fig 4.6.3.2			
Effective length Y factor (key) =	1.00	Fig 4.6.3.2	Holes =	0	mm² (axial reduction only)
Bending:					
Bending length (Lb) =	4000	mm	Eff. length Lex(4000,1.00) =	4000	mm
Bending effective length factor (ke) =	1.00	Cl 5.6.3	Eff. length Ley(4000,1.00) =	4000	mm
Moment modification factor (αm) =	1.75	Cl 5.6.1.1(a)	Eff. length Leb(4000,1.00) =	4000	mm

Loadings

S.Wt = 0.15 kN/m (excluded)

	DL	LL	
3B6	20.9	14.6	: R|R
GL3	14.3	1.4	: L|L
Σ	35.2	16.0	

Elastic Analysis

Dead load comp. (Ndl) =	35.2	kN	ψe =	1	(1)st order,(2)nd order
Live load comp. (Nll) =	16.0	kN	ψe =	B	(B)raced/(S)way - Cl 4.1.2
Nc* = 1.2*Ndl+1.5*Nll =	66.2	kN	ψm =	0.0	cm = 0.60
			δbx = cm/(1-N*/Nomx) =	1.00	and δby = 1.00
Beam End Connection (For moment) =	C	(C)ap,(F)ace,(M)anual,(L)oading			
Major axis Mx* = δbx.Nc*(D/2) =	2.9	kNm			
Minor axis My*=δby.My* =	0.0	kNm - App. E	Minor bending (My*) =	0.0	kNm
D =	89	mm (Bending about the strong axis only)			

Capacity

Section doubly symmetric

Description =	89 x 6.0 SHS (G350)#		Warping constant (Iw) =	0	x10⁹ mm⁶
Flange yield (fyf) =	350	MPa	Torsional constant (J) =	3550	x10³ mm⁴
Web yield (fyw) =	350	MPa	Effective section mod. (Zex) =	56.6	x10³ mm³
Area (Ag) =	1870	mm²	Effective section mod. (Zey) =	56.6	x10³ mm³
Stiffness (Ix) =	2.06	x10⁶ mm⁴	Elastic modulus (E) =	200000	MPa - Cl 1.4
Stiffness (Iy) =	2.06	x10⁶ mm⁴	Shear modulus (G) =	80000	MPa - Cl 1.4
rx =	33.2	mm	αb =	-0.5	(Comp.)
ry =	33.2	mm	Net area (An) =	1870	mm²

Nomx = π²*E*Ix/(kex*Lx)² = 254 kN - Cl 4.6.2
Nomy = π²*E*Iy/(key*Ly)² = 254 kN

Compression - Section 6

ø =	0.9	Table 3.4	øNs = ø*kf*An*fy =	589.1	kN - Cl 6.2.1
αcx (Lex) =	0.346		øNcx = øNs*αcx =	203.8	kN - Cl 6.3.3
αcx1 (kex=1, Lex=Lx) =	0.346		øNcy = øNs*αcy =	203.8	kN - Cl 6.3.3
αcy (Ley) =	0.346		øNc =	203.8	kN
αcy1 (key=1, Ley=Ly) =	0.346		øNcx1 = øNs*αcx1 =	203.8	kN - Cl 8.4.2.2
			øNcy1 = øNs*αcy1 =	203.8	kN - Cl 8.4.2.2

Bending - Section 5

ø =	0.9	Table 3.4				øMsy =	17.8 kNm
Msx = min(fyf,fyw)*Zex =	19.8	kNm - Cl 5.2.1	øMsx =	17.8	kNm	øMbx =	17.8 kNm
Moa =	268.7	kNm	αs = 0.996		αm = 1.75	øMbx(αm=1) =	17.8 kNm

Combined - Section 8

Uniaxial bending about major axis - øMrxc = øMsx*(1-Nc*/øNs) =	15.8	kNm - Cl 8.3.2	OK (0.19)
In-plane capacity - øMixc = øMsx*(1-Nc*/øNcx1) =	12.0	kNm - Cl 8.4.2.2	OK (0.24)
Out-of-plane capacity - øMoxc = øMbx*(1-Nc*/øNcy) =	12.0	kNm - Cl 8.4.4.1	OK (0.24)
In-plane member ratio = Mx*/øMsx + Nc*/øNcx1 =	0.49		OK (0.49)
In-plane member ratio = My*/øMsy + Nc*/øNcy1 =	0.32		OK (0.32)
Out-of-plane member ratio = Mx*/øMbx + Nc*/øNcy =	0.49		OK (0.49)
øMcx = min(øMoxc & øMixc) =	12.0	kNm - Cl 8.4.5	
øMiyc = øMsy*(1-Nc*/øNcy1) =	12.0	kNm - Cl 8.4.2.2	
Biaxial bending ratio = (Mx*/øMcx)^1.4 + (My*/øMiy)^1.4 =	0.14	Cl 8.4.5	OK (0.14)
Biaxial section ratio = Nc*/øNs + Mx*/øMsx + My*/øMsy =	0.28		OK (0.28)

Wall:	**(RW2 600) 600mm retaining ht., 300mm thick (With key)**	
Loads:	**Surcharge = 5.00kPa, Drained**	
Footing:	**800mm long (overall), 0mm overhang (behind wall), 600mm deep**	
Stability:	**M*o = 5.8kNm < øMr = 7.1kNm**	**OK (0.81)**
Sliding:	**V*slide = 12.6kN < øVr = 19.9kN**	**OK (0.63)**
Wall:	**M*wall = 1.0kNm, V*wall = 4.1kN, Design factor Φn = 1.0**	
Bearing:	**Max. bearing pressure = 49kPa < Allowable = 150kPa**	**OK (0.33)**

Geometry

Wall assumed fully drained

Retaining height (z) =	600	mm (= Wall height)
Risk class =	B	(A),(B),(C) - Moderate damage and loss of services - Table 1.1
Backfill type =	1	Class(1), Class(2), (U)ncontrolled, (I)n-situ - Table 5.1(A)

Soil parameters

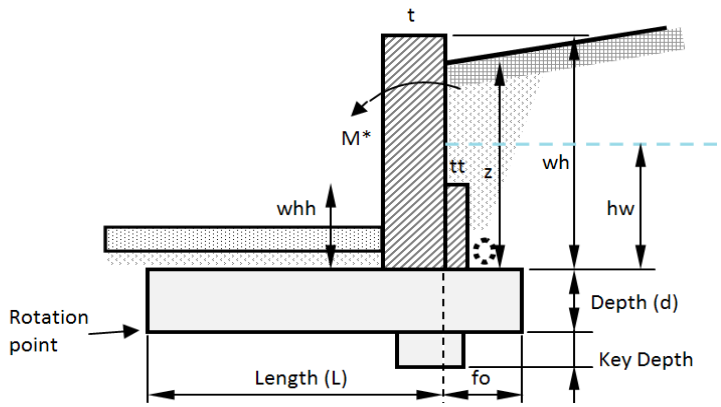
Internal friction (ø) =	25	° (0° ≤ ø ≤ 45°)
Incline (β) =	0	° (0° ≤ β ≤ 45°) 1 in 0.0
Soil weight (γ) =	23.0	kN/m³
Cohesion (c) =	0	kPa
Friction coefficient (μ) =	0.443	(-1 to ignore sliding)
Use passive =	Y	(Y)es,(N)o
Manual Kp value =	0.00	0 for default
Soil depth to Ignore =	0	mm (for passive)
Allowable bearing =	150	kPa
Slab overlay (ts) =		mm
Soil overlay (tsl) =		mm

Wall

Wall thickness (t) =	300	mm
Wall height (wh) =	600	mm (= Retaining height)
Add'l thickness (tt) =		mm (behind wall)
Add'l th. height (whh) =		mm
Add'l th. on soil side =	Y	(Y)es,(N)o
Wall Wt (Wwt) =	25	kN/m³

Footing

Footing depth (d) =	600	mm
End thickness (d2) =	0	mm (0 = no taper)
Footing length (L) =	800	mm excluding overhang
Overhang (fo) =	0	mm additional to length
Key depth (key) =	200	mm (sliding only)
Key length (klen) =	200	mm
Key position from heel/back (kpos) =	0	mm (to face)



Design loads - Appendix J - AS4678 & Section 4

Surcharge Min. =	5.0	kPa min. (Table 4.1)
Surcharge (S) =	5.0	kPa
Water height (hw) =	0	mm (over footing, 0=no water)
Earth factor =	1.25	(1.25)
Water pressure =	1.00	(1.00)
Live load factor =	1.50	(1.50 - 0.0 for stabilising effect)
Stabilising factor (øs) =	0.80	AS 4678 - Appendix J2

Additional Loads at top of wall:

Overturning (Ma) =	0.00	kNm/m
Thrust (Va) =	0.00	kN/m
Load factor =	1.50	
Ma* =	0.00	kNm/m
Va* =	0.00	kN/m
(Moment/Thrust about top wall)		
Additional dead load (Pv) =	0.00	kN/m

Material design factors - Section 5

Φuc =	0.90	c*=c*Φuc =	0	kPa	Cl 5.2.1		
Φuo =	0.95	ø* =	23.9	°	Cl 5.2.2	ø* =	0.417 rad
Design factor (Φn) =	1.00	Table 5.2					
	Ka =	0.423			Depth of tension zone =	0	mm
	Kp =	2.362			Acting soil height (ha) =	600	mm

Design Moment in wall (about top of footing, per m of wall)

	Pressure	Thrust	Thrust*	Lever arm	Mw	Mw*	Comments
	kPa	kN/m	kN/m	mm	kNm/m	kNm/m	(At wall base)
Soil = Ka*γ*ha =	5.84	1.75	2.19	200	0.35	0.44	Max. pressure at base
Water = None =	0.00	0.00	0.00	0	0.00	0.00	Max. pressure at base
Surcharge = Ka*S =	2.12	1.27	1.91	300	0.38	0.57	Uniform pressure dist.
Additional =		0.00	0.00	600	0.00	0.00	
Total		**3.02**	**4.10**		**0.73**	**1.01**	

Total thrust (Vw) =	3.02	kN/m
Total ult. thrust (Vw*) =	4.10	kN/m
Total ult. design thrust (Vw/Φn) =	4.10	kN/m
Total moment (Mw) =	0.73	kNm/m
Total ult. moment (Mw*) =	1.01	kNm/m
Total ult. design moment (Mw*/Φn) =	1.01	kNm/m

Overturning (Limit mode U2) (about base of footing, per m of wall)

Depth for rotation (deff) = 600 mm (Footing depth)

	Pressure	Thrust	Thrust*	Lever arm	Mo	Mo*	Comments
	kPa	kN/m	kN/m	mm	kNm/m	kNm/m	(At footing base)
Soil = Ka*γ*(ha+deff) =	11.69	7.01	8.77	400	2.80	3.51	Max. pressure at base
Water = None =	0.00	0.00	0.00	0	0.00	0.00	Max. pressure at base
Surcharge = Ka*S =	2.12	2.54	3.81	600	1.52	2.29	Uniform pressure dist.
Additional =		0.00	0.00	1200	0.00	0.00	
Total		**9.55**	**12.58**		**4.33**	**5.79**	

Total thrust =	9.55	kN/m
Total ult. thrust =	12.58	kN/m
Total moment (Mo) =	4.33	kNm/m
Total ult. moment (Mo*) =	5.79	kNm/m
Total ult. (Mo*/Φn) =	5.79	kNm/m

Restoring (Limit mode U2) (about base of footing, per m of wall)

	Force	Lever arm	Mr	øMr	Ecc	Mb	
	kN/m	mm	kNm/m	kNm/m	mm	kNm/m	
Footing =	11.52	324	3.73	2.98	0	0.00	
Soil overlay =	0.00	174	0.00	0.00	150	0.00	
Slab overlay =	0.00	174	0.00	0.00	150	0.00	
Wall =	4.50	574	2.58	2.06	-250	-1.13	
Lower wall (back) =	0.00	724	0.00	0.00	-400	0.00	Using Wwt-Soil dentity (γ)
Soil behind wall =	0.00	724	0.00	0.00	-400	0.00	
Dead load (Pv) =	0.00	574	0.00	0.00	-250	0.00	
Tapered =	0.00	0	0.00	0.00	400	0.00	
Key =	1.00	624	0.62	0.50	-300	-0.30	
Passive pressure =			1.96	1.56			
Total	**17.02**		**8.89**	**7.11**		**-1.43**	

Total force (Wt) =	17.02	kN/m	
Total bearing overturning (Mb) =	-1.43	kN/m	
Total restoring (Mr) =	8.89	kNm/m	
Total ult. Restoring (øs(0.80)*"Mr) =	7.11	kNm/m	OK (0.81)

Sliding (Limit mode U1)

Sliding (V*slide/Φn) =	12.58	kN/m at base	
Passive resistance of footing and key (Rp) =	17.38	kN/m	
Sliding resistance (Rs = μ*Wt) =	7.54	kN/m	
Total resistance øVr = øs(0.80)*(Rp+Rs) =	19.94	kN/m	OK (0.63)

Bearing

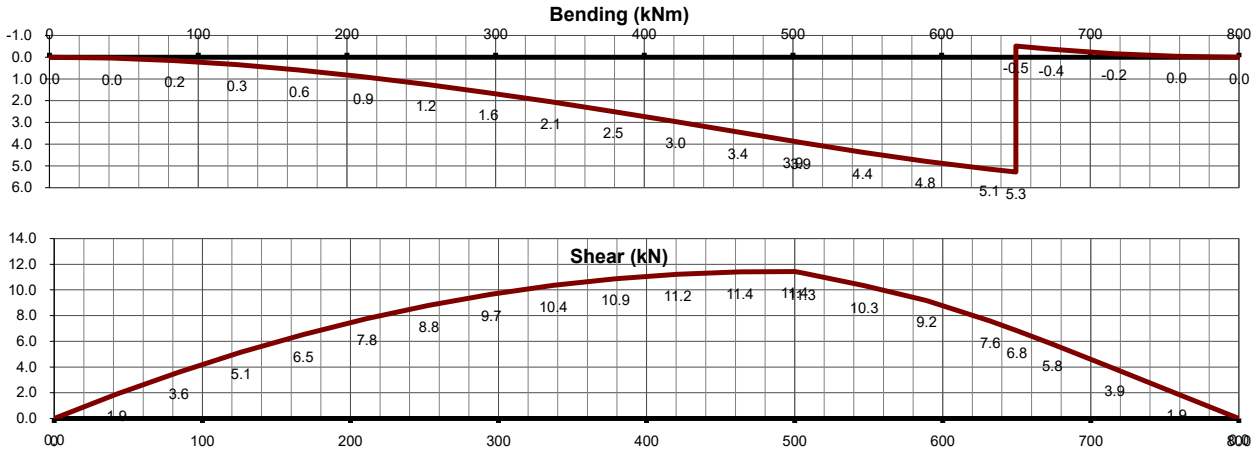
Total (Wt) =	17.02	kN/m	
Overturning moment (Mot = Mo + Mb) =	2.90	kNm/m	
Ecc = Mot / Wt =	171	mm	
Minimum bearing pressure (q.min) =	0.0	kPa	
Maximum bearing pressure (q.max) =	49.5	kPa	OK (0.33)
Centroid from left/front edge of footing (y) =	229	mm	(688mm of footing under pressure)

Design Moment and Shear in footing due to bearing (per m of wall)

Manual force position = 400 mm (from left/front edge of footing)
Equivalent load factor = 1.34

	Moment* kNm/m	Shear* kN/m	Lever arm mm	Position mm
Front face of wall =	3.9	11.4	338	500
Centre of wall (from the left) =	5.3	6.8	772	650
Centre of wall (from the right) =	-0.5	6.8	76	650
Back face of wall (soil side) =	0.0	0.0	-	800
Max. moment (+ve) =	5.3	6.8	-	650
Max. moment (-ve) =	-0.5	6.8	-	650
Max. shear =	3.9	11.4	-	500
Manual position =	2.7	11.1	-	400

Graphs (Footing)



Wall:	**(RW2 1200) 1000mm retaining ht., 300mm thick (No key)**	
Loads:	**Surcharge = 5.00kPa, Drained**	
Footing:	**1300mm long (overall), 1000mm overhang (behind wall), 600mm deep**	
Stability:	**M*o = 12.4kNm < øMr = 21.0kNm**	**OK (0.59)**
Sliding:	**V*slide = 20.7kN < øVr = 25.3kN**	**OK (0.82)**
Wall:	**M*wall = 3.6kNm, V*wall = 9.3kN, Design factor Φn = 1.0**	
Bearing:	**Max. bearing pressure = 72kPa < Allowable = 150kPa**	**OK (0.48)**

Geometry

Wall assumed fully drained

Retaining height (z) =	1000	mm (= Wall height)
Risk class =	B	(A),(B),(C) - Moderate damage and loss of services - Table 1.1
Backfill type =	1	Class(1), Class(2), (U)ncontrolled, (I)n-situ - Table 5.1(A)

Soil parameters

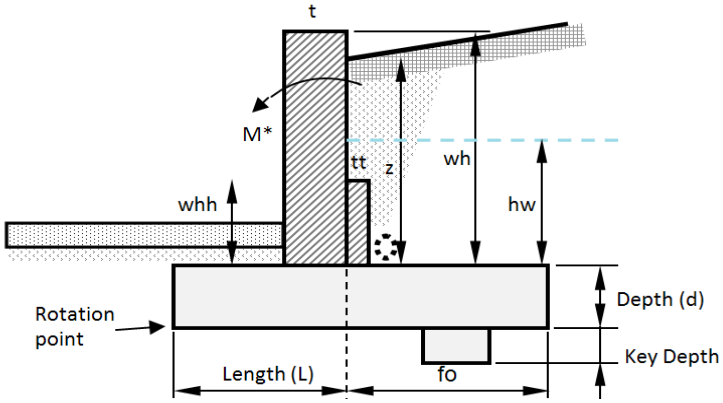
Internal friction (ø) =	25	° (0° ≤ ø ≤ 45°)
Incline (β) =	0	° (0° ≤ β ≤ 45°) 1 in 0.0
Soil weight (γ) =	23.0	kN/m³
Cohesion (c) =	0	kPa
Friction coefficient (μ) =	0.443	(-1 to ignore sliding)
Use passive =	Y	(Y)es,(N)o
Manual Kp value =	0.00	0 for default
Soil depth to Ignore =	0	mm (for passive)
Allowable bearing =	150	kPa
Slab overlay (ts) =		mm
Soil overlay (tsl) =		mm

Wall

Wall thickness (t) =	300	mm
Wall height (wh) =	1000	mm (= Retaining height)
Add'l thickness (tt) =		mm (behind wall)
Add'l th. height (whh) =		mm
Add'l th. on soil side =	Y	(Y)es,(N)o
Wall Wt (Wwt) =	25	kN/m³

Footing

Footing depth (d) =	600	mm
End thickness (d2) =	0	mm (0 = no taper)
Footing length (L) =	300	mm excluding overhang
Overhang (fo) =	1000	mm additional to length
Key depth (key) =	0	mm (sliding only)
Key length (klen) =	0	mm
Key position from heel/back (kpos) =	0	mm (to face)



Design loads - Appendix J - AS4678 & Section 4

Surcharge Min. =	5.0	kPa min. (Table 4.1)
Surcharge (S) =	5.0	kPa
Water height (hw) =	0	mm (over footing, 0=no water)
Earth factor =	1.25	(1.25)
Water pressure =	1.00	(1.00)
Live load factor =	1.50	(1.50 - 0.0 for stabilising effect)
Stabilising factor (øs) =	0.80	AS 4678 - Appendix J2

Additional Loads at top of wall:

Overturning (Ma) =	0.00	kNm/m
Thrust (Va) =	0.00	kN/m
Load factor =	1.50	
Ma* =	0.00	kNm/m
Va* =	0.00	kN/m
(Moment/Thrust about top wall)		
Additional dead load (Pv) =	0.00	kN/m

Material design factors - Section 5

Φuc =	0.90	c*=c*Φuc =	0	kPa	Cl 5.2.1		
Φuo =	0.95	ø* =	23.9	°	Cl 5.2.2	ø* =	0.417 rad
Design factor (Φn) =	1.00	Table 5.2					
	Ka =	0.423			Depth of tension zone =	0	mm
	Kp =	2.362			Acting soil height (ha) =	1000	mm

Design Moment in wall (about top of footing, per m of wall)

	Pressure	Thrust	Thrust*	Lever arm	Mw	Mw*	Comments
	kPa	kN/m	kN/m	mm	kNm/m	kNm/m	(At wall base)
Soil = Ka*γ*ha =	9.74	4.87	6.09	333	1.62	2.03	Max. pressure at base
Water = None =	0.00	0.00	0.00	0	0.00	0.00	Max. pressure at base
Surcharge = Ka*S =	2.12	2.12	3.18	500	1.06	1.59	Uniform pressure dist.
Additional =		0.00	0.00	1000	0.00	0.00	
Total		**6.99**	**9.26**		**2.68**	**3.62**	

Total thrust (Vw) =	6.99	kN/m
Total ult. thrust (Vw*) =	9.26	kN/m
Total ult. design thrust (Vw/Φn) =	9.26	kN/m
Total moment (Mw) =	2.68	kNm/m
Total ult. moment (Mw*) =	3.62	kNm/m
Total ult. design moment (Mw*/Φn) =	3.62	kNm/m

Overturning (Limit mode U2) (about base of footing, per m of wall)

Depth for rotation (deff) = 600 mm (Footing depth)

	Pressure	Thrust	Thrust*	Lever arm	Mo	Mo*	Comments
	kPa	kN/m	kN/m	mm	kNm/m	kNm/m	(At footing base)
Soil = Ka*γ*(ha+deff) =	15.58	12.47	15.58	533	6.65	8.31	Max. pressure at base
Water = None =	0.00	0.00	0.00	0	0.00	0.00	Max. pressure at base
Surcharge = Ka*S =	2.12	3.39	5.08	800	2.71	4.07	Uniform pressure dist.
Additional =		0.00	0.00	1600	0.00	0.00	
Total		**15.85**	**20.66**		**9.36**	**12.38**	

Total thrust =	15.85	kN/m
Total ult. thrust =	20.66	kN/m
Total moment (Mo) =	9.36	kNm/m
Total ult. moment (Mo*) =	12.38	kNm/m
Total ult. (Mo*/Φn) =	12.38	kNm/m

Restoring (Limit mode U2) (about base of footing, per m of wall)

	Force	Lever arm	Mr	øMr	Ecc	Mb	
	kN/m	mm	kNm/m	kNm/m	mm	kNm/m	
Footing =	18.72	499	9.34	7.47	0	0.00	
Soil overlay =	0.00	-151	0.00	0.00	650	0.00	
Slab overlay =	0.00	-151	0.00	0.00	650	0.00	
Wall =	7.50	-1	-0.01	-0.01	500	3.75	
Lower wall (back) =	0.00	149	0.00	0.00	350	0.00	Using Wwt-Soil dentity (γ)
Soil behind wall =	23.00	649	14.92	11.94	-150	-3.45	
Dead load (Pv) =	0.00	-1	0.00	0.00	500	0.00	
Tapered =	0.00	0	0.00	0.00	650	0.00	
Key =	0.00	1149	0.00	0.00	-650	0.00	
Passive pressure =			1.96	1.56			
Total	**49.22**		**26.20**	**20.96**		**0.30**	

Total force (Wt) =	49.22	kN/m	
Total bearing overturning (Mb) =	0.30	kN/m	
Total restoring (Mr) =	26.20	kNm/m	
Total ult. Restoring (øs(0.80)*"Mr) =	20.96	kNm/m	OK (0.59)

Sliding (Limit mode U1)

Sliding (V*slide/Φn) =	20.66	kN/m at base	
Passive resistance of footing and key (Rp) =	9.78	kN/m	
Sliding resistance (Rs = μ*Wt) =	21.80	kN/m	
Total resistance øVr = øs(0.80)*(Rp+Rs) =	25.26	kN/m	OK (0.82)

Bearing

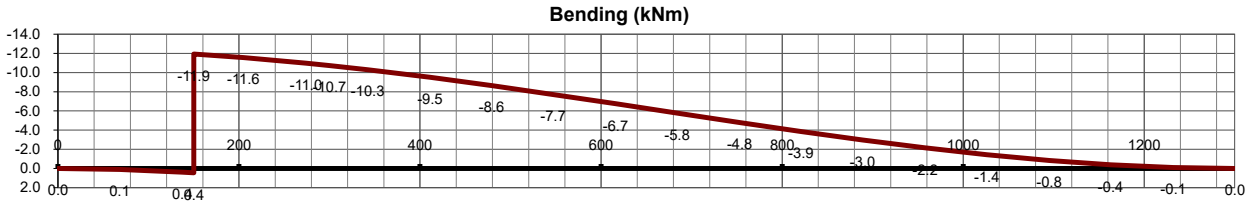
Total (Wt) =	49.22	kN/m	
Overturning moment (Mot = Mo + Mb) =	9.66	kNm/m	
Ecc = Mot / Wt =	196	mm	
Minimum bearing pressure (q.min) =	3.6	kPa	
Maximum bearing pressure (q.max) =	72.2	kPa	OK (0.48)
Centroid from left/front edge of footing (y) =	454	mm	(Entire footing under pressure)

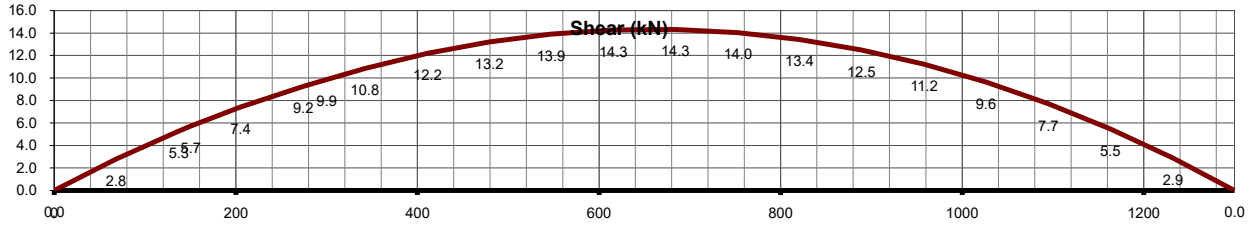
Design Moment and Shear in footing due to bearing (per m of wall)

Manual force position = 650 mm (from left/front edge of footing)
Equivalent load factor = 1.32

	Moment* kNm/m	Shear* kN/m	Lever arm mm	Position mm
Front face of wall =	0.0	0.0	-	0
Centre of wall (from the left) =	0.4	5.7	78	150
Centre of wall (from the right) =	-11.9	5.7	2088	150
Back face of wall (soil side) =	-10.7	9.9	1090	300
Max. moment (+ve) =	0.4	5.7	-	150
Max. moment (-ve) =	-11.9	5.7	-	150
Max. shear =	-5.8	14.3	-	684
Manual position =	-6.3	14.3	-	650

Graphs (Footing)





XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

GT

TIMBER ROOF BEAM V5.10

Xstruct

Beam:	**(GT) 450mm x 58mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 8.82kNm (+ve) < øM(dl) = 38.52kNm, M* = 13.18kNm (+ve) < øM = 64.95kNm**	**OK (0.23,0.20)**
	Mw* = 6.76kNm (-ve) < øMw = 53.65kNm	**OK (0.13)**
Shear:	**V(dl)* = 5.43kN < øV(dl) = 39.57kN, V* = 8.11kN < øV = 65.26kN**	**OK (0.14,0.12)**
	Vw* = 4.16kN < øVw = 69.43kN	**OK (0.06)**
Deflection:	**δDL = L/762 (9mm) , δΨs.LL = L/3988 (2mm), δWLs = L/1159 (-6mm)**	**OK**
Reactions:	**(Each end) Rdl = 4.02kN, Rll = 2.19kN, Rwl* = -7.77kN, R.dn* = 8.11kN, R.up* = 4.16kN**	

Geometry

(House member affecting ≤ 25m² or secondary building member)

Category =	1 (1) House, (2) Primary building elements, (3) Important			House =	N (Y)es,(N)o
Span (L) =	6500 mm		Edge restrained (down) =	C	(T)ension,(C)ompression,(B)oth
Centres (cts) =	2700 mm		Lay.t (Top) =	900 mm	
Span type =	S (S)ingle,(D)ouble				

Loadings

Roof area (A) =	17.55 m²		Apply wind reduction =	Y	(Y)es,(N)o
LL = 1.8/A+0.12 ≥ 0.25 =	0.25 kPa		Roof reduction (Ka) =	0.95	AS/NZS 1170.2, Table 5.4
			Ratio Ws/Wu =	0.68	(Refer wind analysis)

Uniform dead loads

Roof dead load (wdl) =	0.40 kPa *	2700 mm +		kN/m =	1.08 kN/m		
Other dead load (wdl) =	kPa *	2700 mm +		kN/m =	0.00 kN/m		
Include S.Wt =	Y (Y)es,(N)o			S.Wt =	0.16 kN/m		
				Σwdl =	1.24 kN/m		

Uniform live loads

Roof live load (wll) =	0.25 kPa *	2700 mm +		kN/m =	0.68 kN/m		
Other live load (wll) =	kPa *	2700 mm +		kN/m =	0.00 kN/m		
Alternate point live load =	1.40 kN	Distr. to	1 members	Σwll =	0.68 kN/m		

Uniform wind loads

Ult. wind load (Wu) =	0.84 kPa *	2700 mm			
Cp,e =	0.9	Cp,i =	0.2	Σwwl* =	-2.39 kN/m (up)

Point loads

Dead load (pdl) =	kN	Position =	3250 mm from LHS
Live load (pll) =	kN	Shear using PL at support =	Y (Y)es,(N)o
Wind load (pwl*) =	kN (-ve up)		

w(dl)* = 1.35*wdl =	1.67 kN/m	M(dl)* =	8.82 kNm (Max at 3250mm)
w* = 1.2*wdl + 1.5*wll =	2.50 kN/m	M* =	13.18 kNm (Max at 3250mm)
w.up* = 0.9*wdl + wwl* =	1.28 kN/m (up)	Mw.up* =	6.76 kNm (Max at 3250mm)
p(dl)* = 1.35*pdl =	0.00 kN	V(dl)* =	5.43 kN
p* = 1.2*pdl+1.5*pll =	0.00 kN	V* =	8.11 kN
p.up* = 0.9*pdl + pwl* =	0.00 kN	Vw.up* =	4.16 kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	450mm x 58mm Smart LVL15	Area (A) =	26100 mm²
Description =	LVL15 seasoned softwood	Section modulus (Zx) =	1958 x10³ mm³
Design depth (dD) =	450 mm	Stiffness (Ix) =	440.4 x10⁶ mm⁴
Design width (dW) =	58 mm	Modulus of elasticity (E) =	15300 MPa - Cl 8.3

S1d = 1.25*dD/dW*(Lay.t/dD)^0.5 =	13.72	For top comp. edge restrained - Cl 3.2.3.2(a)
S1u = (dD/dW)^1.35*(Lay.t/dD)^0.25 =	18.90	For top tension edge restrained in uplift - Cl 3.2.3.2(a)
k12d = 1.5-0.05*ρbd*S1d =	0.846	for 10 ≤ ρbd*S1d ≤ 20 - Cl 3.2.4
k12 = 1.5-0.05*ρb*S1d =	0.865	for 10 ≤ ρb*S1d ≤ 20 - Cl 3.2.4
k12u = 1.5-0.05*ρbu*S1u =	0.671	for 10 ≤ ρbu*S1u ≤ 20 - Cl 3.2.4

			f'b =	43.0	MPa
			f's =	4.2	MPa
Strength reduction factor (ø) =	0.95	Table 2.1	Material constant (ρbd) =	0.95	(rbd=0.25)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	38.52	kNm	Material constant (ρb) =	0.93	(rb=0.41)
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	64.95	kNm	Stress reversal (ρbu) =	0.88	(rbu=1.00)
øMw = ø*(k1=1)*k4*k6*k9*k12u*f'b*Zx =	53.65	kNm	Duration factor (k1) =	0.94	(Live)
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	39.57	kN	Moisture factor (k4) =	1.00	
øV = ø*k1*k4*k6*f's*(2/3*A) =	65.26	kN	Temp. factor (k6) =	1.00	
øVw = ø*(k1=1)*k4*k6*f's*(2/3*A) =	69.43	kN	Sharing factor (k9) =	1.00	
			Size modifier (mod.b & s) =	1.00	& 1.00

Deflections

			Duration factor (j2) =	2.0	
eq'd j2.(DL+ΨI.LL) (16mm max) =	234.8 x10⁶ mm⁴	< Critical	δDL=	8.5 mm	Span / 762
Ireq'd `LL (L/240) =	26.5 x10⁶ mm⁴		δΨs.LL =	1.6 mm	Span / 3988
Ireq'd WLs (L/180) =	68.4 x10⁶ mm⁴		δWLs =	-5.6 mm	Span / 1159

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

RL Large

TIMBER ROOF BEAM V5.10

Xstruct

Beam:	**(RL Large) 190mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 1.71kNm (+ve) < øM(dl) = 6.01kNm, M* = 3.10kNm (+ve) < øM = 10.23kNm**	**OK (0.28,0.30)**
	Mw* = 1.66kNm (-ve) < øMw = 11.76kNm	**OK (0.14)**
Shear:	**V(dl)* = 2.28kN < øV(dl) = 12.10kN, V* = 4.13kN < øV = 19.95kN**	**OK (0.19,0.21)**
	Vw* = 2.22kN < øVw = 21.23kN	**OK (0.10)**
Deflection:	**δDL = L/463 (6mm) , δΨs.LL = L/1399 (2mm), δWLs = L/616 (-5mm)**	**OK**
Reactions:	**(Each end) Rdl = 1.69kN, Rll = 1.40kN, Rwl* = -3.74kN, R.dn* = 4.13kN, R.up* = 2.22kN**	

Geometry

(House member affecting ≤ 25m² or secondary building member)

Category =	1	(1) House, (2) Primary building elements, (3) Important		House =	N (Y)es,(N)o
Span (L) =	3000 mm		Edge restrained (down) =	C	(T)ension,(C)ompression,(B)oth
Centres (cts) =	2700 mm		Lay.t (Top) =	900 mm	
Span type =	S	(S)ingle,(D)ouble			

Loadings

Roof area (A) =	8.10 m²		Apply wind reduction =	Y	(Y)es,(N)o
LL = 1.8/A+0.12 ≥ 0.25 =	0.34 kPa		Roof reduction (Ka) =	1.00	AS/NZS 1170.2, Table 5.4
			Ratio Ws/Wu =	0.68	(Refer wind analysis)

Uniform dead loads

Roof dead load (wdl) =	0.40	kPa *	2700	mm +		kN/m =	1.08 kN/m
Other dead load (wdl) =		kPa *	2700	mm +		kN/m =	0.00 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.05 kN/m
						Σwdl =	1.13 kN/m

Uniform live loads

Roof live load (wll) =	0.34	kPa *	2700	mm +		kN/m =	0.92 kN/m
Other live load (wll) =		kPa *	2700	mm +		kN/m =	0.00 kN/m
Alternate point live load =	1.40	kN (critical)	Distr. to	1	members	Σwll =	0.93 kN/m

Uniform wind loads

Ult. wind load (Wu) =	0.84	kPa *	2700	mm		
Cp,e =	0.9	Cp,i =	0.2		Σwwl* =	-2.49 kN/m (up)

Point loads

Dead load (pdl) =		kN	Position =	1500	mm from LHS
Live load (pll) =		kN	Shear using PL at support =	Y	(Y)es,(N)o
Wind load (pwl*) =		kN (-ve up)			

w(dl)* = 1.35*wdl =	1.52	kN/m	M(dl)* =	1.71	kNm (Max at 1500mm)
w* = 1.2*wdl + 1.5*wll =	2.75	kN/m	M* =	3.10	kNm (Max at 1500mm)
w.up* = 0.9*wdl + wwl* =	1.48	kN/m (up)	Mw.up* =	1.66	kNm (Max at 1500mm)
p(dl)* = 1.35*pdl =	0.00	kN	V(dl)* =	2.28	kN
p* = 1.2*pdl+1.5*pll =	0.00	kN	V* =	4.13	kN
p.up* = 0.9*pdl + pwl* =	0.00	kN	Vw.up* =	2.22	kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	190mm x 42mm Smart LVL15		Area (A) =	7980	mm²
Description =	LVL15 seasoned softwood		Section modulus (Zx) =	253	x10³ mm³
Design depth (dD) =	190 mm		Stiffness (Ix) =	24.0	x10⁶ mm⁴
Design width (dW) =	42 mm		Modulus of elasticity (E) =	15300	MPa - Cl 8.3

S1d = 1.25*dD/dW*(Lay.t/dD)^0.5 =	12.31	For top comp. edge restrained - Cl 3.2.3.2(a)			
S1u = (dD/dW)^1.35*(Lay.t/dD)^0.25 =	11.32	For top tension edge restrained in uplift - Cl 3.2.3.2(a)			
k12d = 1.5-0.05*pbd*S1d =	0.863	for 10 ≤ ρbd*S1d ≤ 20 - Cl 3.2.4			
k12 = 1.5-0.05*pb*S1d =	0.890	for 10 ≤ ρb*S1d ≤ 20 - Cl 3.2.4	f'b =	50.9	MPa
k12u = 1.5-0.05*pbu*S1u =	0.962	for 10 ≤ ρbu*S1u ≤ 20 - Cl 3.2.4	f's =	4.2	MPa
Strength reduction factor (ø) =	0.95	Table 2.1	Material constant (ρbd) =	1.04	(rbd=0.25)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	6.01	kNm	Material constant (ρb) =	0.99	(rb=0.51)
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	10.23	kNm	Stress reversal (ρbu) =	0.95	(rbu=1.00)
øMw = ø*(k1=1)*k4*k6*k9*k12u*f'b*Zx =	11.76	kNm	Duration factor (k1) =	0.94	(Live)
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	12.10	kN	Moisture factor (k4) =	1.00	
øV = ø*k1*k4*k6*f's*(2/3*A) =	19.95	kN	Temp. factor (k6) =	1.00	
øVw = ø*(k1=1)*k4*k6*f's*(2/3*A) =	21.23	kN	Sharing factor (k9) =	1.00	
			Size modifier (mod.b & s) =	1.00	& 1.00

Deflections

			Duration factor (j2) =	2.0		
Ireq'd j2.(DL+Ψl.LL) (L/300) =	15.5	x10⁶ mm⁴	< Critical	δDL=	6.5 mm	Span / 463
Ireq'd `LL (L/240) =	4.1	x10⁶ mm⁴		δΨs.LL =	2.1 mm	Span / 1399
Ireq'd WLs (L/180) =	7.0	x10⁶ mm⁴		δWLs =	-4.9 mm	Span / 616

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

RL Small

TIMBER ROOF BEAM V5.10

Xstruct

Beam:	**(RL Small) 120mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 0.19kNm (+ve) < øM(dl) = 2.96kNm, M* = 0.69kNm (+ve) < øM = 5.02kNm**	**OK (0.06,0.14)**
	Mw* = 0.19kNm (-ve) < øMw = 5.34kNm	**OK (0.04)**
Shear:	**V(dl)* = 0.75kN < øV(dl) = 7.64kN, V* = 2.77kN < øV = 12.60kN**	**OK (0.10,0.22)**
	Vw* = 0.75kN < øVw = 13.41kN	**OK (0.06)**
Deflection:	**δDL = L/3200 (0mm) , δΨs.LL = L/3173 (0mm), δWLs = L/4189 (0mm)**	**OK**
Reactions:	**(Each end) Rdl = 0.56kN, Rll = 1.40kN, Rwl* = -1.25kN, R.dn* = 2.77kN, R.up* = 0.75kN**	

Geometry

(House member affecting ≤ 25m² or secondary building member)

Category =	1	(1) House, (2) Primary building elements, (3) Important		House =	N (Y)es,(N)o
Span (L) =	1000	mm	Edge restrained (down) =	C	(T)ension,(C)ompression,(B)oth
Centres (cts) =	2700	mm	Lay.t (Top) =	900	mm
Span type =	S	(S)ingle,(D)ouble			

Loadings

Roof area (A) =	2.70	m²	Apply wind reduction =	Y	(Y)es,(N)o
LL = 1.8/A+0.12 ≥ 0.25 =	0.79	kPa	Roof reduction (Ka) =	1.00	AS/NZS 1170.2, Table 5.4
			Ratio Ws/Wu =	0.68	(Refer wind analysis)

Uniform dead loads

Roof dead load (wdl) =	0.40	kPa *	2700	mm +		kN/m =	1.08	kN/m
Other dead load (wdl) =		kPa *	2700	mm +		kN/m =	0.00	kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.03	kN/m
						Σwdl =	1.11	kN/m

Uniform live loads

Roof live load (wll) =	0.79	kPa *	2700	mm +		kN/m =	2.12	kN/m
Other live load (wll) =		kPa *	2700	mm +		kN/m =	0.00	kN/m
Alternate point live load =	1.40	kN (critical)	Distr. to	1	members	Σwll =	2.80	kN/m

Uniform wind loads

Ult. wind load (Wu) =	0.84	kPa *	2700	mm		
Cp,e =	0.9	Cp,i =	0.2		Σwwl* =	-2.49 kN/m (up)

Point loads

Dead load (pdl) =		kN	Position =	500	mm from LHS
Live load (pll) =		kN	Shear using PL at support =	Y	(Y)es,(N)o
Wind load (pwl*) =		kN (-ve up)			

w(dl)* = 1.35*wdl =	1.50	kN/m	M(dl)* =	0.19	kNm (Max at 500mm)
w* = 1.2*wdl + 1.5*wll =	5.53	kN/m	M* =	0.69	kNm (Max at 500mm)
w.up* = 0.9*wdl + wwl* =	1.50	kN/m (up)	Mw.up* =	0.19	kNm (Max at 500mm)
p(dl)* = 1.35*pdl =	0.00	kN	V(dl)* =	0.75	kN
p* = 1.2*pdl+1.5*pll =	0.00	kN	V* =	2.77	kN
p.up* = 0.9*pdl + pwl* =	0.00	kN	Vw.up* =	0.75	kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	120mm x 42mm Smart LVL15		Area (A) =	5040	mm²
Description =	LVL15 seasoned softwood		Section modulus (Zx) =	101	x10³ mm³
Design depth (dD) =	120	mm	Stiffness (Ix) =	6.0	x10⁶ mm⁴
Design width (dW) =	42	mm	Modulus of elasticity (E) =	15300	MPa - Cl 8.3

S1d = 1.25*dD/dW*(Lay.t/dD)^0.5 =	9.78	For top comp. edge restrained - Cl 3.2.3.2(a)
S1u = (dD/dW)^1.35*(Lay.t/dD)^0.25 =	6.83	For top tension edge restrained in uplift - Cl 3.2.3.2(a)
k12d = 1.5-0.05*pbd*S1d =	0.971	for 10 ≤ ρbd*S1d ≤ 20 - Cl 3.2.4
k12 =	1.000	for ρb*S1d ≤ 10 - Cl 3.2.4
k12u =	1.000	for ρbu*S1u ≤ 10 - Cl 3.2.4

			f'b =	55.7	MPa
			f's =	4.2	MPa
Strength reduction factor (ø) =	0.95	Table 2.1	Material constant (ρbd) =	1.08	(rbd=0.25)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	2.96	kNm	Material constant (ρb) =	1.01	(rb=0.76)
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	5.02	kNm	Stress reversal (ρbu) =	0.99	(rbu=1.00)
øMw = ø*(k1=1)*k4*k6*k9*k12u*f'b*Zx =	5.34	kNm	Duration factor (k1) =	0.94	(Live)
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	7.64	kN	Moisture factor (k4) =	1.00	
øV = ø*k1*k4*k6*f's*(2/3*A) =	12.60	kN	Temp. factor (k6) =	1.00	
øVw = ø*(k1=1)*k4*k6*f's*(2/3*A) =	13.41	kN	Sharing factor (k9) =	1.00	
			Size modifier (mod.b & s) =	1.00	& 1.00

Deflections

			Duration factor (j2) =	2.0		
Ireq'd j2.(DL+Ψl.LL) (L/300) =	0.6 x10⁶ mm⁴	< Critical	δDL=	0.3	mm	Span / 3200
Ireq'd `LL (L/240) =	0.5 x10⁶ mm⁴		δΨs.LL =	0.3	mm	Span / 3173
Ireq'd WLs (L/180) =	0.3 x10⁶ mm⁴		δWLs =	-0.2	mm	Span / 4189

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

TL1

T LINTEL V5.03

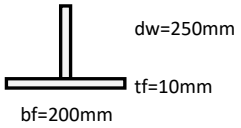
Xstruct

Geometry: (TL1) 250mm x 12mm Pl. Vert., 200mm x 10mm Pl. Horz.
Design: M* = 25.4kNm < øMb(4900,αm=1.13) = 33.4 kNm — **OK (0.76)**
Deflection: δDL = L/748 (7mm), δΨs.LL = L/14095 (0mm), δTotal = L/710 (7mm) — **OK**
Reactions: (Each end) Rdl = 15.4kN, Rll = 1.2kN, R* = 20.7kN

Geometry

Span = Le = 4900 mm

αm = 1.13



Vertical web

Web thickness (tw) = 12 mm
Web depth (dw) = 250 mm
Yield strength = 250 MPa

Horizontal flange

Flange thickness (tf) = 10 mm
Flange width (bf) = 200 mm
Yield strength = 250 MPa

Loading

Live load type = N (N)ormal, (S)torage, (M)anual
AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Roof dead load (wdl) =	0.40	kPa *	900	mm +		kN/m =	0.36 kN/m
Floor dead load (wdl) =		kPa *		mm +		kN/m =	0.00 kN/m
Wall dead load (wdl) =	4.60	kPa *	1200	mm +		kN/m =	5.52 kN/m
Other dead load (wdl) =		kPa *		mm +		kN/m =	0.00 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.39 kN/m
						Σwdl =	6.27 kN/m

Uniform live loads

Roof live load (wll) =	0.53	kPa *	900	mm +		kN/m =	0.48 kN/m
Floor live load (wll) =		kPa *		mm +		kN/m =	0.00 kN/m
Other live load (wll) =		kPa *		mm +		kN/m =	0.00 kN/m
						Σwll =	0.48 kN/m

Point loads

Dead load (Pdl) = kN
Live load (Pll) = kN
Position = 2450 mm from LHS

Horizontal loads

Wall height (wcts) = 0 mm
Ratio Ws/Wu = 0.68
Ult. inward wind load (Wu) = 0.84 kPa
cpe = 0.7 cpi = 0.2 wwl* = 0.00 kN/m
Short term LL (Ψsu) = 0.70 (Ψsp) = 1.00
w* = 1.35*wdl = 8.47 kNm Rdl = wdl*L/2 + pdl*(L-pos)/L = 15.4 kN
p* = 1.2*pdl + 1.5*pll = 0.00 kNm Rll = wll*L/2 + pll*(L-pos)/L = 1.2 kN
M* = 25.4 kNm (Max at 2450mm) R* = 1.35*Rdl = 20.7 kN

Properties

Area =	5000	mm²	Warping constant (Iw) =	0	mm⁶ - Cl H4
Stiffness (Ix) =	35.9	x10⁶ mm⁴	Torsional constant (J) =	210.7	x10³ mm⁴
Stiffness (Iy) =	6.70	x10⁶ mm⁴	Elastic section modulus (Zt) =	202.9	x10³ mm³
Elastic modulus (E) =	200000	MPa - Cl 1.4	Elastic section modulus (Zb) =	432.8	x10³ mm³
Shear modulus (G) =	80000	MPa - Cl 1.4	Min. elastic section modulus (Zmin) =	202.9	x10³ mm³
Elastic (y.top) =	177	mm	Plastic section modulus (S) =	364.2	x10³ mm³
Plastic (yp.top) =	208	mm	Eff. elastic section mod.(Compact) (Zc) =	304.4	x10³ mm³ - Cl 5.2.3

Capacity - Cl 5.6.1.2

Web λs =dw/tw*√(fyw/250) = 20.8 < 22, Non-compact — Cl 5.2.2 — λsy = 22
Zex = Zmin+[(λsy-λs)/(λsy-λsp)*(Zc-Zmin)] = 211.4 x10³ mm³ - Cl 5.2.4 — λsp = 8
ø = 0.9 Table 3.4
Msx = 52.9 kNm øMsx = 47.6 kNm βx = -194.0
Moa = 56.8 kNm αs = 0.621 αm = 1.13
øMbx = αm*αs*øMsx ≤ øMsx = 33.4 kNm - Cl 5.6.1.1(1)

Deflections

Ireq'd DL (L/500) =	24.0	x10⁶ mm⁴	< Critical	δDL =	6.6 mm	Span / 748
Ireq'd Ψs.LL (10mm max) =	1.2	x10⁶ mm⁴		Ψs.δLL =	0.3 mm	Span / 14095
Ireq'd WLs.h (L/250) =	0.0	x10⁶ mm⁴		δWLs.h =	0.0 mm	Span / -
Ireq'd (DL+Ψs.LL) (10mm max) =	24.8	x10⁶ mm⁴		δTotal =	6.9 mm	Span / 710
				1kN midspan δ =	0.3 mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

T1

TIMBER FLOOR BEAM V5.10

Xstruct

Beam:	**(T1) 2 / 120mm x 42mm Smart LVL15 (Oregon) (Single span)**	
Bending:	**M(dl)* = 0.70kNm (+ve) < øM(dl) = 5.74kNm, M* = 0.97kNm (+ve) < øM = 8.34kNm**	**OK (0.12,0.12)**
Shear:	**V(dl)* = 2.82kN < øV(dl) = 15.28kN, V* = 3.90kN < øV = 21.45kN**	**OK (0.18,0.18)**
Deflection:	**δDL = L/1909 (1mm) , δΨs.LL = L/4935 (0mm), δTotal = L/1376 (1mm), 1kN mid. δ = 0.1mm**	**OK**
Reactions:	**(Each end) Rdl = 1.00kN, Rll = 1.80kN, R* = 3.90kN**	

Geometry

(House member affecting ≤ 25m² or secondary building member)

Category =	1	(1) House, (2) Primary building elements, (3) Important			
House =	N	(Y)es,(N)o	Edge restrained =	C	(T)ension, (C)ompression, (B)oth
Span (L) =	1000	mm	Lay.t (Top) =	1000	mm
Centres (cts) =	450	mm			
Span type =	S	(S)ingle,(D)ouble			

Loadings

Floor area (A) =	0.45	m²	Live load type =	N	(N)ormal, (S)torage, (M)anual
					AS/NZS 1170.0 - Table 4.1

Uniform dead loads

Floor dead load (wdl) =	0.50	kPa *	450	mm +		kN/m =	0.23 kN/m
Wall dead load (wdl) =	0.50	kPa *	2700	mm +		kN/m =	1.35 kN/m
Other dead load (wdl) =	0.40	kPa *	900	mm +		kN/m =	0.36 kN/m
Include S.Wt =	Y	(Y)es,(N)o				S.Wt =	0.06 kN/m
						Σwdl =	2.00 kN/m

Uniform live loads

Floor live load (wll) =	1.50	kPa *	450	mm +		kN/m =	0.68 kN/m
Partitions (wll) =	0.25	kPa *	900	mm +		kN/m =	0.23 kN/m
Alternate point live load =	1.80	kN (critical)	Distr. to	1	members	Σwll =	3.60 kN/m

Point loads

Dead load (pdl) =		kN	Position =	500	mm from LHS
Live load (pll) =		kN	Shear using PL at support =	N	(Y)es,(N)o

Short term LL factor (Ψsu) =	0.70		(Ψsp) =	1.00	
Long term LL factor (Ψlu) =	0.40		(Ψlp) =	0.60	
wdl* = 1.2*wdl+1.5*Ψlu*wll =	5.63	kN/m	M(dl+Ψl.ll)* =	0.70	kNm (Max at 500mm)
w* = 1.2*wdl+1.5*wll =	7.79	kN/m	M* =	0.97	kNm (Max at 500mm)
pdl* = 1.2*pdl+1.5*Ψlp*pll =	0.00	kN	V(dl+Ψl.ll)* =	2.82	kN
p* = 1.2*pdl+1.5*pll =	0.00	kN	V* =	3.90	kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	2 / 120mm x 42mm Smart LVL15		Area (A) =	10080	mm²
Description =	LVL15 seasoned softwood		Section modulus (Zx) =	202	x10³ mm³
Design depth (dD) =	120	mm	Stiffness (Ix) =	12.1	x10⁶ mm⁴
Design width (dW) =	42	mm	Modulus of elasticity (E) =	15300	MPa - Cl 8.3

S1 = 1.25*dD/dW*(Lay.t/dD)^0.5 =	10.31	For top comp. edge restrained - Cl 3.2.3.2(a)			
k12d = 1.5-0.05*ρbd*S1 =	0.943	for 10 ≤ ρbd*S1 ≤ 20 - Cl 3.2.4	f'b =	55.7	MPa
k12 = 1.5-0.05*ρb*S1 =	0.976	for 10 ≤ ρb*S1 ≤ 20 - Cl 3.2.4	f's =	4.2	MPa
			Material constant (ρbd) =	1.08	(rbd=0.25)
Strength reduction factor (ø) =	0.95	Table 2.1	Material constant (ρb) =	1.02	(rb=0.69)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	5.74	kNm	Duration factor (k1) =	0.80	
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	8.34	kNm	Moisture factor (k4) =	1.00	
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	15.28	kN	Temp. factor (k6) =	1.00	
øV = ø*k1*k4*k6*f's*(2/3*A) =	21.45	kN	Sharing factor (k9) =	1.00	
			Size modifier (mod.b) =	1.00	
			Size modifier (mod.s) =	1.00	

Deflections

			Duration factor (j2) =	2.0		
Ireq'd j2.(DL+Ψl.LL) (L/300) =	1.9 x10⁶ mm⁴	< Critical	j2.(DL+Ψl.LL) =	0.5	mm	Span / 1909
Ireq'd Ψs.LL (L/300) =	0.7 x10⁶ mm⁴		Ψs.δLL =	0.2	mm	Span / 4935
Ireq'd Total (L/250) =	2.2 x10⁶ mm⁴		δTotal =	0.7	mm	Span / 1376
			1kN midspan δ =	0.1	mm	

XSTRUCT CONSULTING ENGINEERS

Date: 10.0924
Project No: 1685
Designed: ED

RB1

TIMBER ROOF BEAM V5.10

Xstruct

Beam:	**(RB1) 290mm x 42mm Smart LVL15* (Oregon) (Single span)**	
Bending:	**M(dl)* = 3.56kNm (+ve) < øM(dl) = 11.11kNm, M* = 4.95kNm (+ve) < øM = 18.74kNm**	**OK (0.32,0.26)**
	Mw* = 0.00kNm (-ve) < øMw = 21.10kNm	**OK (0.00)**
Shear:	**V(dl)* = 4.18kN < øV(dl) = 18.47kN, V* = 5.82kN < øV = 30.45kN**	**OK (0.23,0.19)**
	Vw* = 1.22kN < øVw = 32.40kN	**OK (0.04)**
Deflection:	**δDL = L/700 (5mm) , δΨs.LL = L/3874 (1mm), δWLs = L/4062 (-1mm)**	**OK**
Reactions:	**(Each end) Rdl = 3.10kN, Rll = 1.40kN, Rwl* = -1.57kN, R.dn* = 5.82kN, R.up* = -1.22kN (Down)**	

Geometry

(House member affecting ≤ 25m² or secondary building member)

Category =	1 (1) House, (2) Primary building elements, (3) Important			House =	N (Y)es,(N)o
Span (L) =	3400 mm		Edge restrained (down) =	C	(T)ension,(C)ompression,(B)oth
Centres (cts) =	1000 mm		Lay.t (Top) =	900 mm	
Span type =	S (S)ingle,(D)ouble				

Loadings

Roof area (A) =	3.40 m²		Apply wind reduction =	Y	(Y)es,(N)o
LL = 1.8/A+0.12 ≥ 0.25 =	0.65 kPa		Roof reduction (Ka) =	1.00	AS/NZS 1170.2, Table 5.4
			Ratio Ws/Wu =	0.68	(Refer wind analysis)

Uniform dead loads

Roof dead load (wdl) =	0.40 kPa *	1000 mm +		kN/m =		0.40	kN/m
Other dead load (wdl) =	0.50 kPa *	2700 mm +		kN/m =		1.35	kN/m
Include S.Wt =	Y (Y)es,(N)o			S.Wt =		0.07	kN/m
				Σwdl =		1.82	kN/m

Uniform live loads

Roof live load (wll) =	0.65 kPa *	1000 mm +		kN/m =		0.65	kN/m
Other live load (wll) =	kPa *	1000 mm +		kN/m =		0.00	kN/m
Alternate point live load =	1.40 kN (critical)	Distr. to	1 members	Σwll =		0.82	kN/m

Uniform wind loads

Ult. wind load (Wu) =	0.84 kPa *	1000 mm					
Cp,e =	0.9	Cp,i =	0.2	Σwwl* =		-0.92	kN/m (up)

Point loads

Dead load (pdl) =	kN		Position =	1700	mm from LHS
Live load (pll) =	kN		Shear using PL at support =	Y	(Y)es,(N)o
Wind load (pwl*) =	kN (-ve up)				

w(dl)* = 1.35*wdl =	2.46 kN/m		M(dl)* =	3.56	kNm (Max at 1700mm)
w* = 1.2*wdl + 1.5*wll =	3.42 kN/m		M* =	4.95	kNm (Max at 1700mm)
w.up* = 0.9*wdl + wwl* =	-0.72 kN/m (down)		Mw.dn* =	0.00	kNm
p(dl)* = 1.35*pdl =	0.00 kN		V(dl)* =	4.18	kN
p* = 1.2*pdl+1.5*pll =	0.00 kN		V* =	5.82	kN
p.up* = 0.9*pdl + pwl* =	0.00 kN		Vw.up* =	1.22	kN

Bending and Shear capacity - Cl 3.2.1 & Cl 3.2.5

Member =	290mm x 42mm Smart LVL15*		Area (A) =	12180	mm²
Description =	LVL15 seasoned softwood		Section modulus (Zx) =	589	x10³ mm³
Design depth (dD) =	290 mm		Stiffness (Ix) =	85.4	x10⁶ mm⁴
Design width (dW) =	42 mm		Modulus of elasticity (E) =	15300	MPa - Cl 8.3

S1d = 1.25*dD/dW*(Lay.t/dD)^0.5 =	15.20	For top comp. edge restrained - Cl 3.2.3.2(a)			
S1ud = 1.25*dD/dW*(Lay.t/dD)^0.5 =	15.20	For top comp. edge restrained - Cl 3.2.3.2(a)			
k12d = 1.5-0.05*ρbd*S1d =	0.744	for 10 ≤ ρbd*S1d ≤ 20 - Cl 3.2.4			
k12 = 1.5-0.05*ρb*S1d =	0.761	for 10 ≤ ρb*S1d ≤ 20 - Cl 3.2.4	f'b =	46.9	MPa
k12u = 1.5-0.05*ρbu*S1u =	0.805	for 10 ≤ ρbu*S1u ≤ 20 - Cl 3.2.4	f's =	4.2	MPa
Strength reduction factor (ø) =	0.95	Table 2.1	Material constant (ρbd) =	0.99	(rbd=0.25)
øM(dl) = ø*(k1=0.57)*k4*k6*k9*k12d*f'b*Zx =	11.11	kNm	Material constant (ρb) =	0.97	(rb=0.36)
øM = ø*k1*k4*k6*k9*k12*f'b*Zx =	18.74	kNm	Stress reversal (ρbu) =	0.91	(rbu=1.00)
øMw = ø*(k1=1)*k4*k6*k9*k12u*f'b*Zx =	21.10	kNm	Duration factor (k1) =	0.94	(Live)
øV(dl) = ø*(k1=0.57)*k4*k6*f's*(2/3*A) =	18.47	kN	Moisture factor (k4) =	1.00	
øV = ø*k1*k4*k6*f's*(2/3*A) =	30.45	kN	Temp. factor (k6) =	1.00	
øVw = ø*(k1=1)*k4*k6*f's*(2/3*A) =	32.40	kN	Sharing factor (k9) =	1.00	
			Size modifier (mod.b & s) =	1.00	& 1.00

Deflections

			Duration factor (j2) =	2.0		
Ireq'd j2.(DL+Ψl.LL) (L/300) =	36.6 x10⁶ mm⁴	< Critical	δDL=	4.9 mm		Span / 700
Ireq'd `LL (L/240) =	5.3 x10⁶ mm⁴		δΨs.LL =	0.9 mm		Span / 3874
Ireq'd WLs (L/180) =	3.8 x10⁶ mm⁴		δWLs =	-0.8 mm		Span / 4062

Wall:	**(RW1 ALT 500) 1500mm retaining ht., 300mm thick (No key)**	
Loads:	**Surcharge = 5.00kPa, Drained**	
Footing:	**1700mm long (overall), 1400mm overhang (behind wall), 600mm deep**	
Stability:	**M*o = 27.8kNm < øMr = 43.2kNm**	**OK (0.64)**
Sliding:	**V*slide = 35.9kN < øVr = 36.5kN**	**OK (0.98)**
Wall:	**M*wall = 11.2kNm, V*wall = 19.8kN, Design factor Φn = 0.9**	
Bearing:	**Max. bearing pressure = 90kPa < Allowable = 150kPa**	**OK (0.60)**

Geometry

Wall assumed fully drained

Retaining height (z) =	1500	mm (= Wall height)
Risk class =	C	(A),(B),(C) - Significant damage or risk to life - Table 1.1
Backfill type =	1	Class(1), Class(2), (U)ncontrolled, (I)n-situ - Table 5.1(A)

Soil parameters

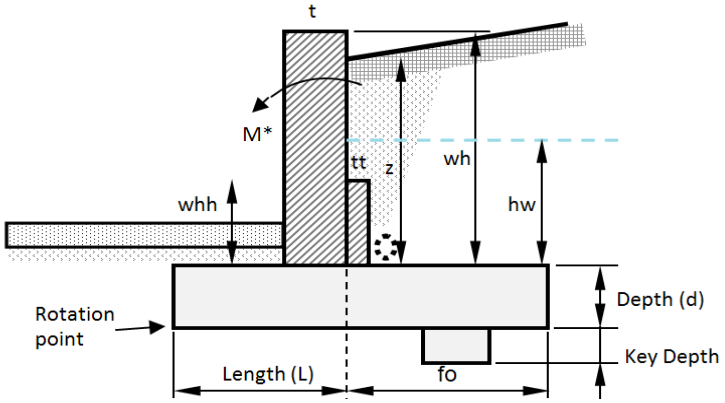
Internal friction (ø) =	25	° (0° ≤ ø ≤ 45°)
Incline (β) =	0	° (0° ≤ β ≤ 45°) 1 in 0.0
Soil weight (γ) =	22.0	kN/m³
Cohesion (c) =	0	kPa
Friction coefficient (μ) =	0.443	(-1 to ignore sliding)
Use passive =	Y	(Y)es,(N)o
Manual Kp value =	0.00	0 for default
Soil depth to Ignore =	0	mm (for passive)
Allowable bearing =	150	kPa
Slab overlay (ts) =		mm
Soil overlay (tsl) =		mm

Wall

Wall thickness (t) =	300	mm
Wall height (wh) =	1500	mm (= Retaining height)
Add'l thickness (tt) =		mm (behind wall)
Add'l th. height (whh) =		mm
Add'l th. on soil side =	Y	(Y)es,(N)o
Wall Wt (Wwt) =	25	kN/m³

Footing

Footing depth (d) =	600	mm
End thickness (d2) =	0	mm (0 = no taper)
Footing length (L) =	300	mm excluding overhang
Overhang (fo) =	1400	mm additional to length
Key depth (key) =	0	mm (sliding only)
Key length (klen) =	0	mm
Key position from heel/back (kpos) =	0	mm (to face)



Design loads - Appendix J - AS4678 & Section 4

Surcharge Min. =	5.0	kPa min. (Table 4.1)
Surcharge (S) =	5.0	kPa
Water height (hw) =	0	mm (over footing, 0=no water)
Earth factor =	1.25	(1.25)
Water pressure =	1.00	(1.00)
Live load factor =	1.50	(1.50 - 0.0 for stabilising effect)
Stabilising factor (øs) =	0.80	AS 4678 - Appendix J2

Additional Loads at top of wall:

Overturning (Ma) =	0.00	kNm/m
Thrust (Va) =	0.00	kN/m
Load factor =	1.50	
Ma* =	0.00	kNm/m
Va* =	0.00	kN/m
(Moment/Thrust about top wall)		
Additional dead load (Pv) =	0.00	kN/m

Material design factors - Section 5

Φuc =	0.90	c*=c*Φuc =	0	kPa	Cl 5.2.1		
Φuo =	0.95	ø* =	23.9	°	Cl 5.2.2	ø* =	0.417 rad
Design factor (Φn) =	0.90	Table 5.2					
	Ka =	0.423			Depth of tension zone =	0	mm
	Kp =	2.362			Acting soil height (ha) =	1500	mm

Design Moment in wall (about top of footing, per m of wall)

	Pressure	Thrust	Thrust*	Lever arm	Mw	Mw*	Comments
	kPa	kN/m	kN/m	mm	kNm/m	kNm/m	(At wall base)
Soil = Ka*γ*ha =	13.97	10.48	13.10	500	5.24	6.55	Max. pressure at base
Water = None =	0.00	0.00	0.00	0	0.00	0.00	Max. pressure at base
Surcharge = Ka*S =	2.12	3.18	4.76	750	2.38	3.57	Uniform pressure dist.
Additional =		0.00	0.00	1500	0.00	0.00	
Total		**13.66**	**17.86**		**7.62**	**10.12**	

Total thrust (Vw) =	13.66	kN/m
Total ult. thrust (Vw*) =	17.86	kN/m
Total ult. design thrust (Vw/Φn) =	19.85	kN/m
Total moment (Mw) =	7.62	kNm/m
Total ult. moment (Mw*) =	10.12	kNm/m
Total ult. design moment (Mw*/Φn) =	11.25	kNm/m

Overturning (Limit mode U2) (about base of footing, per m of wall)

Depth for rotation (deff) = 600 mm (Footing depth)

	Pressure	Thrust	Thrust*	Lever arm	Mo	Mo*	Comments
	kPa	kN/m	kN/m	mm	kNm/m	kNm/m	(At footing base)
Soil = Ka*γ*(ha+deff) =	19.56	20.54	25.68	700	14.38	17.97	Max. pressure at base
Water = None =	0.00	0.00	0.00	0	0.00	0.00	Max. pressure at base
Surcharge = Ka*S =	2.12	4.45	6.67	1050	4.67	7.00	Uniform pressure dist.
Additional =		0.00	0.00	2100	0.00	0.00	
Total		**24.99**	**32.35**		**19.05**	**24.98**	

Total thrust =	24.99	kN/m
Total ult. thrust =	32.35	kN/m
Total moment (Mo) =	19.05	kNm/m
Total ult. moment (Mo*) =	24.98	kNm/m
Total ult. (Mo*/Φn) =	27.75	kNm/m

Restoring (Limit mode U2) (about base of footing, per m of wall)

	Force	Lever arm	Mr	øMr	Ecc	Mb	
	kN/m	mm	kNm/m	kNm/m	mm	kNm/m	
Footing =	24.48	648	15.86	12.69	0	0.00	
Soil overlay =	0.00	-202	0.00	0.00	850	0.00	
Slab overlay =	0.00	-202	0.00	0.00	850	0.00	
Wall =	11.25	-52	-0.58	-0.47	700	7.88	
Lower wall (back) =	0.00	98	0.00	0.00	550	0.00	Using Wwt-Soil dentity (γ)
Soil behind wall =	46.20	798	36.87	29.49	-150	-6.93	
Dead load (Pv) =	0.00	-52	0.00	0.00	700	0.00	
Tapered =	0.00	0	0.00	0.00	850	0.00	
Key =	0.00	1498	0.00	0.00	-850	0.00	
Passive pressure =			1.87	1.50			
Total	**81.93**		**54.02**	**43.21**		**0.95**	

Total force (Wt) =	81.93	kN/m	
Total bearing overturning (Mb) =	0.95	kN/m	
Total restoring (Mr) =	54.02	kNm/m	
Total ult. Restoring (øs(0.80)*"Mr) =	43.21	kNm/m	OK (0.64)

Sliding (Limit mode U1)

Sliding (V*slide/Φn) =	35.94	kN/m at base	
Passive resistance of footing and key (Rp) =	9.35	kN/m	
Sliding resistance (Rs = μ*Wt) =	36.29	kN/m	
Total resistance øVr = øs(0.80)*(Rp+Rs) =	36.52	kN/m	OK (0.98)

Bearing

Total (Wt) =	81.93	kN/m	
Overturning moment (Mot = Mo + Mb) =	19.99	kNm/m	
Ecc = Mot / Wt =	244	mm	
Minimum bearing pressure (q.min) =	6.7	kPa	
Maximum bearing pressure (q.max) =	89.7	kPa	OK (0.60)
Centroid from left/front edge of footing (y) =	606	mm	(Entire footing under pressure)

Design Moment and Shear in footing due to bearing (per m of wall)

Manual force position = 850 mm (from left/front edge of footing)
Equivalent load factor = 1.31

	Moment* kNm/m	Shear* kN/m	Lever arm mm	Position mm
Front face of wall =	0.0	0.0	-	0
Centre of wall (from the left) =	0.5	6.7	78	150
Centre of wall (from the right) =	-24.5	6.7	3642	150
Back face of wall (soil side) =	-23.0	12.0	1921	300
Max. moment (+ve) =	0.5	6.7	-	150
Max. moment (-ve) =	-24.5	6.7	-	150
Max. shear =	-11.7	22.2	-	895
Manual position =	-12.7	22.2	-	850

Graphs (Footing)