Tekla Tedds	Project BEAM A - Plate Connection - Restraining in centre or			ntre on mid wall	Job no. 2023-	-7459
PlanningApplications.com Summer House, Upper Court Road Woldingham Surrey CR3 7BF	Calcs for Mr Ashley Mujer 12 Avondale Gardens Hounslow TW4 5HX			Start page no./Revision 1		
support@planningapplications.com 07922 148 701	Calcs by SB	Calcs date 28/09/2023	Checked by DB	Checked date 28/09/2023	Approved by SB	Approved date 28/09/2023

BOLTED COVER PLATE SPLICE CONNECTION TO BS5950-1:2000

TEDDS calculation version 1.0.08 465 →25 ▶25 ◄ -2 x 90-▶ 4 55 ▶ 4 -2 x 90· -\$ - 170-25 - 120 -25 - 100 - 25 - 150-2 x 90-2 x 90-25 ►25 ▶ ₹ 55 ▶ ₹ **Connection loads** Design moment M = 50 kNm Axial force in the member (compression +ve) N = 50 kN Shear force in the member V = **50** kN Steel beam details Beam section classification UC 203x203x46 S275 Grade of steel section Section bearing strength p_{bs_s} = 460 N/mm² **General connection details** Grade of steel plate S275 Plate bearing strength p_{bs_p} = **460** N/mm² M16 (Torqued General Grade HSFG) Bolt classification Hole diameter D_h = **18** mm Bolt slip factor $\mu = 0.50$ Hole type factor $K_{s} = 1.0$ Flange plate details - plates bolted to one side of each flange Thickness of flange plates t_{fp} = **10** mm Width of flange plates b_{fp} = **170** mm Length of flange plates l_{fp} = **465** mm Flange bolting details Rows of flange bolts on each side of joint n_{fb_r} = 3 Bolts per row n_{fb_p} = 2 Total number of flange bolts each side of joint $n_{fb} = n_{fb_r} \times n_{fb_p} = \textbf{6}$ Spacing between rows of bolts S_f = **90** mm

Tedds	Project BEAM A - Pla Calcs for							
PlanningApplications.com Summer House, Upper Court Road Woldingham Surrey CR3 7BF	lujer 12 Avondale	12 Avondale Gardens Hounslow TW4 5HX			Start page no./Revision 2			
support@planningapplications.com 07922 148 701	Calcs by SB	Calcs date 28/09/2023	Checked by DB	Checked date 28/09/2023	Approved by SB	Approved da 28/09/202		
Spacing between rows of bolts	across joint	S _{fc} = 55 mr	n					
Spacing at end of flange plates	6	S _{fe} = 25 mr	n					
Lateral spacing between centra	al bolts	S _{flc} = 120 n	nm					
Lateral spacing at edge of flan	ge plates	S _{fle} = 25 mi	m					
Web plate details - plates bo	Ited to both sid	es of the web						
Thickness of web plates		t _{wp} = 10 mn	n					
Width of web plates		b _{wp} = 465 n	nm					
Length of web plates		l _{wp} = 150 m	m					
Web bolting details								
Rows of web bolts		n _{wb_r} = 2						
Bolts per row each side of joint		$n_{wb_p} = 3$						
Total number of web bolts each side of joint		$\mathbf{n}_{wb} = \mathbf{n}_{wb_r} \times \mathbf{n}_{wb_p} = 6$						
Spacing between rows of bolts		S _w = 100 mm						
Spacing at end of web plates		S _{we} = 25 mm						
Lateral spacing between bolts	S _{wi} = 90 mm							
Lateral spacing between centra	S _{wic} = 55 mm							
Lateral spacing at edge of web	S _{wle} = 25 m	m						
Step 1 - Distribution of force	s in momhar fla	andes						
Step 1 - Distribution of force		-	ь - Ть)] — N / 2	= 235 kN				
Forces in member tension flan	ge	T = [M / (D	ь - Ть)] — N / 2 ь - Ть)] + N / 2					
	ge	T = [M / (D C = [M / (D	_b - T _b)] + N / 2					
Forces in member tension flan Forces in member compressio	ge n flange	T = [M / (D) C = [M / (D F _f = max(T						
Forces in member tension flan Forces in member compressio Force in the flange	ge n flange	T = [M / (D) C = [M / (D F _f = max(T	_b - T _b)] + N / 2					
Forces in member tension flan Forces in member compressio Force in the flange Step 2 - Calculate distributio	ge n flange	T = [M / (D) C = [M / (D F _f = max(T	_b - T _b)] + N / 2 , C) = 285 kN					
Forces in member tension flan Forces in member compressio Force in the flange Step 2 - Calculate distributio Check area of flange	ge n flange n of forces in n	T = [M / (D C = [M / (D F _f = max(T nember flanges	_b - T _b)] + N / 2 , C) = 285 kN					
Forces in member tension flan Forces in member compressio Force in the flange Step 2 - Calculate distributio Check area of flange Design strength of section	ge n flange n of forces in n	T = [M / (D C = [M / (D F _f = max(T nember flanges p _{ys} = 275 N	_b - T _b)] + N / 2 , C) = 285 kN					
Forces in member tension flan Forces in member compressio Force in the flange Step 2 - Calculate distributio Check area of flange Design strength of section Minimum required effective flan	ge n flange n of forces in n	$T = [M / (D] C = [M / (D] C = [M / (D] F_{f} = max(T) + max(T) +$	_b - T _b)] + N / 2 , C) = 285 kN		ь) = 2212 mm	2		
Forces in member tension flan Forces in member compressio Force in the flange Step 2 - Calculate distributio Check area of flange Design strength of section Minimum required effective flan Effective net area coefficient	ge n flange n of forces in n	$T = [M / (D] C = [M / (D] C = [M / (D] F_{f} = max(T) + max(T) +$	_b - T _b)] + N / 2 , C) = 285 kN	= 285 kN				
Forces in member tension flan Forces in member compression Force in the flange Step 2 - Calculate distribution Check area of flange Design strength of section Minimum required effective flan Effective net area coefficient Effective flange area Check area of flange plates	ge n flange n of forces in n	$T = [M / (D] C = [M / (D] C = [M / (D] F_{f} = max(T)]$ nember flanges $p_{ys} = 275 N$ $F_{f} / p_{ys} = 10$ $K_{e} = 1.2$ $A_{ef} = min(K)$	b - T _b)] + N / 2 , C) = 285 kN //mm ² 037 mm ² fe × [B _b - (n _{fb_P}	= 285 kN × D _h)] × T _b , B _b × T				
Forces in member tension flan Forces in member compression Force in the flange Step 2 - Calculate distribution Check area of flange Design strength of section Minimum required effective flan Effective net area coefficient Effective flange area Check area of flange plates Design strength of plates	ge n flange n of forces in n nge area	$T = [M / (D_{f} C = [M / (D_{f} C = [M / (D_{f} F_{f} = max(T nember flanges)]$ $p_{ys} = 275 N$ $F_{f} / p_{ys} = 10$ $K_{e} = 1.2$ $A_{ef} = min(K)$ $p_{yp} = 275 N$	b - T _b)] + N / 2 , C) = 285 kN //mm ² 037 mm ² 	= 285 kN × D _h)] × T _b , B _b × T				
Forces in member tension flan Forces in member compression Force in the flange Step 2 - Calculate distribution Check area of flange Design strength of section Minimum required effective flan Effective net area coefficient Effective flange area Check area of flange plates Design strength of plates Minimum required effective flan	ge n flange n of forces in n nge area	$T = [M / (D_{f} C = [M / (D_{f} C = [M / (D_{f} F = max(T nember flanges)]$ $p_{ys} = 275 N$ $F_{f} / p_{ys} = 10$ $K_{e} = 1.2$ $A_{ef} = min(K)$ $p_{yp} = 275 N$ $F_{f} / p_{yp} = 10$	b - T _b)] + N / 2 , C) = 285 kN //mm ² 37 mm ² f.e × [B _b - (n _{fb_p} //mm ² 1 /mm ²	= 285 kN × D _h)] × T _b , B _b × T <i>PASS - Effecti</i>	ve flange are	ea is adequa		
Forces in member tension flan Forces in member compression Force in the flange Step 2 - Calculate distribution Check area of flange Design strength of section Minimum required effective flan Effective net area coefficient Effective flange area Check area of flange plates Design strength of plates	ge n flange n of forces in n nge area	$T = [M / (D_{f} C = [M / (D_{f} C = [M / (D_{f} F = max(T nember flanges)]$ $p_{ys} = 275 N$ $F_{f} / p_{ys} = 10$ $K_{e} = 1.2$ $A_{ef} = min(K)$ $p_{yp} = 275 N$ $F_{f} / p_{yp} = 10$	$(h_{b} - T_{b}) + N / 2$ $(h_{c} - T_{b}) + N / 2$ $(h_{c} - 285 \text{ kN})$ $(h_{c} - 285 \text{ kN})$	= 285 kN × D _h)] × T _b , B _b × T	ve flange are	ea is adequa		
Forces in member tension flan Forces in member compression Force in the flange Step 2 - Calculate distribution Check area of flange Design strength of section Minimum required effective flan Effective net area coefficient Effective flange area Check area of flange plates Design strength of plates Minimum required effective flan	ge n flange n of forces in n nge area nge plate area	$T = [M / (D_{f} C = [M / (D_{f} C = [M / (D_{f} F = max(T nember flanges)]$ $p_{ys} = 275 N$ $F_{f} / p_{ys} = 10$ $K_{e} = 1.2$ $A_{ef} = min(K)$ $p_{yp} = 275 N$ $F_{f} / p_{yp} = 10$	$(h_{b} - T_{b}) + N / 2$ $(h_{c} - T_{b}) + N / 2$ $(h_{c} - 285 \text{ kN})$ $(h_{c} - 285 \text{ kN})$	= 285 kN × D₁)] × T♭, B♭ × T <i>PASS - Effecti</i> × D₁)] × tſp, bſp × tſ	ve flange are	ea is adequa		
Forces in member tension flan Forces in member compressio Force in the flange Step 2 - Calculate distributio Check area of flange Design strength of section Minimum required effective flan Effective net area coefficient Effective flange area Check area of flange plates Design strength of plates Minimum required effective flan Effective flange plate area	ge n flange n of forces in n nge area nge plate area ts	$T = [M / (D_{f} C = [M / (D_{f} C = [M / (D_{f} F = max(T nember flanges)]$ $p_{ys} = 275 N$ $F_{f} / p_{ys} = 10$ $K_{e} = 1.2$ $A_{ef} = min(K)$ $p_{yp} = 275 N$ $F_{f} / p_{yp} = 10$ $A_{ep} = min(K)$	$(h_{b} - T_{b}) + N / 2$ $(h_{c} - T_{b}) + N / 2$ $(h_{c} - 285 \text{ kN})$ $(h_{c} - 285 \text{ kN})$	= 285 kN × Dh)] × Tb, Bb × T PASS - Effecti × Dh)] × tfp, bfp × tf SS - Effective flat	ve flange are	ea is adequa		
Forces in member tension flan Forces in member compression Force in the flange Step 2 - Calculate distribution Check area of flange Design strength of section Minimum required effective flan Effective net area coefficient Effective flange area Check area of flange plates Design strength of plates Minimum required effective flan Effective flange plate area Step 3 - Design of flange bol	ge n flange n of forces in n nge area nge plate area ts nterface	$T = [M / (D_{f} C = [M / (D_{f} C = [M / (D_{f} F_{f} = max(T + max($	$(h_{b} - T_{b}) + N / 2$ $(h_{c} - T_{b}) = 285 \text{ kN}$ $(h_{m}m^{2})$ $(h_{c} \times [B_{b} - (n_{fb_{p}})]$ $(h_{c} \times [B_{fp} - (n_{fb_{p}})]$ $(h_{c} \times [b_{fp} - (n_{fb_{p}})]$ $(h_{b} - PA)$	= 285 kN × D _h)] × T _b , B _b × T <i>PASS - Effecti</i> × D _h)] × t _{fp} , b _{fp} × t _f <i>SS - Effective fla</i> . 50.7 kN	ve flange are	ea is adequa		
Forces in member tension flan Forces in member compression Force in the flange Step 2 - Calculate distribution Check area of flange Design strength of section Minimum required effective flan Effective flange area Check area of flange plates Design strength of plates Minimum required effective flan Effective flange plate area Step 3 - Design of flange bol Slip resistance of the bolt per i	ge n flange n of forces in n nge area nge plate area ts nterface the flange	$T = [M / (D]$ $C = [M / (D]$ $F_{f} = max(T)$ nember flanges $p_{ys} = 275 \text{ N}$ $F_{f} / p_{ys} = 10$ $K_{e} = 1.2$ $A_{ef} = min(K)$ $p_{yp} = 275 \text{ N}$ $F_{f} / p_{yp} = 10$ $A_{ep} = min(K)$ $S_{fb} = 1.1 \times P_{bg_{s}} = 1.5$	$(h_{s} - T_{b}) + N / 2$ $(h_{s} - T_{b}) = 285 \text{ kN}$ $(h_{m}m^{2})$ $(h_{s} \times [B_{b} - (n_{fb_{p}}m^{2})]$ $(h_{s} \times [b_{fp} - (n_{fb_{p}}m^{2})]$ $(h_{s} \times \mu \times P_{p} = 5)$	= 285 kN × D _h)] × T _b , B _b × T <i>PASS - Effecti</i> × D _h)] × t _{fp} , b _{fp} × t _f <i>SS - Effective fla</i> 50.7 kN s = 121.4 kN	ve flange are	ea is adequa		
Forces in member tension flan Forces in member compressio Force in the flange Step 2 - Calculate distribution Check area of flange Design strength of section Minimum required effective flan Effective net area coefficient Effective flange area Check area of flange plates Design strength of plates Minimum required effective flan Effective flange plate area Step 3 - Design of flange bol Slip resistance of the bolt per i Bearing capacity of the bolt in	ge n flange n of forces in n nge area nge plate area ts nterface the flange the plate	$T = [M / (D_{I} C = [M - 1.2])])])]$ $p_{ys} = 275 N$ $F_{f} / p_{ys} = 100$ $A_{ef} = min(K)$ $P_{yp} = 275 N$ $F_{f} / p_{yp} = 100$ $A_{ep} = min(K)$ $S_{fb} = 1.1 \times P_{bg_s} = 1.5$ $P_{bg_p} = 1.5$	[-2] + N / 2 $(-2) = 285 kN$ $(-2) = 28$	= 285 kN × D _h)] × T _b , B _b × T <i>PASS - Effecti</i> × D _h)] × t _{fp} , b _{fp} × t _f <i>SS - Effective fla</i> 50.7 kN s = 121.4 kN	ve flange are	ea is adequa		
Forces in member tension flan Forces in member compression Force in the flange Step 2 - Calculate distribution Check area of flange Design strength of section Minimum required effective flan Effective net area coefficient Effective flange area Check area of flange plates Design strength of plates Minimum required effective flan Effective flange plate area Step 3 - Design of flange bol Slip resistance of the bolt per i Bearing capacity of the bolt in Average flange bolt end distan	ge n flange n of forces in n nge area nge plate area ts nterface the flange the plate ce	$T = [M / (D_{I} C = [M / (D_{I} C = [M / (D_{I} F_{f} = max(T member flanges))]$ $p_{ys} = 275 N$ $F_{f} / p_{ys} = 100$ $K_{e} = 1.2$ $A_{ef} = min(K)$ $p_{yp} = 275 N$ $F_{f} / p_{yp} = 100$ $A_{ep} = min(K)$ $S_{fb} = 1.1 \times P_{bg_s} = 1.5$ $P_{bg_p} = 1.5$ $S_{fe_ave} = S_{fe}$	$[/mm^{2}] + N / 2$ $(-mm^{2}) + (-mm^{2}) + N / 2$ $(-mm^{2}) + (-mm^{2}) + N / 2$ $(-mm^{2}) + (-mm^{2}) + (-mm^{2}$	= 285 kN × D _h)] × T _b , B _b × T <i>PASS - Effecti</i> <i>SS - Effective fla</i> 50.7 kN s = 121.4 kN 5 _f / 2 = 115 mm	p) = 1608 mm nge plate are	ea is adequa		
Forces in member tension flan Forces in member compression Force in the flange Step 2 - Calculate distribution Check area of flange Design strength of section Minimum required effective flan Effective net area coefficient Effective flange area Check area of flange plates Design strength of plates Minimum required effective flan Effective flange plate area Step 3 - Design of flange bol Slip resistance of the bolt per in Bearing capacity of the bolt in	ge n flange n of forces in n nge area nge plate area ts nterface the flange the plate ce	$T = [M / (D_{I})]$ $C = [M / (D_{I})]$ $F_{f} = max(T)$ $F_{f} = max(T)$ $F_{f} / p_{ys} = 275 N$ $F_{f} / p_{ys} = 10$ $K_{e} = 1.2$ $A_{ef} = min(K)$ $p_{yp} = 275 N$ $F_{f} / p_{yp} = 10$ $A_{ep} = min(K)$ $S_{fb} = 1.1 \times$ $P_{bg_s} = 1.5$ $P_{bg_s} = 1.5$ $S_{fe_save} = S_{fe}$ $P_{bg_s} = 0$	$[/mm^{2}] + N / 2$ $(/mm^{2}) = 285 \text{ kN}$ $(/mm^{2}) = 285 \text{ kN}$ $(/mm^{2}) = (R_{b} - (R_{b_{p}} - R_{b_{p}} - R_{b_{p}$	 = 285 kN × D_h)] × T_b, B_b × T <i>PASS - Effecti</i> × D_h)] × t_{fp}, b_{fp} × t_f <i>SS - Effective flat</i> 50.7 kN s = 121.4 kN s = 110.4 kN S_f / 2 = 115 mm p × p_{bs_p} = 264.5 kN 	ve flange are) = 1608 mm nge plate are	ea is adequa		
Forces in member tension flam Forces in member compression Force in the flange Step 2 - Calculate distribution Check area of flange Design strength of section Minimum required effective flam Effective net area coefficient Effective flange area Check area of flange plates Design strength of plates Minimum required effective flam Effective flange plate area Step 3 - Design of flange bol Slip resistance of the bolt per in Bearing capacity of the bolt in Average flange bolt end distant Bearing capacity limit of the bolt	ge n flange n of forces in n nge area nge plate area ts nterface the flange the plate ce	$T = [M / (D_{I})]$ $C = [M / (D_{I})]$ $F_{f} = max(T)$ $F_{f} = max(T)$ $F_{f} / p_{ys} = 275 N$ $F_{f} / p_{ys} = 10$ $K_{e} = 1.2$ $A_{ef} = min(K)$ $p_{yp} = 275 N$ $F_{f} / p_{yp} = 10$ $A_{ep} = min(K)$ $S_{fb} = 1.1 \times$ $P_{bg_s} = 1.5$ $P_{bg_s} = 1.5$ $S_{fe_save} = S_{fe}$ $P_{bg_s} = 0$	$[/mm^{2}] + N / 2$ $(/mm^{2}) + (/mt^{2}) + (/mt^{2}$	= 285 kN × D _h)] × T _b , B _b × T <i>PASS - Effecti</i> <i>SS - Effective fla</i> 50.7 kN s = 121.4 kN 5 _f / 2 = 115 mm	ve flange are) = 1608 mm nge plate are	ea is adequa		

Tekla Tedds	Project BEAM A - Plate Connection - Restraining in centre on mid wall				Job no. 2023-7459	
PlanningApplications.com Summer House, Upper Court Road Woldingham Surrey CR3 7BF	Calcs for Mr Ashley Mujer 12 Avondale Gardens Hounslow TW4 5HX				Start page no./Revision 3	
support@planningapplications.com 07922 148 701	Calcs by SB	Calcs date 28/09/2023	Checked by DB	Checked date 28/09/2023	Approved by SB	Approved date 28/09/2023

Step 4 - Design of web plates and bolts

Check web plate in shear	
Shear force in web plates	V = 50 kN
Gross shear area	$A_v = n_{wp} \times I_{wp} \times t_{wp} = 3000 \text{ mm}^2$
Net shear area (allowing for bolt holes)	$A_{v_net} = n_{wp} \times (I_{wp} - n_{wb_r} \times D_h) \times t_{wp} = 2280 \text{ mm}^2$
Net shear area limit	$0.85 \times A_v$ / K _e = 2125 mm ²
	$A_{v_net} >= 0.85 \times A_v / K_e$ - Bolt holes may be ignored in the shear area
Gross shear capacity of web plates	p_{v_gross} = 0.6 × A _v × p_{yp} = 495 kN
Length of block shear face	$L_v = S_{we} + (n_{wb_r} - 1) \times S_w = 125 \text{ mm}$
Length of block tension face	$L_t = S_{wle} + (n_{wb_p} - 1) \times S_{wl} = 205 \text{ mm}$
Block shear coefficient	k = if(n _{wb_p} > 1, 2.5, 0.5) = 2.5
Block shear capacity of web plates	$p_{v_block} = 0.6 \times p_{yp} \times t_{wp} \times n_{wp} \times [L_v + K_e \times (L_t - k \times D_h)] = \textbf{1046 kN}$
Shear capacity of web plates	$p_v = min(p_{v_gross}, p_{v_block}) = 495 \text{ kN}$
	PASS - Effective web plate area is adequate in shear

Check web plate in bending

Second moment of area of web plate

Distance from joint to centroid of bolt group Moment in web plate Moment capacity of web plates

Check web plate bolts

Moment of inertia of bolt group Force on bolt due to direct shear Vertical force on bolt due to moment Horizontal force on bolt due to moment Resultant bolt load Angle of the resultant bolt load Minimum edge distance Edge distance factor for web plate bearing Slip resistance of the bolt per interface Bearing capacity of the bolt in the web Bearing capacity of the bolt in the plate Bolt capacity

$$\begin{split} I &= (t_{wp} \times I_{wp}{}^{3} / 12) - (n_{wb_r} \times t_{wp} \times D_{h}{}^{3} / 12) - (t_{wp} \times D_{h} \times K \times S_{w}{}^{2}) \\ I &= 1902780 \text{ mm}^{4} \\ a &= [((n_{wb_p} - 1) \times S_{wl}) + S_{wlc}] / 2 = 117 \text{ mm} \\ M_{wp} &= V \times a = 5.9 \text{ kNm} \\ M_{cap} &= p_{yp} \times n_{wp} \times I / (I_{wp} / 2) = 14.0 \text{ kNm} \\ PASS - Effective web plate area is adequate in bending \\ \end{split}$$

$$\begin{split} I_{bg} &= 47400 \text{ mm}^2 \\ F_v &= V \ / \ n_{wb} = 8.3 \text{ kN} \\ F_{mv} &= M_{wp} \times x \ / \ I_{bg} = 11.2 \text{ kN} \\ F_{mh} &= M_{wp} \times y \ / \ I_{bg} = 6.2 \text{ kN} \\ F_r &= \sqrt{((F_v + F_{mv})^2 + F_{mh}^2)} = 20.5 \text{ kN} \\ \theta &= atan(F_{mh} \ / \ (F_v + F_{mv})) = 17.6 \text{ deg} \\ e_r &= min(S_{we} \ / \ cos(\theta), \ S_{wie} \ / \ cos(90 - \theta)) = 26 \text{ mm} \\ K_{edge} &= min(e_r \ / \ (3 \times d), 1) = 0.5 \\ S_{fb} &= 1.1 \times K_s \times \mu \times P_p = 50.7 \text{ kN} \\ P_{bg_s} &= 1.5 \times d \times t_b \times p_{bs_s} = 79.5 \text{ kN} \\ P_{bg_s} &= 1.5 \times K_{edge} \times d \times t_{wp} \times n_{wp} \times p_{bs_s} = 120.7 \text{ kN} \\ P_s &= min(n_{wp} \times S_{fb}, \ P_{bg_s}, \ P_{bg_s}, \ P_{as_s} = 79.5 \text{ kN} \\ PASS - Web \ plate \ bolting \ is \ adequate \end{split}$$

Connection summary	
Beam classification	UC 203x203x46
Bolt classification	M16 (Torqued General Grade HSFG)
Flange plates	465 mm x 170 mm x 10 mm to the outside of each flange
Flange bolting	12 No. total per flange - 3 No. rows of 2 No. bolts on each side of the joint
Web plates	150 mm x 465 mm x 10 mm on each side of the web
Web bolting	12 No. total - 2 No. rows of 3 No. bolts on each side of the joint