CON	SULTING	Enginoprin	a Calculatio	n Chaot		Job No.	Sheet No.		Rev.
	NEEDS	Consulting	g Calculatio Engineers	on Sneet		iVVV		1	
ENGI	NEERS	consulting	Engineers			]^^^		T	
						Member/Locat	on		
Job Title	Member De	esign - Stee	el BeamColu	ımn BS595	0 v2015.01	Drg. Ref.			
Member De	esign - Stee	el BeamColu	ımn			Made by X	X Date 21	/11/2021	3hd.
Material F	Properties								<u>BS5950</u>
	Steel grade	e =					5275 (43) 🔻		
	Design stre	ength, $p_y =$					265	N/mm <sup>2</sup>	
	ε <b>= √(275</b> /	p <sub>y</sub> ) =					1.02		
	Modulus of	elasticity,	E =				205000	N/mm <sup>2</sup>	
Section									
		•							
		Equ	uivalent						
		I-9	Section					-	
	Section =				UC 356x406x2	287			
	Mass per n	netre, m =					287.1	kg/m	
	Overall uti	lisation =					22%		ОК
Spans									
	Euler effec	tive length,	$L_{ex} =$				4.854	m	Т.22
	Euler effec	tive length,	$L_{ey} =$				4.740	m	T.22
	Euler effec	tive length,	$L_{ev} =$				4.797	m	Т.22
	LTB effecti	ve length, L	e,ltb =				4.797	m	Т.13, Т.14
	Span, L =						3.198	m	
	LTB length	cannot be	shortened v	with stiffene	ers, which o	only increa	ases local tor	sional stiffn	ess;
Loading									
	Elem	Case	F <sub>x</sub>	Fy	Fz	M <sub>xx</sub>	M <sub>yy</sub>	M <sub>zz</sub>	
			[kN]	[kN]	[kN]	[kNm]	[kNm]	[kNm]	
	SColumn	ULS	-1387	0	0	0	30	11	
	Note that f	for F <sub>x</sub> , tens	ion is positi	ve and com	pression ne	egative;			
	Note that t	hese effects	s are effect	s on a parti	cular sectio	on, e.g. m	id-span secti	on OR end	
	support se	ction, and t	hus are not	necessarily	/ max value	es over er	itire member	/	
	Axial force	, F (GSA F <sub>x</sub> )	) =				1387	kN	
	Shear force	e in y-plane	, $V_x$ (GSA F	z) =			0	kN	
	Shear force	e in x-plane	, V <sub>y</sub> (GSA F	<sup>z</sup> <sub>y</sub> ) =			0	kN	
	Bending m	oment in y-	plane, M <sub>x</sub> (	$GSA M_{yy}) =$			30	kNm	
	Bending m	oment in x-	plane, M <sub>y</sub> (	$GSA M_{zz}) =$			11	kNm	
			,						
	Unfactored	l live load, o	o <sub>LL</sub> =				0.0	kN/m	
	Unfactored	SLS load, o	D <sub>SLS</sub> =				0.0	kN/m	
		,							
Deflection	<u> </u> 								
	Support fo	r deflection	s =			Simply sup	orted		
	Percentage	e of dead an	d superimr	osed dead	load deflect	tion preca	m 0.0	%	
	y		I					1	
		1				1	1	1	·

CONSULTING		Engineering Calculation Sheet				Job No. Sheet No.				Rev.
	SULTING	Engineerin	g Calculatio	n Sheet				2		
ENGI	NEERS	Consulting	Engineers			JXXX		2		
						Member/Location				
Job Title	Member De	esign - Stee	l BeamColu	mn BS595	) v2015.01	Drg. Ref.				
Member De	esign - Stee	el BeamColu	Imn			Made by XX	Date	21/1	<b>1/2021</b> <sup>d</sup>	hd.
Additiona	l Paramete	ers						Í		BS5950
-	Type of sec	tion and pr	000000 =		Rolled I			•		
anc	Hot finishe	d or cold fo	rmed rolled	RHS and r		Hot finished		- -		
ion ype	Rolled Dou	hle Angle o	rientation =	Both sides	of support she	ort side conne	cted	• •		
n T	Rolled Dou	hle Channe	l orientation	n = Both	sides of support	ort web conne	cted	• •		
rier ctio		hle T orient	ation -	Roth si	des of support	flange conne	cted			
, C nne	Rolted or w		action type	_			Velded	-		
Co	No of holt	holes (for e	ection type	 if double s	ections) N	· · · · =	8	•		
Sec	Diameter o	f bolt boles				bolthole	22.0	m	h	
			, abolthole –				22.0			
	Dollad I an	d Woldod I	connection	connectivit	Wab and both	flanges conn	acted	_		
Ę					web and both	flanges conno	stod	<u> </u>		
oaci						Thicknoss cor	nacted	<u> </u>		
Cap				ιy =		Web connect	ad	<u> </u>		
ion			nnoction of	nnoctivity		Chart side so	eu	<u> </u>		
ess					-	Mah connect	ad	<u> </u>		
ubr				connectivit	.y =		eu	<u> </u>		
CO				cuvity =		Flange conne		•		
l or	Rolled Dou	ble Channe		onnectivity	=	SHOLL SIDE	connect	eu		
sior	Rolled Dou				ty =	Web Flamas		ea a d		
Ten	Rolled Dou	ble I conne		ectivity =		Flange	connect	ea		
ial .	Rolled Dou	ble Angle c		ype =		Both side	es - weide	ea		
ĂX	Rolled Dou			i type =		Both side	es - weide	ea a d		
	Rolled Dou	DIE I CONNE	ction type	=		BOTH SIDE	es - weiae	ea		
			a va al a b d a va b a v			in 1.00		_		
		allowable si		s resisting load	vind - 180		<b>-</b>			
	Robertson	constant, a	(option for	I type sect	ion) =	Ro	billed H			
τζ	Rolled Sing	Ile Angl Shor	t side connecte	ed - two bolts,	ted - two or more rows of bolts					
paci	Rolled Sing	le Channel	connection	t Web conned	cted - two or m	nore rows of b	olts	<b>-</b>		
Cal	Rolled Sing	le l connec	tion type =	Flange conr	ected - two or	more rows of	bolts	<b>-</b>		
ling	Rolled Dou	ble Angle c	onnection t	ype Iwo or n	hore bolts, star	ndard clearanc	e	•		
uck	Rolled Dou	ble Angle c		ype =						
a le	ides of sup	port, short	side connec	cted - two c	or more boli	ts, standar	d clearan	се		
xura	Rolled Dou	ble Channe	l connectior	n type =						
Fle:				Both	siaes of su	ipport, web	connecte	ed		
	Kolled Dou	DIE I CONNE	ction type :	=						
	D II I -			Both s	des of supp	port, flange	connecte	ed		
	Kolled Dou	ble Angle, F	kolled Doub	ie Channel,	RELIEVEN bat	ten(s) within s	pan L	▼		
				- A I		   · · · ·	 			
Ē	Kolled Sing	jie Angle, R		e Angle LIE	mo Heel of a	angle in tensio	n	<b>-</b>  -		
LT apa	Rolled Sing	jle T, Rolled	Double T L	TB momen	t ori Flange o	of I in compres	sion	▼		
0	Equivalent	uniform mo	oment facto	r for LIB, r	n <sub>LT</sub> =		1.000			4.3.6.6
	Travel 1	:6			- 1.1-1.1.1.1					4005
rall ling city	⊏quivalent	uniform mo	oment racto	r for flexur	ai buckling,	m <sub>x</sub> =	1.000			4.8.3.3.4
Ove uck apa	⊏quivalent	uniform mo	oment facto	r for flexur	al DUCKling,	m <sub>y</sub> =	1.000			4.8.3.3.4
с m с	⊏quivalent	uniform mo	oment racto	r for flexur	ai buckling,	m <sub>yx</sub> =	1.000			4.8.3.3.4
	Note that u	iniform moi	nent factor	s are not to	be used fo	or sway sen	sitive str	uctur	res;	4.8.3.3.4

ENGINEERS       Consulting Engineers       jXXX       3         Job Title       Member Design - Steel BeamColumn BS5950 v2015.01       Drg. Ref.         Member Design - Steel BeamColumn       Made by       XX       Date       21/11/2021 <sup>chd.</sup> Utilisation Summary       Image Design - Steel BeamColumn       Made by       XX       Date       21/11/2021 <sup>chd.</sup> Image Design - Steel BeamColumn       Image Design - Steel BeamColumn       Image Design - Steel BeamColumn       BS5         Image Design - Steel BeamColumn       Image Design - Steel BeamColumn       Image Design - Steel BeamColumn       BS5         Image Design - Steel BeamColumn         Image Design - Steel BeamColumn       Image Design - Steel BeamColumn       Image Design - Steel BeamColumn       Image Design - Steel BeamColumn       Image Design - Steel BeamColumn       Image Design - Steel BeamColumn       Image Design - Steel BeamColumn       Image Design - Steel BeamColumn       Image Design - Steel BeamColumn       Image Design - Steel BeamColumn       Image Design - Steel BeamColumn       Image Design - Steel BeamColumn       Image Design - Steel BeamColumn       Image Design - Steel BeamColumn       Image Design - Steel BeamColumn       Image Design - Steel BeamColumn       Image Design - Steel BeamColumn	<u>950</u>
Job Title       Member Design - Steel BeamColumn BS5950 v2015.01       Drg. Ref.         Member Design - Steel BeamColumn       Made by       XX       Date       21/11/2021 <sup>chd.</sup> Utilisation Summary       Image: Steel BeamColumn       Image: Ste	<u>950</u>
Image:	<u>950</u>
Job Title       Member Design - Steel BeamColumn       Drg. Ref.         Member Design - Steel BeamColumn       Made by       XX       Date       21/11/2021 <sup>chd.</sup> Utilisation Summary       Image: Checks	<u>950</u>
Member Design - Steel BeamColumn       Made by       XX       Date       21/11/2021 chd.         Utilisation Summary       Image: Steel BeamColumn       Image: Steel BeamColumn       Image: BSE       Image: Steel BeamColumn       Image: BSE         Utilisation Summary       Image: Steel BeamColumn       Image: Steel BeamColumn <td< td=""><td><u>950</u></td></td<>	<u>950</u>
Utilisation Summary       BSE         Checks       UT       Status       Overall         Cross Section Classification       36%       OK       Image: Construction of the section of the secti	<u>950</u>
ChecksUTStatusOverallCross Section Classification36%OKShear X Capacity0%OKShear Buckling X Capacity0%OKShear Y Capacity0%OKShear Buckling Y Capacity0%OKShear Buckling Y Capacity0%OKTension or Compression Capacity14%OK	
ChecksOTStatusOVerallCross Section Classification36%OK	
Cross Section Classification       36%       OK         Shear X Capacity       0%       OK         Shear Buckling X Capacity       0%       OK         Shear Y Capacity       0%       OK         Shear Buckling Y Capacity       0%       OK         Tension or Compression Capacity       14%       OK	
Shear X Capacity     0%     0K       Shear Buckling X Capacity     0%     0K       Shear Y Capacity     0%     0K       Shear Buckling Y Capacity     0%     0K       Tension or Compression Capacity     14%     0K	
Shear Y Capacity     0%     0K       Shear Y Capacity     0%     0K       Shear Buckling Y Capacity     0%     0K       Tension or Compression Capacity     14%     0K	
Shear Buckling Y Capacity     0%     OK       Tension or Compression Capacity     14%     OK	
Tension or Compression Capacity 14% OK	
Moment Capacity 2% OK	
Local Capacity 18% OK 22%	
Slenderness Capacity 26% OK	
Flexural Buckling Capacity     17%     OK	
Lateral Torsional Buckling Capacity 2% OK	
Overall Buckling (Simple) Capacity 22% OK	
Overall Buckling (Exact) Capacity 21% OK	
Deflection (Live Load) 0% OK	
Note the overall utilisation does not include cross section classification, shear buckling or	
slenderness utilisations: If the section is not <b>at least semi compact</b> , then the equations	
within the sheet are NOT valid! If the section classification, shear buckling or slenderness	
utilisations is violated, the overall utilisation is set at 999%;	
Dead and superimposed dead load deflection precamber = 0.0 mm	
Beam weight = m.L (single sections) or 2m.L (double section 918 kg	
Note web bearing and buckling capacity is not included in the above overall utilisation:	
Unstiffened web bearing and buckling capacity utilisation = 0%	К
Stiffened web bearing and buckling capacity utilisation = 0%	к
Outstand of web stiffener length limit utilisation = 85%	К
Typical Initial Span / Depth Ratios	
Table 10. Spen (depth vetic tables for steel becaus leasted in the	floore
Table 11: Table 10: Span/depth ratio tables for steel beams located in the Column size estimate based on storey	noor a
of structure (from section 5.3 of The Type of beam Maximum floor span De	pth of
Manual for the design of Steel Primary beams 15m	Sp
Structures to Eurocode 3) Secondary beams 12m	Sp
Number	
of Column size (Tata Steel Europe website)	
storeys Death of roof boom	
3 203x203 UC	
5 254x254 UC 15m Span/25	
8 305X305 UC 15m Span/25	
8-12 356X356 UC	



CON	NSULTING Engineering Calculation			n Chash		Job No.	Sheet No.		Rev.
		Consulting	g Calculatio Engineers	n Sneet		;vvv		F	
ENGI	NEEKS	consulting	Linginieers			]^^^		5	
						Member/Location			
Job Title	Member De	esign - Stee	l BeamColu	mn BS5950	) v2015.01	Drg. Ref.	1		
Member D	esign - Stee	l BeamColu	mn			Made by XX	Date 21	/11/2021	hd.
General S	ection Pro	perties							BS5950
	Total dept	th, D =					393.6	mm	
	Web thick	ness.t=					22.6	mm	
	Flange wi	dth, B =					399.0	mm	
	Flange thi	ckness. T	=				36.5	mm	
	Root radiu	JS, r: =					15.2	mm	
	Rolled T b	/T ratio =					5.5		
-	Rolled I d	/t ratio =					12.8		
	Roncu I u	/ [ ] ] [ ]							
	Gross are	a of sectio	n, A_ =				366.0	cm <sup>2</sup>	
	Second m	oment of a	rea about	x-x axis	I., =		99875	cm <sup>4</sup>	
	Second m	oment of a	area about	v-v axis	<u> </u>		38677	cm <sup>4</sup>	
	Second m	oment of a	area about	maior avi	-, - s. I. =		N / A	cm <sup>4</sup>	
	Second m	oment of a	area about	minor axi	s, <u> </u>		N/A	cm <sup>4</sup>	
	Radius of	avration a	hout x-x a	x = x	3, <b>1</b> v –		16 5	cm	
	Radius of	avration a	bout v-v a	$x_{1}, x_{2} =$			10.3	cm	
	Radius of	avration a	bout main	ravis r :	=		N/A	cm	
-	Radius of	gyration a	bout mine	ravis r	-			cm	
	Elactic mo	gyracion a		$r a x s, r_v$	-		N/A	cm <sup>3</sup>	
	Elastic mo			s, 2 <sub>x</sub> -			1020	cm <sup>3</sup>	
	Diastic me		ut y-y axis	s, Z <sub>y</sub> -			1939	cm <sup>3</sup>	
	Plastic Inc			s, s <sub>x</sub> -			2040	cm <sup>3</sup>	
	Flastic III	Juulus abo	ut y-y axis	s, s <sub>y</sub> -			2949	CUL	
	Duckling						0.025		
	BUCKIING P		, u =				0.835		
	Torsional	index, x =	1_				10.2		
	Torsional	constant,	J = I _				1441	Cm	
	Warping C	constant, r	1 =				12.3	am	
	Monosym		ex,ψ=				N/A		
	V = (1.2)	for 612 1	1 for CEO	1 0 for C	5E) —		1.2		212
	$R_e = (1.2)$	101 645, 1	1 101 050	, 1.0 101 G	55) -		1.2		5.4.2

CONSULTING Engineering Calculation Sheet						Job No.	Sheet No.		Rev.
	NFFPS	Consulting	y Calculatio Fnoineers	in Sheet		iXXX		6	
ENGI		consulting	Linginicero			JAAA		0	
						Member/Location			
Job Title	Member De	esign - Stee	el BeamColu	ımn BS595	0 v2015.01	Drg. Ref.	1		
Member De	esign - Stee	el BeamColu	ımn			Made by XX	Date 21	/11/2021	Chd.
Particular	Section P	roperties							<u>BS5950</u>
	_							2	
	Gross are	a of sectio	n, A <sub>g, double</sub>	<sub>angle</sub> = 2A <sub>c</sub>	, =		N/A	cm²	
gle	Space betw	veen section	ns, s =			(5.7	15.0	mm	
An	Centrold of	r section fro		e to x-x axi	S, X <sub>c, double a</sub>	$_{ngle, x} = (B.I)$	N/A	mm	
e	Centrold of		т раск тас	e to y-y axi	S, X <sub>c, double a</sub>	<sub>ngle, y</sub> = (D.t	. N/A	mm	
qno	₿.×	ı ıl×		у	у				
ŏ	y	.y y 🔔 .	_y x:====	x ×	x				
led					<b>, U</b> -	Applicabl			
Rol	Case 1	Case 2	►x Case	3 🕹 🛯	→ Case 4		N/A		
Ğ	T	(cr	m <sup>4</sup> ) I		$m^4$ ) 7		$m^{3}$ ) 7	((	rm <sup>3</sup> )
es f	Case 1	N/A	··· ) -v, (	N/A	— , — , — , — , — , — , — , — , — , — ,	N/A		N/A	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
Ĕ	Case 2	N/A		N/A		N/A		N/A	
be	Case 3	N/A		N/A		N/A		N/A	
P C	Case 4	, N/A		, N/A		, N/A		, N/A	
L L	Second m	oment of a	area about	x-x axis,	I <sub>x, double ang</sub>	<sub>le</sub> =	N/A	cm <sup>4</sup>	
ctic	Second m	oment of a	area about	: y-y axis,	I <sub>y, double angl</sub>	le =	N/A	cm <sup>4</sup>	
Se.	Radius of	gyration a	bout x-x a	axis, r <sub>x, doul</sub>	$_{\text{ole angle}} = $	(I <sub>x, double an</sub>	N/A	cm	
ar	Radius of	gyration a	bout y-y a	ixis, r <sub>y, dout</sub>	$_{\text{ole angle}} = $	(I <sub>y, double an</sub>	N/A	cm	
icu	Elastic mo	odulus abo	ut x-x axis	s, Z <sub>x, double</sub> ;	<sub>angle</sub> =		N/A	cm <sup>3</sup>	
arti	Elastic mo	odulus abo	ut y-y axis	s, Z <sub>y, double</sub> a	<sub>angle</sub> =		N/A	cm <sup>3</sup>	
ä	Plastic me	odulus abo	ut x-x axi	S, S <sub>x, double a</sub>	$_{\rm angle} = N/A$	=	N/A	cm <sup>3</sup>	
	Plastic me	odulus abo	ut y-y axis	S, S <sub>y, double a</sub>	<sub>angle</sub> = N/A	=	N/A	cm <sup>3</sup>	
es I	Gross are	a of sectio	<b>n, A</b> g, double	<sub>channel</sub> = 2	A <sub>g</sub> =		N/A	cm <sup>2</sup>	
arti	Space betw	veen sectior	ns, s =				270.0	mm	
op	Centroid of	f section fro	m back fac	e, x <sub>c, double cl</sub>	<sub>hannel</sub> = (B.T	.(B/2).2+(I	N/A	mm	
P P	Second m	oment of a	area about	x-x axis,	I <sub>x, double cha</sub>	$_{nnel} = 2I_{x} =$	N/A	cm⁴	
ion	Second m	oment of a	area about	: y-y axis,	I <sub>y, double chai</sub>	$\frac{1}{100} = 2.(I_y)$	• N/A	cm⁴	
Dol	Radius of	gyration a	bout x-x a	axis, r <sub>x, doul</sub>	ole channel =	$\sqrt{(\mathbf{I}_{x, \text{ double}})}$	N/A	cm	
ed S	Radius of	gyration a	idout y-y a	IXIS, r <sub>y, doub</sub>	ole channel = - 27	$V(\mathbf{I}_{y, \text{ double}})$	N/A	2 2 2	
ula olle	Elastic mo		ut x-x axis	>, ∠ <sub>x, double (</sub> s 7	channel = 22	• <u>×</u> –		cm <sup>3</sup>	
r R i	Plactic m	aulus avo	ut y-y axis	r ←y, double o	nannel — ⊥y, 2c	double channel	N/A	cm <sup>3</sup>	
fo	Plastic m	odulus abo	ut v-v avi	<b>S. S</b> ., double (	$\frac{1}{2} = 2\Delta$	<u>x –</u> (s/2+x	N/A	cm <sup>3</sup>	
<u> </u>			July y unit	-, -y, double c		·g· 、- / - ' ^c,		CITI	
Ň	Gross are	a of sectio	n, Aa daubla	т = 2А <sub>-</sub> =			N/A	cm <sup>2</sup>	
fie	Space betw	veen section	, <u>, , , , , , , , , , , , , , , , , , </u>	•y			15.0	mm	
pe T	Centroid of	f section fro	m back fac	e, X <sub>c. double T</sub>	= (B.T.(T/)	2)+(D_T).t.	N/A	mm	
ble ble	Second m	oment of a	area about	x-x axis,	$I_{x, \text{ double T}} =$	2.(I <sub>x</sub> +A <sub>-</sub> .	N/A	cm <sup>4</sup>	
n ng	Second m	oment of a	area about	y-y axis,	$I_{y, \text{ double T}} =$	2I <sub>y</sub> =	N/A	cm <sup>4</sup>	
d D	Radius of	gyration a	bout x-x a	axis, r <sub>x, doul</sub>	$_{\text{ble T}} = \sqrt{\mathbf{I}_{x}}$	, double T / A	N/A	cm	
Se	Radius of	gyration a	bout y-y a	xis, r <sub>y, dout</sub>	$_{\text{ole T}} = \sqrt{(\mathbf{I}_{y})}$	double T / A	N/A	cm	
lar · Rc	Elastic mo	odulus abo	ut x-x axis	s, Z <sub>x, double</sub>	$= \mathbf{I}_{x, \text{ double}}$	т / (s/2+	N/A	cm <sup>3</sup>	
for	Elastic mo	odulus abo	ut y-y axis	s, Z <sub>y, double</sub>	r = 2Z <sub>y</sub> =		N/A	cm <sup>3</sup>	
it.	Plastic mo	odulus abo	ut x-x axi	S, S <sub>x, double</sub>	$r = 2A_g.(s/$	2+x <sub>c, double</sub>	N/A	cm <sup>3</sup>	
Å	Plastic me	odulus abo	ut y-y axis	S, S <sub>y, double 1</sub>	r = 2s <sub>y</sub> =		N/A	cm <sup>3</sup>	

CON	ISHI TING	Enginoorin	a Calculatio	n Choot		Job No.	Sheet No.		Rev.
		Consulting	Fnaineers	II Sheet		iXXX		7	
ENG		oonoannig				JAAA		/	
						Member/Location			
Job Title	Member De	esign - Stee	l BeamColu	imn BS5950	) v2015.01	Drg. Ref.			
Member D	esign - Stee	el BeamColu	Imn			Made by XX	Date 21	/11/2021	Shd.
Relevant	Section Pr	operties							<u>BS5950</u>
	Section T	vpe	A <sub>d relevant</sub>	I <sub>v relevant</sub>	I <sub>v relevant</sub>	I <sub>v relevant</sub>	r <sub>v relevant</sub>		
	Rolled I		A <sub>a</sub>	I <sub>x</sub>	I <sub>v</sub>	N/A	r <sub>v</sub>		
	Rolled RHS	5	Aa	, Ix	, Iv	, N/A	r <sub>v</sub>		
	Rolled CHS	5	Aa	, Ix	, Iv	, N/A	r <sub>v</sub>		
	Welded I		A <sub>a</sub>	I <sub>x</sub>	, I <sub>v</sub>	N/A	r <sub>v</sub>		
	Welded RH	S	A <sub>q</sub>	Ix	, I <sub>v</sub>	N/A	r <sub>v</sub>		
	Solid Bar		A <sub>q</sub>	Ix	, I <sub>v</sub>	N/A	r <sub>v</sub>		
	Plate		A <sub>q</sub>	Ix	, I <sub>v</sub>	N/A	, r <sub>v</sub>		
	Rolled Sing	jle Angle	A <sub>q</sub>	Ix	, I <sub>v</sub>	Iv	r <sub>v</sub>		
	Rolled Sing	gle Channel	A <sub>q</sub>	Ix	Ι <sub>ν</sub>	N/A	r <sub>v</sub>		
	Rolled Sing	jle T	Ag	Ix	I <sub>y</sub>	N/A	r <sub>y</sub>		
	Rolled Dou	ble Angle	A <sub>g, double angle</sub>	I <sub>x, double angle</sub>	I <sub>y, double angle</sub>	N/A	r <sub>y, double angle</sub>		
	Rolled Dou	ble Chann&	g, double chann	x, double channe	y, double chann	N/A	y, double chann	el	
	Rolled Dou	ble T	A <sub>g, double T</sub>	I <sub>x, double T</sub>	I <sub>y, double T</sub>	N/A	r <sub>y, double T</sub>		
	Relevant	gross area	of section	<b>n, A</b> g, relevant	=		366.0	cm <sup>2</sup>	
	Relevant	second mo	ment of a	rea about	x-x axis, I	x, relevant =	99875	cm <sup>4</sup>	
	Relevant	second mo	ment of a	rea about	y-y axis, I	y, relevant =	38677	cm <sup>4</sup>	
	Relevant	second mo	ment of a	rea about	minor axis	<b>5, I</b> v, relevant	N/A	cm <sup>4</sup>	
	Radius of	gyration a	bout y-y a	axis, r <sub>y, relev</sub>	<sub>ant</sub> =		10.3	cm	
	Section Ty	уре	$\mathbf{Z}_{\mathbf{x}, \text{ relevant}}$	Z <sub>y, relevant</sub>	<b>S</b> <sub>x, relevant</sub>	S <sub>y, relevant</sub>			
	Rolled I		Z <sub>x</sub>	Zy	S <sub>x</sub>	s <sub>γ</sub>			
	Rolled RHS	5	Z <sub>x</sub>	Zy	S <sub>x</sub>	s <sub>y</sub>			
	Rolled CHS	5	Z <sub>x</sub>	Zy	S <sub>x</sub>	s <sub>y</sub>			
	Welded I		Z <sub>x</sub>	Zy	S <sub>x</sub>	Sy			
	Welded RH	S	Z <sub>x</sub>	Zy	S <sub>x</sub>	Sy			
	Solid Bar		Z <sub>x</sub>	Zy	S <sub>x</sub>	Sy			
	Plate		Z <sub>x</sub>	Zy	S <sub>x</sub>	Sy			
	Rolled Sing	gle Angle	Z <sub>x</sub>	Zy	S <sub>x</sub>	s <sub>γ</sub>			
	Rolled Sing	le Channel	Z <sub>x</sub>	Zy	S <sub>x</sub>	Sy			
	Rolled Sing	jie i	Ζ <sub>χ</sub>	Ζ <sub>γ</sub>	S <sub>x</sub>	Sy			
	Rolled Dou	ble Angle	∠x, double angle	∠y, double angle	S <sub>x</sub> , double angle	Sy, double angle	2		
			-x, double chann 7	-y, double chann 7	x, double chann	y, double chann	el		
	Kollea Dou	DIE I	∠x, double T	∠y, double T	S <sub>x</sub> , double T	Sy, double T			
	Relevant	elastic mo	dulus abo	lt v-v avia	7.		5075	cm <sup>3</sup>	
	Relevant	elastic mo	dulue abor	ut v-v avie	<ul> <li><i>r</i> - x, relevant</li> <li>7</li> </ul>	-	1020	cm <sup>3</sup>	
	Relevant	nlastic mo	dulue abor	ut y y axis	r ←y, relevant	-	5812	cm <sup>3</sup>	
	Relevant	plastic mo	dulus abor	ut v-v avie	• • x, relevant	=	2949	cm <sup>3</sup>	
					r −y, reievant		2019		
	1			1			1		1

CON	SULTING	Enginoprin	a Calculatio	n Chaot		Job No.	Sheet No.		Rev.
	NEEDS	Consulting	y Calculatio Engineers	n Sneet		ivvv	(	0	
ENGI	NEEKS	consulting	Linginicers			]^^^		5	
						Member/Location			,
Job Title	Member De	esign - Stee	l BeamColu	mn BS5950	) v2015.01	Drg. Ref.			
Member De	esign - Stee	el BeamColu	ımn			Made by XX	Date <b>21</b>	<b>/11/2021</b> d	hd.
Cross Sec	tion Class	ification (L	ocal Buck	ing Effects	s)				<u>BS5950</u>
(At Least	Semi Com	pact Section	on Require	d; At Most	t Compact	Section;)			
y-plane	Section c	lassificatio	n =			Com	pact		
x-plane	Section c	lassificatio	n =			N,	Α		
y-plane	Semi com	pact section	on classific	ation utili	sation =		0.358		ОК
x-plane	Semi com	pact section	on classific	ation utili	sation =		N/A		N/A
overall	Semi com	pact section	on classific	ation utili	sation =		0.358		ОК
Compact	Section Cla	assificatio	า	Limit b/T		Limit d/t			
	Rolled I [(I	B/2)/T,(D-2	T-2r <sub>i</sub> )/t]	<b>10ε =</b>	10.2	ε, 100ε/(1+	46.4		3.5
y-plane	Rolled RHS	5 [(B-3or5t)	/372(;Dor3085;	(62ε or 54	N/A	or 35ε, (80	N/A		3.5
x-plane	Rolled RHS	3Q(800705t)	₥₿Ҳ₿₿₿₸	or 35ε, (80	N/A	(62ε or 54	N/A		3.5
	Rolled CHS	6 [D/t,D/t]		$0, 50\epsilon^2 =$	N/A	$0, 50\epsilon^2 =$	N/A		3.5
	Welded I [	((B-t)/2)/T,	(D-2T)/t]	9ε =	N/A	ε, 100ε/(1+	N/A		3.5
y-plane	Welded RH	IS [((B-t)/2	)/T,(D-2 <b>₿</b> ∦	, 62ε-0.5d/	N/A	(40ε, 80ε/(	N/A		3.5
x-plane	Welded RH	IS [((B-t)/2	\$/OTE, (CD-1217A))/(	(40ε, 80ε/(1	N/A	, 62ε-0.5b/	N/A		3.5
	Solid Bar [	N/A,N/A]		N/A	N/A	N/A	N/A		3.5
	Plate [N/A	,D/t]		N/A	N/A	10ε =	N/A		3.5
	Rolled Sing	gle Angle [B	/T,D/t]	<b>10ε =</b>	N/A	10ε =	N/A		3.5
	Rolled Sing	gle Channel	[B/T,(D-2T	<b>10ε =</b>	N/A	40ε =	N/A		3.5
	Rolled Sing	gle T [(B/2)	/T,D/t]	<b>10ε =</b>	N/A	9ε =	N/A		3.5
	Rolled Dou	ible Angle [	B/T,D/t]	<b>10ε =</b>	N/A	<b>10ε =</b>	N/A		3.5
	Rolled Dou	ible Channe	I [B/T,(D-2	<b>10ε =</b>	N/A	40ε =	N/A		3.5
	Rolled Dou	ible T [(B/2	)/T,D/t]	10ε =	N/A	9ε =	N/A		3.5
y-plane	Rolled I b	$\frac{0}{T}$ ratio =			5.5	<	10.2		OK
x-plane	Rolled I b	$\frac{1}{1}$ / T ratio =			5.5	<	N/A		N/A
y-plane	Rolled I d	/t ratio =			12.8	<	46.4		
x-piane	Note if 1 L	r < 0.1 th	on the co	t t = 0 1 t = 0	12.8	A state	N/A		N/A
Comi Com		$r_1 < 0.1, un$	en 1+1 <sub>1</sub> se		avoiu siriyu				
Semi Com					15.2	$\frac{\mathbf{LIIIII} \mathbf{u}}{(40a + 120a)}$	0E 1		2 5
v plana		D/Z//T,(D-Z)	(T (D 2 or E))	$15\varepsilon =$	15.5	(408, 1208)	95.1		2.5
y-plane		2010-20121)	/T,(D-3013- /ar/101/3/4401	$\frac{1}{100}$		t OF JJt, (1			2.5
x-piane		<u>Σ[D(+ D(+)</u> Σ[6000010316]	/ui,(ib/-wuitw o	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	N/A	+000000000000000000000000000000000000			3.5 2.5
		/(B_+)/)/T	8 (ר-2ד\/+1	υε, 140ε 13c -	N/A	UE, 14UE			25
v-nlane		<u>(()</u>  S[((R_+)/)	עד (ח_סדע) )/ד (ח_סדע)	40° -	N/A	(40° 120°			3.5
y plane		IS [((B-+)/2	// '/\ ⊂ ∠ ' // 1/210€⊡r>1012/	(40s. 120c	N/A	40c -	N/A		3.5
	Solid Bar	N/A N/A1	יייי י <i>ב</i> ייש אריי- <i>יק</i> ע ערייייני גע אריי-יק	Ν/Δ	N/A	Ν/Δ	Ν/Δ		3.5
	Plate [N/A			N/A	N/A	150 =	N/A		3.5
	Rolled Sinc	je Anale (R	/T.D/t1	15ε =	N/A	<u>15ε</u> =	N/A		3.5
	Rolled Sing	ale Channel	[B/T.(D-2T	<u>15ε</u> =	N/A	40ε =	N/A		3.5
	Rolled Sind	ale T [(B/2)	 /T,D/t1	<u>15</u> ε =	N/A	18ε =	N/A		3.5
	Rolled Dou	ible Anale []	B/T,D/t1	15ε =	N/A	15ε =	N/A		3.5
	Rolled Dou	ible Channe	I [B/T,(D-2	15ε =	, N/A	40ε =	N/A		3.5
	Rolled Dou	ıble T [(B/2	)/T,D/t]	15ε =	N/A	18ε =	N/A		3.5
y-plane	Rolled I b	/T ratio =			5.5	<	15.3		ОК
x-plane	Rolled I b	/T ratio =			5.5	<	N/A		N/A
y-plane	Rolled I d	l/t ratio =			12.8	<	95.1		ОК
x-plane	Rolled I d	/t ratio =			12.8	<	N/A		N/A
	Note if 1+2	2r <sub>2</sub> < 0.1, t	then $1+2r_2$	set to 0.1 t	to avoid sir	ngularity;			

CON	ISTIL TINC	Engineering Calculation Sheet				Job No. Sheet No.		Rev.	
	SULTING	Consulting	g Calculatio Engineers	on Sheet		ivvv		0	
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						Member/Locatio	n		
Job Title	Member De	esign - Stee	l BeamColu	ımn BS595(	) v2015.01	Drg. Ref.			
Member D	esign - Stee	el BeamColu	ımn			Made by X	X Date 2	1/11/2021	Chd.
Shear Ca	pacity								<u>BS5950</u>
	Note that t	the shear ca	pacity in a	particular d	lirection is i	ndepende	nt of wheth	er there	
	is shear fix	ity in the pa	articular dir	ection or no	ot, as if the	latter, the	en shear co	nnection	
	capacity is	provided by	y web beari	ng and buc	kling;				
-	Thickness	of section a	t hole, t <sub>bolth</sub>	<sub>ole</sub> = t =			22.6	mm	
	Area of sec	ction to ded	uct, A <sub>deduct</sub>	$= t_{bolthole}.d_{bolthole}$	olthole. Nbolthole	_ =	0	mm <sup>2</sup>	
	Note A <sub>deduc</sub>	$_{ct} = 0.0$ if w	elded conn	ection type	;				
	Note A <sub>deduc</sub>	<sub>ct</sub> is doubled	d to 2.A <sub>dedu</sub>	<sub>ct</sub> for doubl	e sections;				
	Rolled I sh	ear X area,	$A_{vx} = tD =$				8895	mm²	4.2.3
	Rolled RHS	shear X ar	ea, $A_{vx} = A$	<sub>g</sub> .D/(D+B) =	=		N/A	mm <sup>2</sup>	4.2.3
	Rolled CHS	shear X ar	ea, $A_{vx} = 0$	.6A <sub>g</sub> =			N/A	mm <sup>2</sup>	4.2.3
	Welded I s	hear X area	, $A_{vx} = t(D \cdot$	-2T) =			N/A	mm²	4.2.3
	Welded RH	IS shear X a	irea, $A_{vx} =$	2t(D-2T) =			N/A	mm <sup>2</sup>	4.2.3
	Solid Bar s	hear X area	$A_{vx} = 0.9$	A <sub>g</sub> =			N/A	mm²	4.2.3
	Plate shear	r X area, A <sub>v</sub>	$x = 0.9A_{g} =$				N/A	mm²	4.2.3
-	Rolled Sing	gle Angle sh	ear X area,	$A_{vx} = 0.9tl$	) =		N/A	mm <sup>2</sup>	4.2.3
	Rolled Sing	gle Channel	shear X are	$a, A_{vx} = tD$	) =		N/A	mm <sup>2</sup>	4.2.3
	Rolled Sing	gle T shear	X area, A <sub>vx</sub>	= tD =			N/A	mm²	4.2.3
	Rolled Dou	ible Angle s	hear X area	$A_{vx} = 2(0)$	.9tD) =		N/A	mm <sup>2</sup>	4.2.3
-	Rolled Dou	ible Channe	I shear X ar	rea, $A_{vx} = 2$	.tD =		N/A	mm <sup>2</sup>	4.2.3
	Rolled Dou	ible T shear	X area, A <sub>vx</sub>	= 2.tD =			N/A	mm²	4.2.3
								2	
	Shear X ar	ea, A <sub>vx</sub> =					8895	mm²	
	Net shear 2	X area, A <sub>vx,r</sub>	$het = A_{vx} - A$	deduct =			8895	mm²	6.2.3
	Bolt holes	need not be	allowed for i	n the shear a	area provide	d that:			
	$A_{v.net} \ge$	$0.85A_v/K_e$							
					0.054		6004	2	6.0.0
	Snear X ar	ea limit for	significance	e of dolt noi	es, 0.85A <sub>vx</sub>	$/K_e =$	6301	mm <sup>2</sup>	6.2.3
	Chase as a								
	Snear cap	bacity, $P_{vx}$					1414	KN	( 2 2
	insignificant	t bolt holes	$P_{vx} = 0.6p_y$	$A_{VX} =$			1414	KN	4.2.3
	significant	t bolt holes	$P_{vx} = 0.7p_{y}$	.K <sub>e</sub> .A <sub>vx,net</sub> =	-		1980	KN	6.2.3
	$\mathbf{v}_{\mathbf{x}} / \mathbf{P}_{\mathbf{v}\mathbf{x}} \mathbf{u}$	tilisation =					0.000		OK
	Chase V h		/h	70 :6		: <b>f</b>	4 1 2 0	< <b>71.</b> 0	422
	Snear X D	uckling, a	/t ratio (<			it weide		< /1.3	4.2.3
	Snear X D	uckling ut	lisation =				0.000		OK
	1	1							

CON	NSULTING Engineering Calculation Sheet					Job No.		Sheet No.		Rev.
	NSULTING INFFPS	Consulting	9 Calculatio Fngineers	n Sneet		iXX	'X		10	
ENG	INEERS	consulting	Engineers			Jvv			10	
						Member/L	ocation			
Job Title	Member De	esign - Stee	el BeamColu	ımn BS595	0 v2015.01	Drg. Ref.				
Member D	)esign - Stee	el BeamColu	umn			Made by	XX	Date 21	/11/2021	Chd.
										<u>BS5950</u>
	Thickness	of section a	t hole, t <sub>bolth</sub>	<sub>lole</sub> = T =				36.5	mm	
	Area of sec	ction to ded	uct, A <sub>deduct</sub>	$= t_{bolthole}.d_b$	olthole.Nbolthol	e =		0	mm <sup>2</sup>	
	Note A dedu	$_{ct} = 0.0$ if w	velded conn	ection type	;					
	Note A dedu	<sub>ct</sub> is doubled	d to 2.A <sub>dedu</sub>	<sub>ct</sub> for doubl	e sections;					
	Rolled I sh	ear Y area,	$A_{vv} = 0.9(2$	2BT) =				26214	mm <sup>2</sup>	4.2.3
	Rolled RHS	5 shear Y ar	ea, $A_{vy} = 0$	.9(2BT) =				N/A	mm <sup>2</sup>	4.2.3
	Rolled CHS	5 shear Y ar	ea, $A_{vy} = 0$	.6A <sub>g</sub> =				N/A	mm <sup>2</sup>	4.2.3
	Welded I s	hear Y area	$A_{vy} = 0.9$	(2BT) =				N/A	mm <sup>2</sup>	4.2.3
	Welded RH	IS shear Y a	area, $A_{vy} =$	0.9(2BT) =				N/A	mm <sup>2</sup>	4.2.3
	Solid Bar s	hear Y area	$A_{vy} = 0.9$	A <sub>g</sub> =				N/A	mm <sup>2</sup>	4.2.3
	Plate shear	r Y area, A <sub>v</sub>	$y = 0.9A_{g} =$					N/A	mm <sup>2</sup>	4.2.3
	Rolled Sing	gle Angle sh	near Y area,	$A_{vy} = 0.9B$	T =			N/A	mm <sup>2</sup>	4.2.3
	Rolled Sing	gle Channel	shear Y are	ea, $A_{vy} = 0$ .	9(2BT) =			N/A	mm <sup>2</sup>	4.2.3
	Rolled Sing	gle T shear	Y area, A <sub>vy</sub>	= 0.9BT =				N/A	mm <sup>2</sup>	4.2.3
	Rolled Dou	ible Angle s	hear Y area	$A_{vy} = 2(0)$	.9BT) =			N/A	mm <sup>2</sup>	4.2.3
	Rolled Dou	ible Channe	l shear Y ar	rea, $A_{vy} = 2$	(0.9(2BT))	=		N/A	mm <sup>2</sup>	4.2.3
	Rolled Dou	ible T shear	Y area, A <sub>vy</sub>	, = 2(0.9BT	) =			N/A	mm <sup>2</sup>	4.2.3
	Shear Y ar	ea, A <sub>vy</sub> =						26214	mm <sup>2</sup>	
	Net shear `	Y area, A <sub>vy,r</sub>	$het = A_{vy} - A$	deduct =				26214	mm <sup>2</sup>	6.2.3
	Bolt holes	need not be	allowed for i	n the shear	area provide	d that:				
	$A_{v \text{ net}} \ge$	$0.85A_v/K_a$								
	v.acc									
	Shear Y ar	ea limit for	significance	e of bolt ho	es, 0.85A <sub>vy</sub>	$K_e =$		18568	mm <sup>2</sup>	6.2.3
	Shear cap	oacity, P <sub>vy</sub>						4168	kN	
	insignificant	t bolt holes	$P_{vy} = 0.6p_{vy}$	$_{\gamma}.A_{vy} =$				4168	kN	4.2.3
	significant	t bolt holes	$P_{vy} = 0.7p_{y}$	,.K <sub>e</sub> .A <sub>vy,net</sub> =	=			5835	kN	6.2.3
	V <sub>y</sub> / P <sub>vy</sub> u	tilisation =	<b>-</b>					0.000		ОК
	Shear Y b	uckling, b	/T ratio (<	<b>ζ 70ε if rol</b>	ed and 62	ε if we	lded	5.5 -	< 71.3	4.2.3
	Shear Y b	uckling ut	ilisation =					0.000		ОК
						-				
						ļ				

CONSULTING Engineering Calculation Sheet						Job No. Sheet No		. Rev.	
	NEEDS	Consulting	g Calculatio Engineers	on Sheet		ivvv		11	
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						Member/Location			
Job Title	Member De	esign - Stee	l BeamColu	ımn BS595(	) v2015.01	Drg. Ref.			
Member D	esign - Stee	el BeamColu	Imn			Made by XX	Date 2:	1/11/2021	Chd.
Axial Ten	sion or Coı	mpression	Capacity						<u>BS5950</u>
	Note that A	A <sub>e</sub> is applica	able for axia	al tension w	ith bolted o	connections	;		
	Note that A	$A_g$ is application	able for axia	al tension w	vith welded	connections	5;		
	Note that A	$A_g$ (as $A_e$ b	ecomes A <sub>g</sub>	) is applica	ble for axia	l compressi	on with bo	lted connec	tions;
	Note that A	A <sub>g</sub> is applica	able for axia	al compress	ion with we	elded conne	ctions;		
	Tests sho	w that hole	s do not re	duce the ca	pacity of a	member in	tension		
	provided	that the rational terms of the second s	o of net area	to gross are	a is greater t	than the ratio	o of yield		
	strengen	to utilinate s	strength.						
	Rolled I a	nd Welded	I						
	Gross area	of connect	ed part(s),	$a_1 = (D.t, 2)$	2B.T, D.t+B	$S.T \text{ or } A_g) =$	366.0	cm <sup>2</sup>	
	Gross area	of unconne	ected part(s	s), a <sub>2</sub> = A <sub>g</sub> -	a <sub>1</sub> =		0.0	cm <sup>2</sup>	
	Thickness	of section a	t hole, t <sub>bolth</sub>	<sub>ole,I</sub> =			36.5	mm	
	Area of sec	ction to ded	uct, A <sub>deduct,I</sub>	$= t_{bolthole,I}$	d <sub>bolthole</sub> .N <sub>bolt</sub>	<sub>hole</sub> =	0.0	cm <sup>2</sup>	
	Note A deduc	$_{ct,I} = 0.0 \ if$	welded con	nection type	e;				
	Net area of	f connected	part(s), a <sub>n</sub>	$a_1 = a_1 - A_{dec}$	duct,I =		366.0	cm <sup>2</sup>	
	Net area of	f unconnect	ed part(s),	$a_{n2} = a_2 =$			0.0	cm <sup>2</sup>	
	Effective n	et area of c	onnected p	art(s), a <sub>e1</sub> =	= K <sub>e</sub> .a <sub>n1</sub> (<=	$= a_1) =$	366.0	cm <sup>2</sup>	
	Effective n	et area of u	nconnected	l part(s), a <sub>e</sub>	$_{2} = K_{e}.a_{n2}$ (	$(<= a_2) =$	0.0	cm <sup>2</sup>	
	Effective	net area of	f section, I	$\mathbf{A}_{\mathbf{e},\mathbf{I}} = [\mathbf{If} \mathbf{F}]$	, > 0, a <sub>e1</sub> +	•a <sub>e2</sub> (<= 1.	366.0	cm <sup>2</sup>	
	Bolted	$P_t \text{ or } P_{ca} =$	р <sub>у</sub> (А <sub>е,I</sub> -1.00	$(a_2) =$			9699	kN	4.6.1
	Welded	$P_t \text{ or } P_{ca} =$	р <sub>у</sub> (А <sub>g</sub> -1.00а	a <sub>2</sub> ) =			9699	kN	4.6.1
	Axial tens	sion or con	pression	capacity, F	$P_t \text{ or } P_{ca} =$		9699	kN	
	Rolled RH	S and Wel		(25.)				2	
	Gross area	of connect	ed part(s),	$a_1 = (2D.t,$	2B.1, 2D.t	+B.I or A <sub>g</sub> )	N/A	cm <sup>2</sup>	-
	Gross area		ected part(s	$a_2 = A_g - A_g$	a <sub>1</sub> =		N/A	cm²	
	I NICKNESS	or section a	t noie, t <sub>bolth</sub>	ole,RHS =			N/A	mm 2	
	Area of sec		uct, A <sub>deduct,</sub>	$\chi_{\rm HS} = \tau_{\rm bolthole}$	,RHS. abolthole	$N_{bolthole} =$	N/A	cm²	
	Note A deduc	$c_{t,RHS} = 0.0$		onnection ty	/pe;		N1 / A	2	-
	Net area of	r connected	part(s), a <sub>n</sub>	$a_1 = a_1 - A_{dec}$	Juct,I =		N/A	cm <sup>2</sup>	
	Ret area of		ed part(s),	$a_{n2} = a_2 =$			N/A	cm <sup>2</sup>	
	Effoctive r		nconnected p	$a_{11}(s), a_{e1} =$	$- \kappa_{e} d_{n1} (< =$	$-a_1 = \frac{1}{2}$		cm <sup>-</sup>	
	Effective			ι μαιτ(S), a <sub>e</sub>	2 - N <sub>e</sub> .d <sub>n2</sub> (	$(-a_2) =$	N/A	cm <sup>2</sup>	
	Poltod		$\frac{1}{n} (\Lambda) = \frac{1}{n}$	$\mathbf{r}_{e,RHS} = \mathbf{L}\mathbf{I}\mathbf{r}$	r <sub>x</sub> ∕ ∪, d <sub>e</sub>	1⊤α <sub>e2</sub> (<=			1 5 1
	Boiled	P <sub>t</sub> OI P <sub>ca</sub> –	$p_y(A_{e,RHS}^{-1})$	$\frac{1}{2}$			N/A		4.0.1
	Avial topo	$r_t $ or $r_{ca} $ –	$p_y(R_g^{-1.000})$	a <sub>2</sub> ) —	Dor D -		N/A		4.0.1
	AXIAI LEIIS		ipression	сарасну, г	ture <sub>ca</sub> –		N/A	KIN	
	Dollad CH	6							
	Thickness	of section a	thole t				NI / A	mm	
	Aroa of cor	stion to dod	uct A	ole,CHS — — +	d	N _	N/A		
	Note A		if welded a	CHS - Colthole	,CHS·Ubolthole	••••bolthole —	N/A		
	Net area of	$f_{\text{section}} \wedge$			, μς, =		NI / A	cm <sup>2</sup>	
	Fffective	net area of	isection		- F > 0 M	TN (K A		cm <sup>2</sup>	
	Boltad	P. or P -		•e,CHS — LII	· <sub>X</sub> ~ U <sub>1</sub> PI.	('`e'Anet,			461
	Welded	Por P -	ryme,CHS — nΔ —						7.0.1
	Avial tens	$r_{ca} =$	Pyrg -	canacity F	Por P –		N/A		4.0.1
			ווטונפט וקי				N/A		
				L		1			

CON	ISTIL TINC	Engineerin	a Calaulatia	n Chaot		Job No. Sheet N			Rev.
	INEERS	Consulting	g Calculatio Engineers	in Sheet		iXXX		12	
ENG		concarring				JAAA		12	
						Member/Location			
Job Title	Member De	esign - Stee	l BeamColu	imn BS595	0 v2015.01	Drg. Ref.			
Member D	esign - Stee	el BeamColu	Imn	1	1	Made by XX	Date 2:	1/11/2021	Chd.
									<u>BS5950</u>
	Solid Bar							2	
	Effective	net area of	section, A	A <sub>e,bar</sub> = A <sub>g</sub> :	=		N/A	cm <sup>2</sup>	
	Bolted	$P_t \text{ or } P_{ca} =$	$p_y A_{e,bar} =$				N/A	kN	4.6.1
	Welded	$P_t \text{ or } P_{ca} =$	$p_{y}A_{g} =$				N/A	KN	4.6.1
	Axial tens	SION OF COM	pression	сарасіту, н	$P_t \text{ or } P_{ca} =$		N/A	KN	
	Diata								
	Thicknoor	of costion of	tholo t				NI / A		
	Aron of co	of section a	uct A	ole,plate =	d	N -	N/A		
	Note A		if welded c	blate - Colthol	e,plate.Ubolthole	e-Nbolthole –	N/A	CIII	
	Note A deduc	$f_{\text{section}} \Delta$			урс, _		NI/A	cm <sup>2</sup>	
		net area of	f section		<u>.</u> ff > 0 M	ΙΤΝ (Κ Δ	N/A	cm <sup>2</sup>	
	Bolted	$P_{1} \text{ or } P =$	$n_A = =$	•e,piate — L⊥	x ~ 0, M		N/A	kN	461
	Welded	$P_{\perp}$ or $P =$	$P_{y'} = P_{y'} = D_{y'} A_{z} =$				N/A	kN	461
	Axial tens	sion or con	pression (	capacity, F	P. or P., =		N/A	kN	4.0.1
			-p. 000.011				n/n		
	Rolled Sir	nale Anale							
	Gross area	of connected	ed leg, $a_1 =$	(B.T or D.	t) =		N/A	cm <sup>2</sup>	
	Gross area	of unconne	ected leg, a	$a_2 = A_a - a_1$	=		, N/A	cm <sup>2</sup>	
	Thickness	of section a	t hole, t <sub>bolth</sub>	ole,single angle	=		N/A	mm	
	Area of sec	ction to ded	uct, A <sub>deduct,s</sub>	$t_{\text{single angle}} = t$	bolthole,single a	$d_{\text{bolthole}}$ .	N/A	cm <sup>2</sup>	
	Note A dedu	ct,single angle =	0.0 if weld	led connect	ion type;				
	Net area o	f connected	$leg, a_{n1} = a$	a <sub>1</sub> - A <sub>deduct,si</sub>	ingle angle =		N/A	cm <sup>2</sup>	
	Net area o	f unconnect	ed leg, a <sub>n2</sub>	= a <sub>2</sub> =			N/A	cm <sup>2</sup>	
	Effective n	et area of c	onnected le	$a_{e1} = K_e$	a <sub>n1</sub> (<= a <sub>1</sub> )	) =	N/A	cm <sup>2</sup>	
	Effective n	et area of u	nconnected	l leg, a <sub>e2</sub> =	K <sub>e</sub> .a <sub>n2</sub> (<=	a <sub>2</sub> ) =	N/A	cm <sup>2</sup>	
	Effective	net area of	f section, A	A <sub>e,single</sub> angle	= [If $F_x >$	0, a <sub>e1</sub> +a <sub>e2</sub>	N/A	cm <sup>2</sup>	
	Bolted	$P_t$ or $P_{ca}$ =	p <sub>y</sub> (A <sub>e,single ar</sub>	$_{ngle}$ -0.50 $a_2$ )	=		N/A	kN	4.6.3.1
	Welded	$P_t$ or $P_{ca}$ =	р <sub>у</sub> (А <sub>g</sub> -0.30а	a <sub>2</sub> ) =			N/A	kN	4.6.3.1
	Axial tens	sion or con	pression	capacity, F	P <sub>t</sub> or P <sub>ca</sub> =		N/A	kN	
	Rolled Sir	ngle Chann	el						
	Gross area	of connecte	ed leg, $a_1 =$	D.t =			N/A	cm <sup>2</sup>	
	Gross area	of unconne	ected leg, a	$_{2} = A_{g} - a_{1}$	=		N/A	cm²	
	Thickness	of section a	t hole, t <sub>bolth</sub>	ole,single channe	el =		N/A	mm	
	Area of sec	ction to ded	uct, A <sub>deduct,s</sub>	single channel =	C <sub>bolthole</sub> ,single	channel.0boltho	N/A	cm²	
	Note A dedu	ct,single channel	= 0.0 If we	laea conne	ction type;		NI / A	2	
	Net area of	r connected	$eg, a_{n1} = a_{n1}$	a <sub>1</sub> - A <sub>deduct,si</sub>	ingle channel =		N/A	2 CM <sup>2</sup>	
		ot area of o	eu ley, a <sub>n2</sub>	$= a_2 =$	2 (z - 2)	) _	N/A	cm <sup>-</sup>	
	Effective		nconnected	iy, a <sub>e1</sub> = r <sub>e</sub> .	$\frac{a_{n1}}{k} = d_{1}$	) — a.) —		cm <sup>2</sup>	
	Effective		f section	$a_{e2} =$	. = [Tf ⊑	a <sub>2</sub> ) =	N/A	cm <sup>2</sup>	
	Roltad	P. or P -	n (A	re,single chanr ດຸຣດຊ	) =	∽ v, a <sub>e1</sub> ⊤d			4621
	Waldad	$P_{t}$ or $P_{t} =$	۳۷۱٬ <sup>¬</sup> e,single ch ۵(۵ -۵ 3۵:	$a_{nnel} 0.00a_2$	<i>,</i> –		N/A	kN	4621
	Axial tene	$\frac{1}{1} \cdot t = \frac{1}{1} \cdot t = \frac{1}{1} \cdot \frac{1}{1} \cdot \frac{1}{1} \frac{1}{1} \cdot \frac{1}{1} = \frac{1}{1} \cdot \frac{1}{1} \cdot \frac{1}{1} \cdot \frac{1}{1} \cdot \frac{1}{1} = \frac{1}{1} \cdot \frac{1}{1} \cdot \frac{1}{1} \cdot \frac{1}{1} = \frac{1}{1} \cdot \frac{1}{1$	npression	canacity G	P. or P. =		N/A	kN	7.0.3.1
			-p. 0001011		ca				

CON	ONSULTING Engineering Calculation Sheet					Job No.	Sheet No.		Rev.
	NEEDS	Consulting	y Calculatio Engineers	n Sneet		iVVV		12	
ENGI	NEEKS	consulting	Engineers			JVVV		15	
						Member/Location			
Job Title	Member De	esign - Stee	l BeamColu	mn BS5950	) v2015.01	Drg. Ref.			
Member D	esign - Stee	l BeamColu	Imn			Made by XX	Date 21	/11/2021	hd.
									<u>BS5950</u>
	Rolled Sin	igle T							
	Gross area	of connecte	ed leg, $a_1 =$	B.T =			N/A	cm <sup>2</sup>	
	Gross area	of unconne	ected leg, a	$_{2} = A_{g} - a_{1} =$	=		N/A	cm <sup>2</sup>	
-	Thickness	of section a	t hole, t <sub>bolth</sub>	ole,single T =			N/A	mm	
	Area of sec	tion to ded	uct, A <sub>deduct,s</sub>	$_{ingle T} = t_{bolth}$	nole, single T.db	olthole.Nbolthole	N/A	cm <sup>2</sup>	
	Note A <sub>deduc</sub>	t, single T = 0.	0 if welded	connection	type;				
	Net area of	<sup>-</sup> connected	$leg, a_{n1} = a$	a <sub>1</sub> - A <sub>deduct,si</sub>	ngle T =		N/A	cm <sup>2</sup>	
	Net area of	unconnect	ed leg, a <sub>n2</sub>	= a <sub>2</sub> =			N/A	cm <sup>2</sup>	
	Effective n	et area of co	onnected le	$g, a_{e1} = K_e$	$a_{n1} (<= a_1)$	) =	N/A	cm <sup>2</sup>	
	Effective n	et area of u	nconnected	$leg, a_{e2} =$	K <sub>e</sub> .a <sub>n2</sub> (<=	a <sub>2</sub> ) =	N/A	cm <sup>2</sup>	
	Effective	net area of	f section, A	a <sub>e1</sub> +a <sub>e2</sub> (<	N/A	cm <sup>2</sup>			
	Bolted	$P_t \text{ or } P_{ca} =$	$p_y(A_{e,single T})$	$0.50a_2) =$			N/A	kN	4.6.3.1
	Welded	$P_t \text{ or } P_{ca} =$	р <sub>у</sub> (А <sub>g</sub> -0.30а	a <sub>2</sub> ) =			N/A	kN	4.6.3.1
	Axial tens	ion or com	pression	capacity, F	P <sub>t</sub> or P <sub>ca</sub> =		N/A	kN	
	Rolled Do	uble Angle	•						
	Gross area	of connecte	ed leg, $a_1 =$	(B.T or D.	t) =		N/A	cm <sup>2</sup>	
	Gross area	of unconne	ected leg, a	$_{2} = A_{g} - a_{1} =$	=		N/A	cm²	
	Thickness	of section a	t hole, t <sub>bolth</sub>	ole,double angle	=		N/A	mm	
	Area of sec	tion to ded	uct, A <sub>deduct,d</sub>	ouble angle = 1	bolthole,double	angle.d <sub>bolthole</sub> .	N/A	cm²	
	Note A <sub>deduc</sub>	t,double angle	= 0.0 if well	ded connec	tion type;			2	
	Net area of	connected	leg, $a_{n1} = a$	a <sub>1</sub> - A <sub>deduct,d</sub>	ouble angle =		N/A	cm <sup>2</sup>	
	Net area of	unconnect	ed leg, a <sub>n2</sub>	$= a_2 =$			N/A	cm <sup>2</sup>	
	Effective n	et area of co	onnected le	$g, a_{e1} = K_{e}$	$a_{n1} (<= a_1)$	) =	N/A	cm <sup>2</sup>	
	Effective n	et area of u	nconnected	leg, $a_{e2} =$	$K_{e}.a_{n2}$ (<=	$a_2) =$	N/A	cm <sup>2</sup>	
	Effective		section, A	e,double angle	= [11 F <sub>x</sub> >	• 0, 2.(a <sub>e1</sub> +	N/A	cm²	1622
	Same sid	de - bolted	$P_t \text{ or } P_{ca} =$	$2.p_y(A_{e,doubl})$	e angle/2-0.5	$(0a_2) =$	N/A	KN	4.6.3.2
	Same sia	e - weiaea	$P_t \text{ or } P_{ca} =$	$2.p_y(A_{g,doubl})$	e angle/2-0.3	$(a_2) = \frac{1}{2}$	N/A	KN	4.6.3.2
-	Both side	es - Doltea	$P_t \text{ or } P_{ca} =$	$2.p_y(A_{e,doubl})$	e angle/2-0.2	$5a_2) = $	N/A	KN	4.6.3.2
		s - welaea	$P_t \text{ or } P_{ca} =$	Z.P <sub>y</sub> (A <sub>g,doubl</sub>	e angle/2-0.1	5a <sub>2</sub> ) =	N/A	KIN	4.6.3.2
	Axial tens		ipression	сарасіту, н	$P_t \text{ or } P_{ca} =$		N/A	KN	
	Delled De	uhla Cham							
	Gross area	of connect	nei od log a –	D+-			NI / A	am <sup>2</sup>	
	Gross area	of unconno	$a_1 = \frac{1}{2}$				N/A		
	Thickness	of section at	t hole t	$2 - A_g - a_1$	_		N/A	cm	
	Aroa of cor	tion to dod	uct A	ole,double chann	el — - +	d	N/A		
	Note A	LION LO UEU	-0.0 if we	louble channel –	- ubolthole,doub	le channel Ubolt	N/A	cm	
-	Not area of	t,double channel			<u></u>		NI / A	cm <sup>2</sup>	
	Net area of		ed lea e	-1 $-1$ deduct, ded	ouble channel —		N/A	cm <sup>2</sup>	
	Effoctivo p	ot aroa of o	opported lo	$-a_2 - k_2$	(-2)	\	N/A		
	Effective n		nconnected	y, a <sub>e1</sub> – n <sub>e</sub> . Iea a - –	$K_{n1} (-a_{1})$	, - a <sub>2</sub> ) -		cm <sup>2</sup>	
	Effective	net area of	section /			>0 2 (>	N/A	cm <sup>2</sup>	
	Both sid	as - holted	P. or P -	•e,double chan 2 n (Δ	<u>nei - L+ Ix</u> , ./フ_∩	$\frac{2}{25a_{e}} = \frac{2}{25a_{e}}$	N/A	LN €N	4630
	Both side	s - wolded	PorP –	- · Py\^e,doubl	e channel/ ∠-0.	$\frac{15a_2}{-15a_2}$			4622
		s = weided		-·Py(~g,doubl	e channel/ $2^{-0}$	- 502) -	N/A		7.0.3.2
			1016551011	capacity, r			N/A		
								1	

		Encirci	a Calastat	n Chart		Job No.	Sheet No.		Rev.
	NEEDC	Consulting	y Calculatio Engineers	in Sheet		iYYY	-	4	
LNG						]^^^		L+	
						Member/Location			
Job Title	Member De	esign - Stee	el BeamColu	ımn BS5950	) v2015.01	Drg. Ref.			-
Member D	esign - Stee	l BeamColu	ımn			Made by XX	<sup>Date</sup> 21	/11/2021	Chd.
									<u>BS5950</u>
	Rolled Do	uble T							
	Gross area	of connect	ed leg, $a_1 =$	B.T =			N/A	cm <sup>2</sup>	
	Gross area	of unconne	ected leg, a	$_{2} = A_{g} - a_{1} =$	-		N/A	cm <sup>2</sup>	
	Thickness of	of section a	t hole, t <sub>bolth</sub>	ole,double T =			N/A	mm	
	Area of sec	tion to ded	uct, A <sub>deduct,c</sub>	$_{\text{louble T}} = t_{\text{bolt}}$	hole,double T.d	bolthole.Nbolt	no N/A	cm <sup>2</sup>	
	Note A <sub>deduc</sub>	t, double T = C	0.0 if welded	d connectio	n type;				
	Net area of	<sup>c</sup> connected	$leg, a_{n1} = a$	a <sub>1</sub> - A <sub>deduct,d</sub>	ouble T =		N/A	cm <sup>2</sup>	
	Net area of	unconnect	ed leg, a <sub>n2</sub>	= a <sub>2</sub> =			N/A	cm <sup>2</sup>	
	Effective ne	et area of c	onnected le	g, $a_{e1} = K_e$ .	$a_{n1} (<= a_1)$	) =	N/A	cm <sup>2</sup>	
	Effective ne	et area of u	nconnected	$leg, a_{e2} =$	K <sub>e</sub> .a <sub>n2</sub> (<=	a <sub>2</sub> ) =	N/A	cm <sup>2</sup>	
	Effective	net area o	f section, A	$A_{e,double T} =$	$[If F_x > 0,$	, 2.(a <sub>e1</sub> +a	e N/A	cm <sup>2</sup>	
	Both side	es - bolted	$P_t \text{ or } P_{ca} =$	2.p <sub>y</sub> (A <sub>e,doubl</sub>	<sub>е т</sub> /2-0.25а	2) =	N/A	kN	4.6.3.2
	Both side	s - welded	$P_t \text{ or } P_{ca} =$	2.p <sub>y</sub> (A <sub>g,doubl</sub>	<sub>е т</sub> /2-0.15а	<sub>2</sub> ) =	N/A	kN	4.6.3.2
	Axial tens	ion or con	npression (	capacity, P	$P_t \text{ or } P_{ca} =$		N/A	kN	
	Axial tens	ion or con	npression	capacity, P	P <sub>t</sub> or P <sub>ca</sub> =		9699	kN	
	F / (P <sub>t</sub> or	P <sub>ca</sub> ) utilisa	tion =				0.143		ОК

CONSULTING Engineering Calculation Sheet						Job No.	Sheet No.		Rev.
	NEEDS	Consulting	y Calculatio Engineers	in Sheet		iVVV	1	5	
ENGI	NEEKS	consulting	Linginicers			]^^^		.5	
						Member/Location			
Job Title	Member De	esign - Stee	l BeamColu	ımn BS595(	) v2015.01	Drg. Ref.			
Member De	esign - Stee	el BeamColu	ımn			Made by XX	Date 21	/11/2021	Chd.
Plastic (o	r Elastic) M	Moment Ca	pacity						<u>BS5950</u>
(With Lov	v or High S	Shear Force	e; At Least	t Semi Con	pact Sect	ion)			
	Low shear	$(V_x <= 0.6)$	P <sub>vx</sub> ) or high	shear (V <sub>x</sub> >	> 0.6P <sub>vx</sub> ) ?		Low Shear		4.2.5
	Low shear	$(V_y <= 0.6)$	P <sub>vy</sub> ) or high	shear (V <sub>y</sub> >	> 0.6P <sub>vy</sub> ) ?		Low Shear		4.2.5
	Section cla	ssification (	y-plane wh	ere applica	ble) =		Compact		4.2.5
	Section cla	ssification (	x-plane wh	ere applica	ble) =		Compact		4.2.5
	Moment C	Capacity Ca	ise			M <sub>x</sub>	My		
1	Low shear	and compa	ct =			Valid	Valid		4.2.5.2
2	High shear	and compa	ict =			Invalid	Invalid		4.2.5.3
3	Low shear	and semi co	ompact =			Invalid	Invalid		4.2.5.2
4	High shear	and semi c	compact =			Invalid	Invalid		4.2.5.3
	Moment C	Capacity (E	xcept Sing	gle Angle a	nd Double	M <sub>x</sub>	My		
1	Low shear;	; Compact;	$M_c = p_y \cdot s_r$	elevant =		1540	781	kNm	4.2.5.2
2	High shear	; Compact;	$M_c = p_y .$ (	$s_{relevant}$ - $\rho s_v$	, relevant) =	1308	89	kNm	4.2.5.3
3	Low shear;	; Semi com	pact; M <sub>c</sub> = J	$p_y \cdot Z_{relevant}$	=	1345	514	kNm	4.2.5.2
4	High shear	; Semi com	pact; $M_c =$	$p_y$ . ( $Z_{relevan}$	<sub>it</sub> - ρ <b>s</b> <sub>v, relevai</sub>	1190	52	kNm	4.2.5.3
	Moment C	Capacity (C	only Single	Angle and	d Double A	M <sub>x</sub>	My		
1	Low shear;	; Compact;	M <sub>c</sub> = 0.8 .	p <sub>y</sub> . Z <sub>relevant</sub>	=	N/A	N/A	kNm	4.2.5.2
2	High shear	; Compact;	$M_{\rm c}$ = 0.8 .	$p_y$ . ( $Z_{relevan}$	<sub>it</sub> - ρ <b>s</b> <sub>v, relevar</sub>	N/A	N/A	kNm	4.2.5.3
3	Low shear;	; Semi com	pact; $M_c = 0$	0.8.p <sub>y</sub> .Z <sub>r</sub>	elevant =	N/A	N/A	kNm	4.2.5.2
4	High shear	; Semi com	pact; $M_c =$	0.8.p <sub>y</sub> .(2	$Z_{\text{relevant}} - \rho S_v$	N/A	N/A	kNm	4.2.5.3
-									
	Reduction	<b>1 factor,</b> ρ :	= [2(V/P <sub>v</sub> )	$(-1]^2 =$		1.000	1.000		4.2.5.3
-									
	Section	2	2			s <sub>v</sub> for M <sub>x</sub>	s <sub>v</sub> for M <sub>y</sub>	2	
	Rolled I =	t.D <sup>2</sup> /4 and 2	2.(0.9T.B <sup>2</sup> /4	4) =		875	2615	cm <sup>°</sup>	4.2.5.3
	Rolled RHS	$S = A_g D^2/4/$	(D+B) and	2.(0.9T.B <sup>2</sup> /	(4) =	N/A	N/A	cm <sup>3</sup>	4.2.5.3
	Rolled CHS	5 = 0.6.[0.4]	24(D/2).πD	<sup>2</sup> /8-0.424(I	D/2-t).π(D-	N/A	N/A	cm <sup>3</sup>	4.2.5.3
-	Welded I =	= t.(D-2T) <sup>2</sup> /-	4 and 2.(0.	$9T.B^{2}/4) =$		N/A	N/A	cm <sup>3</sup>	4.2.5.3
	Welded RH	$\frac{ S  = 2t.(D-2)}{2}$	2T) <sup>2</sup> /4 and 2	2.(0.9T.B <sup>2</sup> /4	4) =	N/A	N/A	cm <sup>°</sup>	4.2.5.3
	Solid Bar =	= 0.424(D/2	$(1).0.9A_{g} =$			N/A	N/A	cm <sup>3</sup>	4.2.5.3
	Plate = 0.9	PAg.D/4 and	$0.9A_{g}.t/4 =$	-		N/A	N/A	cm <sup>2</sup>	4.2.5.3
	Kolled Sing	jie Angle =	$0.9t.D^{2}/4a$	nd (0.9T.B	(4) =	N/A	N/A	cm <sup>2</sup>	4.2.5.3
	Rolled Sing	jie Channel	= t.D <sup>2</sup> /4 ar	nd 2.(0.9T.E	3 <sup>-</sup> /4) =	N/A	N/A	cm <sup>2</sup>	4.2.5.3
	Kolled Sing	$\text{gle } T = \text{t.} D^2,$	$\frac{4 \text{ and } (0.9)}{2}$	$1.B^{-}/4) =$		N/A	N/A	cm <sup>2</sup>	4.2.5.3
	Rolled Dou	ble Angle =	2.(0.9t.D <sup>2</sup> )	/4) and 2.((	D.9T.B <sup>2</sup> /4) =	N/A	N/A	cm <sup>3</sup>	4.2.5.3
	Rolled Dou	ble Channe	$I = 2.t.D^{2}/4$	and 4.(0.9	T.B). $(s/2+$	N/A	N/A	cm <sup>2</sup>	4.2.5.3
	Rolled Dou	ble $T = 2.t.$	D.(s/2+D/2)	2) and 2.(0.	$9T.B^{2}/4) =$	N/A	N/A	cm <sup>2</sup>	4.2.5.3
	Relevant	plastic mo	aulus of si	near area,	S <sub>v, relevant</sub> =	875	2615	cm <sup>2</sup>	4.2.5.3

CON	ICHI TINC	E a si s a si s		Charak		Job No.	Sheet No.		Rev.
	IN F F D S	Consulting	g Calculatio Fnoineers	on Sneet		iXXX	1	6	
ENGI		consulting	Linginicero	1		J		.0	
						Member/Location			
Job Title	Member De	esign - Stee	el BeamColu	umn BS5950	) v2015.01	Drg. Ref.			
Member D	esign - Stee	el BeamColu	ımn			Made by XX	Date 21	/11/2021	3hd.
									<u>BS5950</u>
	Limiting m	oment capa	city, M <sub>cx,lim</sub>	$= 1.2p_y.Z_{x_i}$	relevant =		1614	kNm	4.2.5.1
	Limiting m	oment capa	CITY, M <sub>cy,lim</sub>	$= 1.2p_{y}.Z_{y}$	relevant =		617	kNm	4.2.5.1
	Manaata		NATNI /		\		1540	Lablace	425
	Moment C	apacity, M	cx = MIN (	M <sub>cx,lim</sub> , M <sub>cx</sub>	) =		1540	KNM	4.2.5
	Moment	арасну, м	<sub>cy</sub> — MIIN (	l"cy,lim/ "cy	) — 		017	KINITI	4.2.5
	M / M u	tilisation	=				0 0 2 0		OK
	M <sub>u</sub> / M <sub>av</sub> U	tilisation	=				0.020		OK
-	· · · y / · · · cy -								
	MAX (M <sub>x</sub> )	/ M <sub>cx</sub> , M <sub>v</sub> /	M <sub>cv</sub> ) utilis	ation =			0.020		ОК
Local Cap	acity								b. Ve
	Note that i	n compress	ion membe	rs, the loca	l capacity n	nay not alw	ays be less		
	onerous th	an the over	all buckling	capacity be	ecause the	local capac	ity includes	the	63
	effects of s	ection area	reduction of	due to bolt i	holes and c	connection o	connectivity	,	v
	whereas th	ne overall bu	uckling capa	acity is base	ed on the g	ross sectior	area.		, lìst a
	Clearly in t	ension men	nbers, the l	local capacit	ty is expect	ed to be m	ore onerous	; as	
	buckling ef	fects are no	ot applicable	e;					" "
									. L
	$F_t$ $M_x$	My	Tonsion	$F_{\rm c}$ $M_{\rm x}$	M <sub>y</sub>	Commerce		-	
	$\overline{P_t}^+ \overline{M_{ex}}$	$+ \overline{M_{ey}} \le 1$	rension	$\overline{A_{g}p_{y}}^{\dagger} \overline{M_{ex}}$	$+ \overline{M_{cy}} \le 1$	Compress	sion		4.8. * [la
									4.0.5.2
	1387	+	30	+	11				۷.
	9699	· · ·	1540	• · ·	617				
								-	b
	0.143	+	0.020	+	0.018	=	0.181		ОК
									R
	Note A <sub>g</sub> p <sub>y</sub>	above refe	rs to P <sub>ca</sub> ;						
-									
								<u> </u>	
								+	
								+	
								1	

CONSULTING						Job No. Sheet No. Rev.			Rev.
CONSU		Engineering	g Calculatio	n Sheet				_	
ENGIN	E E R S	Consulting	Engineers			jXXX	1	.7	
						Member/Location			<b>b</b>
lah Titla Ma	mbor Do	cian Stop	BoomColu		V201E 01	Dra. Ref.			
		- Stee			0 12015.01	Mada by a sa s		111 (2024)	bd
Member Desig	n - Stee	el BeamColu	imn	-		Wade by XX	Date 21	/11/2021	
Flexural Buc	kling (P	erry-Robe	rtson) Ca	pacity					<u>BS5950</u>
Slend	erness	λ	x	λ	y		lv		
R	Rolled I	$L_{ex}/r_{x}$	29.4	$L_{ey}/r_{y}$	46.0	N/A	N/A		4.7.2
Rolle	ed RHS	$L_{ex}/r_{x}$	N/A	$L_{ey}/r_{y}$	N/A	N/A	N/A		4.7.2
Roll	ed CHS	$L_{ex}/r_{x}$	N/A	$L_{ey}/r_{y}$	N/A	N/A	N/A		4.7.2 ¥
W	elded I	$L_{ex}/r_{x}$	N/A	$L_{ev}/r_{v}$	N/A	N/A	N/A		4.7.2
Weld	ed RHS	$L_{ex}/r_{x}$	N/A	$L_{ev}/r_v$	N/A	N/A	N/A		4.7.2
So	olid Bar	L <sub>av</sub> /r <sub>v</sub>	N/A	$L_{ev}/r_v$	N/A	N/A	N/A		4.7.2
	Plate		N/A	L <sub>ay</sub> /r <sub>y</sub>	N/A	N/A	N/A		4.7.2
Rolled Single		Short sid	e connecte	-ey, y	s standard	and kidne	( clearance		
Roned Shigh	Angie			Ac below					47102
	1	AS DEIUW	N/A	AS DEIOW	N/A	AS DEIOW	N/A		4.7.10.2
	╤━┥┡	1.01 /2	N1 / A	0.077 1.	N1 / A	0.857 /-	N1 / A		
<u> </u>	∙∔_1	$1.0L_{\rm B}/r_{\rm B}$	N/A	$0.80L_{\rm b}/T_{\rm b}$	N/A	$0.80L_{V}T_{V}$	N/A		
'a + +		but $\geq 0.7$ .	$L_{a}/r_{a} + 30$	but $\geq 0.7L$	<sub>b</sub> /r <sub>b</sub> + 30	but $\geq 0.7$	$L_{V}/r_{V} + 15$		
⊯≚. I 🕂 →									
▓╤┈╹▌ᅧ╺	∙†	$0.85L_{b}/r_{b}$	N/A	$1.0L_{\rm a}/r_{\rm a}$	N/A	$0.85L_{v}/r_{v}$	N/A		
∥l <u>a</u>		but $\geq 0.7L$	$b/r_{b} + 30$	but $\geq 0.7$	$L_a/r_a + 30$	but $\geq 0.7$	$L_{\rm v}/r_{\rm v} + 15$		
~									
	4	$1.0L_a/r_a$	N/A	$1.0L_b/r_b$	N/A	$1.0L_v/r_v$	N/A		
		but $\geq 0.7$ .	$L_{a}/r_{a} + 30$	but $\geq 0.7$	$L_{\rm b}/r_{\rm b}+30$	but $\geq 0$ .	$7L_v/r_v + 15$		
	٦.								
• • •	. 4	$1.0L_b/r_b$	N/A	$1.0L_{\rm a}/r_{\rm a}$	N/A	$1.0L_v/r_v$	N/A		
		but $\geq 0.7$	$L_{\rm b}/r_{\rm b} + 30$	but $\geq 0.7$	$L_{a}/r_{a} + 30$	but $\geq 0$ .	$7L_v/r_v + 15$		
	-								
╠╪╤╖║╎┌╍	└── <b>↓</b> [	$1.0L_{a}/r_{a}$	N/A	$1.0L_{b}/r_{b}$	N/A	$1.0L_v/r_v$	N/A		
		but ≥0.7	$L_{c}/r_{c} + 30$	but > 0.7	$L_{1/2} + 30$	$but \ge 0$	$7L_{e}/r_{e} + 15$		
.ey + +	_		ar a	our con	1010 . 00				
	└── <b>↓</b>	1.0L/p	NI/A	$1.0L/r_{\odot}$	NI/A	$1.0L/r_{\odot}$	N/A		
╢╲╢┟╧		1.02676	N/A	$1.0L_{\rm B}n_{\rm B}$		$1.01_{V}n_{V}$	N/A		
		but $\geq 0.7$	<i>L</i> _//1 <sub>0</sub> + 30	But 20.11	$L_{a}r_{a} + 30$	but 20.	$TL_{\rm V}T_{\rm V} \neq 15$		
nied Single C	nannei	A - 4 - 1		web conne	ectea - two	or more ro	WS OF DOILS		47104
		AS DEIOW	N/A	As below	N/A	N/A	N/A		4.7.
									x
		$0.85L_{\rm X}/r_{\rm X}$	N/A	$1.0L_y/r_y$	N/A	N/A	N/A		
U y				but $\geq 0.7$	$L_y/r_y + 30$				
	[								*=
×		$1.0L_{\rm x}/r_{\rm x}$	N/A	$1.0L_y/r_y$	N/A	N/A	N/A		
y I				but $\geq 0.7$	$L_{y}/r_{y} + 30$				

CON	ISTIL TINC	Engineerin	a Calaulatia	on Chaot		Job No.	Sheet No.		Rev.
	NEERS	Consultina	g Calculatio Engineers	on Sneet		iXXX	1	8	
		J	J	1		5000			
a. 1				DOFOE	2015.01	Member/Location			
Job Title Mombor D	Member De	esign - Stee		umn BS5950	) v2015.01	Made by	Date <b>31</b>	/11/2021	thd.
Member D	esign - Stee					××××××××××××××××××××××××××××××××××××××	ZI	/11/2021	BS5050
									<u>D33930</u>
Rolle	d Single T		F	lange conne	ected - two	or more ro	ws of bolts		Ro
		As below	N/A	As below	N/A	N/A	N/A		4.7.10.5
hi×									
		$1.0L_{\rm x}/r_{\rm x}$	N/A	$0.85L_y/r_y$	N/A	N/A	N/A		
FIx.		but $\geq 0.7$	$L_{\rm x}/r_{\rm x} + 30$						
, hi		$1.07./r_{\odot}$	NI/A	$1.0L/r_{\odot}$	NI / A	NI / A			
	, ( <u>-</u>	$but \ge 0.7$	$I_{r_x}/r_x + 30$	LoLyry	IN/A	IN/A	N/A		
Rolled Dou	Jule Angle	port, short	side conne	cted - two c	or more bol	l ts. standard	l clearance		
	<b>j</b>	,,			Eleven b	atten(s) wi	thin span L		
		As Below	N/A	As Below	N/A	N/A	N/A		4.7.10.3
L.									
,		$1.0L_{\rm x}/r_{\rm x}$	N/A I	$[(0.85L_y/r_y)^2 + \lambda$	e <sup>2</sup> ] <sup>0.5</sup> V/A	N/A	N/A		
• <u>×</u>	<u>+</u> '	but ≥0	$1.7L_{\rm x}/r_{\rm x} + 30$	but $\geq 1.4\lambda_c$					
			- 0x0.5 1/A	1.0L/r	NI / A	NI / A	NI / A		
y		$(0.85L_y/r_y)^2 + 1$	le=jn:≊N/A	but $\geq 0$	N/A $1.7L_s/r_s + 30$	IN/A	N/A		
×		$u_l \ge 1.4n_c$			X · X				
y <b>i</b> y		$1.0L_{\rm x}/r_{\rm x}$	N/A	$[(L_y/r_y)^2 + \lambda_c^2]^0$	™ N/A	N/A	N/A		
l II i		but ≥0	$0.7L_{\rm x}/r_{\rm x} + 30$	but $\geq 1.4\lambda_{\rm e}$					
y_		$[(L_y/r_y)^2 + \lambda_c^2]^0$	™ N/A	$1.0L_{\rm x}/r_{\rm x}$	N/A	N/A	N/A		
	+-+-	but $\geq 1.4\lambda_e$		but ≥0	$0.7L_{\rm x}/r_{\rm x} + 30$				
- J <sup>y</sup>		$I(L, h; \lambda^2 + \lambda, 2)0$		0.85L /r	NI / A	N/A	NI/A		
-		but $\geq 1.4\lambda_{\circ}$	N/A	but $\geq 0.7$	$TL_{\rm x}/r_{\rm x} + 30$	N/A	N/A		
ry Jy	╡								
× =		$0.85L_{\chi}/r_{\chi}$	N/A	$[(L_y/r_y)^2 + \lambda_c^2]^0$	™ N/A	N/A	N/A		
, y		but $\geq 0.2$	$7L_{\rm x}/r_{\rm x} + 30$	but $\geq 1.4\lambda_{\rm c}$					
y I									
∎ <u></u> × + [	• 9	$[(L_y h_y)^2 + \lambda_c^2]^0$	™ N/A	$1.0L_{\rm x}/r_{\rm x}$	N/A	N/A	N/A		
ly 🗆	<b>↓</b>	but $\geq 1.4\lambda_c$		but ≥0	$L_{X}/r_{X} + 30$				
		$1.0I_{\odot}/r_{\odot}$	N/A	$[(I, h; )^2 + \lambda , 2]0$	a NI/A	Ν/Λ	Ν/Λ		
		but $\geq 0$	$1.7L_{\rm x}/r_{\rm x} + 30$	but $\geq 1.4\lambda_c$	N/A	N/A	N/A		
₹y									
×		$[(L_y/r_y)^2 + \lambda_c^2]^0$	IS N/A	$1.0L_{\rm x}/r_{\rm x}$	N/A	N/A	N/A		
Чy		but $\geq 1.4\lambda_{\rm e}$	-	but ≥0	$0.7L_{\rm x}/r_{\rm x} + 30$				
,y									
×		$1.0L_{\rm x}/r_{\rm x}$	N/A	$[(L_y/r_y)^2 + \lambda_c^2]^0$	™ N/A	N/A	N/A		
, by		but ≥0	$0.7L_{\rm X}/r_{\rm X} + 30$	but $\geq 1.4\lambda_e$					
	Note that r	and r a	hove refers	tor	, and r				
	Lenath het	ween adiao	ent battens	$\frac{1}{5}, L_{a,bat} = 1$	/ (1 + No o	f battens) :	N/A	m	
	Slendernes	$\delta s, \lambda_c = L_{a} h$	$r_v = r_v$	, —e, uat 🕒	,		N/A		N/A
		, .							

CON	ISHI TING	Enginoorin	a Calculatio	n Choot		Job No.	Sheet No.		Rev.
ENGI	NEERS	Consulting	Engineers	in Sheet		iXXX		19	
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						Member/Location			
Job Title	Member De	esign - Stee	l BeamColu	ımn BS595	0 v2015.01	Drg. Ref.			
Member D	esign - Stee	el BeamColu	Imn			Made by XX	Date 21	/11/2021	hd.
									<u>BS5950</u>
lled Doubl	e Channel			Both	sides of su	pport, web	connected		
					Eleven b	atten(s) wi	thin span L		
	L <sub>ex</sub>	/r <sub>x, double cha</sub>	N/A	$\lambda_{\rm b}$	N/A	N/A	N/A		4.7.9
	$\lambda_{\rm b} = (\lambda_{\rm m}^2 + \lambda_{\rm c})^2$	$c^{2\gamma^{0.5}}$ If $\lambda_{\rm b}$ is l	ess than 1.4λ	<sub>e</sub> the design sl	hould be based	d on $\lambda_b = 1.4\lambda$	c		
	l enath het	ween adiac	ent hattens		/ (1 + No o	f hattens)	= N/Δ	m	
	Slendernes	$s_{1} \lambda_{m} = \int dt dt$	r. dauble above	e, bat -			N/A		
	Slendernes	$s_{\rm s}$ , $\lambda_{\rm c} = l_{\rm c}$ h	$r_{r_{\rm ot}} = r_{r_{\rm ot}} = r_{r_{\rm ot}}$				N/A		N/A
	Sichaernes	, с <b>–</b> е, в	at / 'y						
	The slenderne	$ess \lambda_c$ of a main	1 component (	based on its m	inimum radiu	s of gyration)	between end v	velds	
	or end bolts o	f adjacent bat	tens $\lambda_c$ show	uld not exceed	50.				
Rollec	l Double T			Both s	ides of supr	ort, flange	connected		
Ronee				Dotti S	Eleven b	atten(s) wi	thin span I		
		λı	N/A	w/ry double	N/A	N/A	N/A		4.7.9
			,	eyr - y, double		,			
	$\lambda_{\rm b} = (\lambda_{\rm m}^2 + \lambda_{\rm c})^2$	$c^{2}$ ) <sup>0.5</sup> If $\lambda_{b}$ is l	ess than 1.4λ	<sub>e</sub> the design sl	hould be based	$d \text{ on } \lambda_b = 1.4\lambda$	e		
	Length bet	ween adiac	ent battens	$L_{a hat} = L$	/(1 + No o	f battens)	= N/A	m	
	Slendernes	$s_{\rm s}$ , $\lambda_{\rm m} = L_{\rm ev}$	$r_{x,double T} =$	/ _e, bat _			N/A		
	Slendernes	$s, \lambda_c = L_{a,b}$	$r_{x}$ , double 1				N/A		N/A
		е, в	at 7 ' y					<u> </u>	
	The slenderne	essλ <sub>e</sub> of a main	1 component (	based on its m	inimum radiu	s of gyration)	between end v	velds	
	or end bolts o	i adjacent bat	$\lambda_c$ show	uld not exceed	50.				
	Critical sl	enderness	, λ <sub>max</sub> = <b>Μ</b>	<b>ΑΧ (</b> λ., λ., ζ	λ.,) =		46.0		
	Maximum	allowable	slenderne	255. λομου =	=		180.0		
	Slenderne	ess utilisat	ion = $\lambda_{max}$	$/ \lambda_{\text{allow}} =$			0.256		ОК
	Slenderne	ess, λ. =					29.4		
	Fuler force	$P_{\text{EV}} = \pi^2 \text{F}^2$	v rolovant/l ov	<sup>2</sup> (valid for	$\lambda_{\rm v} > (\pi^2 {\rm F/p})$	$(1)^{1/2} =$	85781	kN	
	Euler stres	$s_{, D_{F_{v}}} = \pi^{2}E$	<sup>-</sup> χ, relevant <u>–ex</u> Ξ/λ <sup>2</sup> (valid	for $\lambda_{\nu} > (\pi^2$	$(E/p_v)^{1/2} =$		2338	N/mm <sup>2</sup>	
		Robertson	constant, a	=			3.5		
			,-						
		The Roberts	on constant o	<i>i</i> should be ta	ken as follow	s:			
		— for str	ut curve (a):	a = 2.0;					
		— for str	ut curve (b):	a = 3.5;					
		— for str	ut curve (c):	a = 5.5;					
		— 10r str	ut curve (a):	a = 8.0.					
		Design stre	ength, $p_v =$				265	N/mm <sup>2</sup>	
		Reduced p	, (–20N/mm	$1^{2}$ ) for plate	airders =		265	N/mm <sup>2</sup>	
	Limiting sle	enderness, 1	$\lambda_0 = 0.2(\pi^2)$	$(E/p_v)^{0.5} =$			17.5	,	
		Perry facto	$r, \eta_x = a(\lambda_x)$	λ_0)/1000 (	(but η <sub>x</sub> >= )	0) =	0.042		
		$\phi_x = [p_v + (r)]$	<sub>1x</sub> +1).p <sub>E.x</sub> ] /	/ 2 =			1351	N/mm <sup>2</sup>	
	Compressiv	ve strength	$p_{cx} = p_{F.x}$	p <sub>v</sub> / [\$,+(\$,	$(2^{-}p_{E,x},p_{v})^{0.5}$	] =	253	N/mm <sup>2</sup>	4.7.5
	Compress	ion capaci	ty, $P_{cx} = p$	cx.A <sub>q, relevan</sub>	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		<u>9265</u>	kN	4.7.4
	F / P <sub>cx</sub> uti	lisation =		<u>,</u>			0.150		ОК

CON	JSULTINC	Engineerin	a Calaulatia	n Chaot		Job No.	Sheet No.		Rev.
		Consulting	g Calculatio Engineers	n Sneet		iVVV		20	
ENG		consulting	Engineers			]^^^		20	
						Member/Location			
Job Title	Member De	esign - Stee	el BeamColu	ımn BS5950	0 v2015.01	Drg. Ref.			
Member D	esign - Stee	el BeamColu	ımn			Made by XX	Date 21	L/11/2021	3hd.
									BS5950
	Slenderne	ess, λ <sub>v</sub> =					46.0		
	Euler force	$P_{\rm EV} = \pi^2 E_{\rm I}$	Ly relevant/Lav	<sup>2</sup> (valid for	$\lambda_{\rm v} > (\pi^2 E/p$	$(1)^{1/2} =$	34830	kN	
	Euler stres	$s_{\rm p} = \pi^2 E$	<u>y, relevanto ey</u> Ξ/λ., <sup>2</sup> (valid	for $\lambda_{\nu} > (\pi^2$	$(E/p_{v})^{1/2}) =$		955	N/mm <sup>2</sup>	
		Robertson	constant. a	=			5.5		
			,,			<u> </u>			
		The Roberts	son constant a	<i>i</i> should be ta	ken as follow	/s:			
		— for str	ut curve (a):	a = 2.0;					
		— for str	ut curve (b):	a = 3.5;					
		— for str	ut curve (c):	a = 5.5;					
		— for str	ut curve (d):	a = 8.0.					
		Design stre	enath n =				265	N/mm <sup>2</sup>	<u> </u>
		Reduced n	(_20N/m~	1 <sup>2</sup> ) for plate	airdere –		205	$N/mm^2$	
	Limiting of	$p_{\lambda}$	$\gamma (-2013/1111)$	$F/n \ 1^{0.5} -$			17 5		<b> </b>
		Porry facto	$r_0 = 0.2(n)$	$\frac{L}{P_y} = \frac{1}{2} \frac{1}{1000}$	but n N-	0) -	0 157		
		$+ - \ln \pm (n)$	$(\lambda_y - a(\lambda_y - a))$	$\frac{-\lambda_0}{2}$		0) –	605	NI /	
	Compressi	$ \psi_y - [P_y + (1)] $	ly+1).PE,y]/	$m / \Gamma + 1 / 1$	<sup>2</sup> n n 10.5	 '1	200	N/mm	475
	Compressi	ve strengtn	$p_{cy} = p_{E,y}$	<u>ρ<sub>y</sub> / [φ<sub>y</sub>+(φ<sub>y</sub></u>	$-p_{E,y}$ , $p_y$ )	] =	220	N/mm <sup>-</sup>	4.7.5
		lication -	ι <b>γ</b> , Ρ <sub>cy</sub> = <b>μ</b>	cy•Ag, relevan	t =		8050	KIN	4.7.4 OV
	F / P <sub>cy</sub> uti	lisation =					0.1/2		OK
	Clandaun								
	Sienderne	$\frac{2}{2}$	г /I	2 (	$\sim \sqrt{2\pi}$	1/2		LINI	
	Euler force	$P_{E,v} = \pi^{-}E$	$L_{v, relevant}/L_{ev}$		$\lambda_v > (\pi^- E/p)$	$(y_{y})^{-,-}) =$	N/A	KIN 2	
	Euler stres	S, $p_{E,v} = \pi E$	$\frac{1}{\lambda_v}$ (valid	for $\lambda_v > (\pi$	$E/p_y$ ) / ) =		IN/A	N/mm <sup>-</sup>	
		Robertson	constant, a	=			N/A		
		The Roberts	son constant a	<i>i</i> should be ta	ken as follow	/s:			
		— for str	ut curve (a):	a = 2.0;					
		— for str	ut curve (b):	a = 3.5;					
		— for str	ut curve (c):	a = 5.5;					
		— for str	ut curve (d):	a = 8.0.					
								2	
		Design stre	$p_y = \frac{1}{2}$	2			N/A	N/mm <sup>2</sup>	
		Reduced p	(-20N/mm)	1 <sup>2</sup> ) for plate	girders =		N/A	N/mm <sup>2</sup>	
	Limiting sle	enderness,	$\lambda_0 = 0.2(\pi^2)$	$E/p_y)^{0.5} =$			N/A		
		Perry facto	$r, \eta_v = a(\lambda_v)$	$(-\lambda_0)/1000$	_out η <sub>v</sub> >=	U) =	N/A		
	-	$\phi_v = \lfloor p_y + (r) \rfloor$	ղ <sub>v</sub> +1).p <sub>E,v</sub> ] /	/ 2 =	2 .05	-	N/A	N/mm <sup>2</sup>	
	Compressi	ve strength	$p_{cv} = p_{E,v}$	p <sub>y</sub> / [φ <sub>v</sub> +(φ <sub>v</sub>	$(-p_{E,v}, p_y)^{0.5}$	<u>] =</u>	N/A	N/mm <sup>2</sup>	4.7.5
	Compress	sion capaci	$\mathbf{ty}, \mathbf{P}_{\mathbf{cv}} = \mathbf{p}$	cv <b>.A</b> g, relevan	t =		N/A	kN	4.7.4
	F / P <sub>cv</sub> uti	lisation =					N/A		N/A
-									_
	Flexural b	ouckling ca	pacity util	isation =			0.172		OK
									<b> </b>
									<b> </b>
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									ļ

CON	ISULTING	Enginoorin	a Calculati	on Shoot		Job No.	Sheet No.		Rev.
ENG	INEERS	Consulting	Engineers			iXXX		21	
			1			<b>J</b>			
						Dra Ref			
Job Title	Member De	esign - Stee		lumn BS5950	) v2015.01	Made by	Date 1	/11/2021	thd
Member D	esign - Stee		umn			XX	21	/11/2021	
	orsional Bu	Shoar Ford		st Sami Can	nact Soct	ion)			<u>DS5950</u>
	Minor avi	s slandarn	$e_i$ At Leas	51 Senn Con			46.6		
		Effective u	nrestraine	•E,LTB/ • y, relevand length. L	ant — 		4 797	m	435
	$\beta_{w} = 1$ (co	pmpact) or	$\beta_{\rm W} = \mathbf{Z}_{\rm Y}$	$\frac{1}{2}$	vant (semi	compact)	1.000		4.3.6.9
	Note sectio	on classifica	tion refers	to v-plane v	where appli	cable:	11000		1131019
	Equivalen	t slendern	ess (I, H,	, single cha	nn $\lambda_{LT} =$	$uv\lambda$ , $\beta_{W}$	32.5		4.3.6.7
		Buckling p	arameter,	u =			0.835		4.3.6.8
			Torsional	index, x =			10.2		4.3.6.8
			$\lambda / x =$		1		4.57		
		Slenderne	ss factor, v	$v = v^{2}$	$[1 + 0.05(\lambda/$	$(x)^2$	0.837		4.3.6.7
	<u> </u>	<u> </u>	(						
	Equivalen	it sienderr	iess (RHS	$\lambda_{LT} = \lambda_{LT}$	$= 2.25(\phi$	$(\lambda \beta_{\rm W})^{0.0}$	N/A		B.2.6
		~	$(I_{y})$	(, J)			NI/A		R 2 6
		$\gamma_{\rm b} = \gamma_{\rm b} =$		$1 - \frac{1}{2.6I_x}$			N/A	+	D.2.0
			0	0.5				+	
		$\phi_{\rm b} = \phi_{\rm b} =$	$=\left(\frac{S_x^2\gamma_b}{\gamma_b}\right)$	0.0			N/A		B.2.6
			(AJ)				,		
		Note A=A	, in the ab	ove equation	;				
	Equivalen	t slenderr	ess (CHS	, solid bar),	$\lambda_{LT} = N/A$	\ =	N/A		
					(B	$mL_{re}d^{0.5}$			
	Equivalen	t slenderr	ess (plat	e), $λ_{LT} = λ_{LT}$	= 2.8	$\frac{W^2 E^{\alpha}}{t^2}$	N/A		B.2.7
	Note $L_E = L$	<sub>E,LTB</sub> and d	=D in the	above ed <del>uun</del>		*			
	Equivalen	it slendern	iess (sing	le angle, do	uble angl	e), λ <sub>ιτ</sub> = Ν	, N/A		
	Equivalen		$\frac{1}{1} - \frac{1}{1}$	le 1, double	: I), ~ <sub>LT</sub> =				D.2.0 P.2.0
		Case A.	$I_{\rm XX} - I_{\rm YY}$	LT is zero		7	N/A	+	D.2.0
		Case B:	$L_{m} > L_{m}$	am - 28	$\left[\frac{\beta_{\rm W}L_{\rm E}B}{M}\right]^{0.2}$	5	N/A		B.2.8
		0000 01	-yy -xx	-LT = 2.0	$T^2$				51210
		Case C:	$I_{xx} > I_{yy}$	$\lambda_{\rm LT} = uv\lambda$	$\beta_{\rm W}$		N/A		B.2.8
					<b>4</b> 7 W				
			Buckling	parameter, u	=		N/A		B.2.8
				Torsional in	ndex, x =		N/A		B.2.8
				$\lambda / x =$			N/A	<u> </u>	
					4H				
				$w = I_y($	$D - T/2)^2$		N/A		В.2.8
				Monosymm	etric index	)/( =	N/A		B 2 8
				Pionosymm		, ψ -	3. tu m	4 (D )4	D.2.0
				$\psi = 2$	$y_0B^-T/$	$12 + BTy_{o}$	$+\frac{1}{4}[(c-T)]$	$-(D-c)^{-}$ ]	1
				"	0		$I_{\rm x}$		(D - T/2)
				Note $\psi$ pos	sitive if flan	in comp	pression and	d vice versa	;
					Centroid, c	$= [B.T^2/2]$	- N/A	mm	B.2.8
					$y_0 = c -$	T/2	N/A	mm	B.2.8
			Slenderne	ess factor, v			N/A		B.2.8
					1			<u> </u>	
			$\nu = 10$	$w + 0.05(\lambda/x)$	$(2^{2} + \psi^{2})^{0.5} +$	$\psi^{0.5}_{1}$			
								+	

CON	ISULTINC	Facinostia	a Calaulatia	n Chaot		Job No.	Sheet No.		Rev.
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ENG		consulting	Engineers			JVVV	2	.2	
						Member/Location			
Job Title	Member De	esign - Stee	el BeamColu	mn BS5950	) v2015.01	Drg. Ref.			
Member D	esign - Stee	el BeamColu	ımn			Made by XX	Date <b>21</b>	/11/2021	Chd.
									<u>BS5950</u>
				1	$p_{\rm E} p_{\rm y}$				
	Bending s	trength, p	<sub>b</sub> = $p_{b}$ =		$\frac{2}{m^2 - p_{\rm T} p_{\rm T}}$	0.5	265	N/mm <sup>2</sup>	B.2.1
				7 LT \7 I	T PEPy				
		Slenderne	ess, λ <sub>ιτ</sub>	. 9	2		32.5		
		Euler stres	$s, p_E = P$	$E = (\pi^{-}E)$	$(\lambda_{\rm LT})$		1912	N/mm <sup>2</sup>	B.2.1
		p <sub>y</sub> =	n + (n - 1)				265	N/mm <sup>2</sup>	
		$\phi_{LT} = \phi_{LT}$	$=\frac{P_y \cdot q_1}{2}$	$\frac{1}{2}$			1089	N/mm²	B.2.1
			Limiting eq	uivalent sle	enderness,	$\lambda_{L0} =$	35.0		B.2.1
			$0.4(\pi^2 E/p)$	0.5					
				<i>y</i> ′					
			Robertson	constant, a	$_{LT} = 7.0 =$		7.0		B.2.1
-			Perry facto	r, η <sub>LT</sub> =			0.000		B.2.1
			The Perry	factor $\eta_{\rm LT}$ s	should be ta	ken as follo	ws:		
			a) for ro	lled section	s:				
			$\eta_{ m LT}$	$= a_{LT}(\lambda_{LT})$	$(-\lambda_{\rm L0})/100$	0 but $\eta_{L'}$	$r \ge 0$		
			b) for we	elded section	ns:			_	
				$if \lambda_{LT} \leq \lambda_{L}$	0:	$\eta_{LT} = 0$			
				$if \lambda_{L0} < \lambda_{LT}$	$< 2\lambda_{L0}$ :	$\eta_{LT} = 2$	$a_{\rm LT}(\lambda_{\rm LT} - \lambda)$	<sub>L0</sub> )/1 000	
				if $2\lambda_{L0} \leq \lambda_1$	$L_T \leq 3\lambda_{L0}$ :	$\eta_{\rm LT}$ = 2	$a_{LT}\lambda_{L0}/100$	0	
				$if \lambda_{LT} > 3\lambda_{I}$	v;	$\eta_{\rm LT} = a$	$LT(\lambda_{LT} - \lambda_{L})$	<sub>0</sub> )/1 000	
	Equivalant	uniform m	mont facto	r for ITD n	<u> </u>		1 000		1266
				$\frac{101 \text{ LID}}{100 \text{ LID}}$					4.3.6.6
	Low siled	$(v_x <= 0.0$	Yvx) OF HIGH		$> 0.0P_{\rm vx}$ ) :		Low Snear		4.2.5
		SSIICATION	y-plane wil	ere applica	bie) =		Compact		4.2.5
	Latoral To	rcional Ru	ckling Coc				M		
1			cking cas				Valid		
1	High choor		ut –				Invalid		
2	Low choor	and comi o	ompact -				Invalid		
J	High choor	and somi o	ompact –				Invalid		
4			ompace –				Invaliu		
	l ateral To	rsional Bu	ckling (Ev	cent Singl	e Angle ar		м.		
1	Low shear	Compact	M <sub>μ</sub> = n, ς		C Aligie di		1540	kNm	4364
2	High shear	: Compact:	$M_{\rm h} = n_{\rm h} \cdot ($		S, , , , , )	=	1308	kNm	4,364
2	Low shear	Semi com	Dact: $M_{L} = 1$		x = vx, relevant		1345	kNm	4.3.6.4
4	High shear	: Semi com	$mact: M_{h} =$	$p_{\rm D} = -x$ , releval	unt = OvSuv v	(1,5) =	1190	kNm	4364
	Note if n h	not applical	ble, then ea	uations rev	ert to p.:		1150		1.5.6.7
1			<i>_,</i>						
F									
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CONSULTING		Enginooriu	ngineering Calculation Sheet				Sheet No.		Rev.	
ENGI	N	EERS	Consulting	ig Calculation Engineers	JII Sheet		iXXX		23	Ĭ
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							Member/Locati	on		
Job Title	Me	mber De	esign - Ste	el BeamColu	umn BS595	0 v2015.01	Drg. Ref.			di i
Member D	esig	n - Stee	el BeamCol	umn	1		Made by X	X Date 21	/11/2021	una.
										<u>BS5950</u>
			usisual D			• • • • • • • • •	NA	м		
	La				ily Single /		Mbx	I <sup>vi</sup> by		1202
	a.	$M_{\rm b} = 0$	$.8p_yZ_x$ h	eel of angle	in compres	s1011				4.3.0.3
	h	M -	$-7^{(135)}$	$0\varepsilon - L_{\rm E}/r_{\rm v}$	hut	M < 0.9	h a	eel of angle i	in tension	4383
	0.	$32_{\rm b} = 1$	$\rho_y z_x$	1625ε )	but	$M_{\rm b} \le 0.8$	$p_y z_x$			4.5.0.5
1	a. I	ow she	ar: Compa	ct: $M_{\rm b} = 0.8$	B. D. Zrolov	ant =	N/A	N/A	kNm	4.3.8.3
	b. I	_ow she	ar; Compa	ct; $M_{\rm b} = p_{\rm v}$	. Z <sub>relevant</sub> . (	1350ε-L <sub>E I TE</sub>	N/A	N/A	kNm	4.3.8.3
2	a. I	ligh she	ear; Compa	act; $M_{\rm b} = 0.3$	8. p <sub>v</sub> . (Z <sub>rel</sub>	evant - pSv. rel	N/A	N/A	kNm	4.3.8.3
	b. I	- High she	ear; Compa	act; $M_b = p_v$	. (Z <sub>relevant</sub> -	$\rho S_{v, relevant}$ )	N/A	N/A	kNm	4.3.8.3
3	a. I	_ow she	ar; Semi c	ompact; M <sub>b</sub>	$= 0.8 \cdot p_v$ .	Z <sub>relevant</sub> =	N/A	N/A	kNm	4.3.8.3
	b. I	_ow she	ar; Semi c	ompact; M <sub>b</sub>	$= p_{y} \cdot Z_{relev}$	<sub>ant</sub> . (1350ε	N/A	N/A	kNm	4.3.8.3
4	a. I	ligh she	ear; Semi o	compact; M <sub>b</sub>	$= 0.8 . p_y$	. (Z <sub>relevant</sub> -	N/A	N/A	kNm	4.3.8.3
	b. I	ligh she	ear; Semi o	compact; M <sub>b</sub>	$p = p_y \cdot (Z_{rel})$	<sub>evant</sub> - ρ <b>s</b> <sub>v, re</sub>	N/A	N/A	kNm	4.3.8.3
	Not	e althou	ugh the eq	uations are	valid only fo	or equal ang	gles, it is	used for une	qual angles	too;
	Re	ductior	<b>factor,</b> ρ	$_{\rm x} = [2(V_{\rm x}/F$	$(v_{vx}) - 1]^2 =$			1.000		4.2.5.3
	Re	ductior	<b>factor,</b> ρ	$y = [2(V_y/F)]$	$(v_{yy}) - 1]^2 =$			N/A		4.2.5.3
	Re	levant	plastic mo	odulus of s	hear area,	<b>S</b> vx, relevant	=	875	cm <sup>3</sup>	4.2.5.3
	Re	levant	plastic mo	odulus of s	hear area,	S <sub>vy, relevant</sub>	=	2615	cm <sup>3</sup>	4.2.5.3
				-						
	Mo	ment c	apacity, I	$1_{cx} =$				1540	kNm	4.2.5
	MO	ment c	apacity, r	∕l <sub>cy</sub> =			(	N/A	kNm	4.2.5
	Lat	eral to	rsional bu	ickling cap	acity, M <sub>b</sub> /	m <sub>LT</sub> (or M <sub>b</sub>	<sub>x</sub> /m <sub>LT</sub> ) =	1540	KINM	4.3.6.2
	Lai	eral to	rsional bu	ickling cap	acity, M <sub>by</sub> /	$m_{LT} = (M/m)$	or M /n	N/A 1540	KINITI	4.3.0.2
		eral to	rsional bi	ickling cap	acity, MIN	$(M_{b}/M_{LT})$	M ) =		kNm	4.3.0.2
	La							N/A	KINITI	4.5.0.2
	М.,	/ MTN	(M <sub>b</sub> /m <sub>b</sub> (	or M <sub>by</sub> /m	), M., ) uti	lisation =		0.020		ОК
	M.,	/ MIN	(M <sub>by</sub> /m <sub>1</sub> ,	M <sub>a</sub> ) utilis	ation =			N/A		N/A
	y	,	(by/L1/							
	MA	X (M <sub>x</sub> )	/ MIN (M <sub>b</sub>	/m <sub>LT</sub> (or M	<sub>bx</sub> /m <sub>LT</sub> ), M	<sub>cx</sub> ), M <sub>v</sub> / M	IN (M <sub>bv</sub> /	m 0.020		ОК
						<b>/</b>	<b>,</b>			
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CON	CONSULTING Engineering Calculation Sheet					Job No.	Sheet No.		Rev.
	NEEDS	Consulting	g Calculatio Engineers	n Sneet		iVVV	2	0.4	
ENGI	NEEKS	consulting	Engineero			JVVV	2	-7	
						Member/Locatio	n		-
Job Title	Member De	esign - Stee	el BeamColu	ımn BS5950	0 v2015.01	Drg. Ref.			
Member D	esign - Stee	el BeamColu	ımn			Made by X	<b>X</b> Date <b>21</b>	/11/2021	hd.
Overall B	uckling (Si	mplified A	pproach)	Capacity					<u>BS5950</u>
	Equivalent	uniform mo	oment facto	or for flexur	al buckling,	m <sub>x</sub> =	1.000		4.8.3.3.4
	Equivalent	uniform mo	oment facto	or for flexur	al buckling,	m <sub>y</sub> =	1.000		4.8.3.3.4
		/=							
	Overall B	uckling (Ex	ccept Sing	le Angle ai	nd Double	Angle)			
$\frac{F_c}{r}$ +	$\frac{m_{LT}M_{LT}}{4}$ +	$\frac{m_y M_y}{-y} \le 1$	0.170	0.020	0.000		0.214		40224
P <sub>cy</sub>	$M_{\rm b}$	$p_y Z_y$	0.172 +	- 0.020 +	0.022	=	0.214		4.8.3.3.4
$F_{c}$	$m_x M_x = m_y$	M	0 1 7 2 +	0 0 2 2 +	0 0 2 2		0 217		10221
$\overline{P_c}^{*}$	$\frac{1}{p_y Z_x} + \frac{1}{p_y}$	$\overline{Z_v}^{\leq 1}$	0.172	0.025	0.022	_	0.217		4.0.3.3.4
	Note 7 au	nd 7 refers	sto Z	and 7	recni	ectively			
			x, relevant $x$ , relevant $x$	ant and Z y, r	elevant, respe				
	Overall R	uckling (Or	nly Single	Angle and	Double Ar	nale)			
	overall b		iny Single						
$\frac{F_{e}}{F_{e}}$ + $\frac{n}{2}$	$n_{\text{LTx}}M_{x} + m_{x}$	$LTyM_y < 1$	N/A +	- N/A +	N/A	=	N/A		I.4.3
$P_{e}$	M <sub>bx</sub>	M <sub>by</sub>							
	Note althou	ugh the equ	ations are	valid only fo	pr equal and	les, it is ι	ised for unec	ual angles	too;
	Note m <sub>LTx</sub>	and $m_{LTV}$ b	oth taken a	$ns m_{LT};$	, _				,
	Overall bu	uckling util	lisation =				0.217		ОК
Overall B	uckling (Ex	kact Appro	ach) Capa	city					
	Equivalent	uniform mo	oment facto	or for flexur	al buckling,	m <sub>yx</sub> =	1.000		4.8.3.3.4
-	Overall B	uckling (O	nly I and H	1)					
	— for	major axis	buckling:						
	$F_{c}$	$+ \frac{m_x M_x}{m_x}$	$+0.5\frac{F_c}{c}$	$+0.5 \frac{m_{yx}M}{2}$	¥ < 1		0.180		4.8.3.3.2
	Pex	M <sub>cx</sub> (1	$(0.0\overline{P_{\rm ex}})$	- 0.3-M <sub>cy</sub>	51				
	— for	lateral-tor	sional buck	ding:			0.044		40000
	$F_{c}$	$+ \frac{m_{LT}M_{LT}}{m_{LT}}$	$\frac{\Gamma}{1} + \frac{m_y M_y}{y}$	$1 + \frac{F_c}{c} < 1$			0.214		4.8.3.3.2
	P <sub>cy</sub>	$_{\rm v}$ $M_{\rm b}$	$M_{\rm ey}$	$P_{ey}$					
	— fo	r interactiv	e buckling:		E (D )		0.051		10222
	<u> </u>	$\frac{M_{\rm x}(1+0.5)}{M_{\rm x}(1+0.5)}$	$\frac{(F_c/P_{ex})}{P}$ +	$\frac{m_y M_y(1 + y)}{M_y(1 + y)}$	$\frac{F_c/P_{cy}}{2/D} \le 1$		0.051		4.0.3.3.2
		$M_{\rm ex}(1-F_{\rm e})$	$P_{\rm ex}$	$M_{\rm cy}(1-F)$	$e'P_{\rm ey}$ )	,┛───			
	Overall B	ucklina (Or	niv RHS an	d CHS)					
	for	major avie	huckling		<u> </u>				
		$m_{\star}M_{\star}$	Fay	$m_{yy}M_{z}$			N/A		4.8.3.3.3
	$\overline{P_{ex}}$	$+\frac{x-x}{M_{ex}}(1)$	$+0.5\frac{c}{P_{cr}}$	$+0.5 - \frac{M_{ev}}{M_{ev}}$	≤ 1				
	— for	minor axis	buckling, i	if a lateral-t	torsio				
	$F_{\rm c}$	$+ \frac{m_{LT}M_{LT}}{m_{LT}}$	$+ \frac{m_y M_y}{m_y}$	$+0.5 \frac{F_{\rm c}}{F_{\rm c}}$	< 1		N/A		4.8.3.3.3
	$P_{ey}$	$M_{\rm b}$	M <sub>cy</sub>	$\overline{P_{\rm cy}}$	- 1				
	— for	interactive	buckling:						
	$\frac{n_x N}{n_x}$	$I_{\rm x}(1+0.5)$	$\frac{P_{c}(P_{cx})}{P_{cx}} + \frac{n}{2}$	$i_y M_y (1 + 0)$	$\frac{5(F_{\rm c}/P_{\rm cy})}{P_{\rm cy}}$	≤ :	N/A		4.8.3.3.3
	1	$M_{\rm ex}(1-F_{\rm c}/I)$	$P_{ex}$ )	$M_{\rm cy}(1-1)$	$F_{\rm c}/P_{\rm cy}$ )	<b>_</b>			
	Overall bu	uckling uti	isation =				0.214		OK

CON	ISHI TING	Enginoorin	Engineering Calculation Sheet				Sheet No.		Rev.
	NEEDS	Consulting	y calculatic Fnaineers	in Sheet		iXXX	2	5	
ENGI		consulting	Linginicero			јллл	2	.5	
						Member/Location			
Job Title	Member De	esign - Stee	l BeamColu	imn BS5950	) v2015.01	Drg. Ref.	-		4
Member D	esign - Stee	el BeamColu	Imn			Made by XX	Date <b>21</b>	/11/2021	lhd.
Bending I	Deflection	in Y-plane	(Under Ui	nfactored L	ive Load	Only)			<u>BS5950</u>
	Support for	r deflections	5 =			Simply	supported		
	Uniformly	distributed i	unfactored	live load, ω <sub>ι</sub>	=		0.0	kN/m	
	Deflection	$h, \delta_{LL} =$			. 4		0.0	mm	
		Simply sup	ported	$\delta_{LL} = 5 \omega_{LL}$	L'/384EL <sub>x</sub>	, relevant =	0.0	mm	
		Cantilever		$\delta_{LL} = \omega_{LL}L$	.'/8EI <sub>x, relev</sub>	<sub>vant</sub> =	0.0	mm	
		Continuous	;	$\delta_{LL} = \omega_{LL}L$	- /384EI <sub>x, I</sub>	relevant =	0.0	mm	
		Continuous	s end span	$\delta_{LL} = \omega_{LL}L$	. '/185EI <sub>x, I</sub>	relevant =	0.0	mm	
							0.0		252
	Max defle		=				8.9	mm	2.5.2
		Simply sup	ported	span / 360	=		8.9	mm	
		Cantilever		span / 180	=		17.8	mm	
		Continuous	; 	span / 360	=		8.9	mm	
		Continuous	s ena span	span / 360	=		8.9	mm	
	Deflection				ian lineit -		0.000		01/
	Deflection	i utilisatio	$n = o_{LL} / n$	lax defiect	ion limit =		0.000		OK
Ponding [	Soflaction	in V nlana	(lindar Si	S Lood)					
Benaing L	Jeffection	іп т-ріапе	(Under SL	S LOAD)					
	Support for	r dofloction	~ _			Cimply	cupported		
	Uniformly distributed SLS load, a					Simply		kN/m	
				sls –			0.0		
	Deflection	λαια =					0.0	mm	
	Deneedor	Simply sup	norted	$\delta = -5 \omega$	a a l <sup>4</sup> /384F	T ,	0.0	mm	
		Cantilever	porteu	$\delta_{SLS} = \delta_{WS}$	_1 <sup>4</sup> /8FI	x, relevant —	0.0	mm	
		Continuous	1	$\delta_{SLS} = \omega_{SL}$	<u>st</u> 7021 <sub>x, r</sub> cl <sup>4</sup> /384FI	elevant —	0.0	mm	
		Continuous	s end snan	$\delta_{SLS} = \omega_{SL}$	<u></u>	x, relevant	0.0	mm	
		continuous	ena opun	USLS WSL	52 / 20022	x, relevant	010		
	Percentage	e of dead an	d superimp	osed dead	load deflect	ion precam	0.0	%	
	Dead and	superimpo	osed dead	load defle	ction prec	amber, %	0.0	mm	
		• •			•				
	Deflection	n with prec	amber inc	orporated	, δ <sub>sιs</sub> - %p	cam . (δ <sub>SLS</sub>	0.0	mm	
		-							
	Max defle	ction limit	=				12.8	mm	2.5.2
		Simply sup	ported	span / 250	=		12.8	mm	
		Cantilever		span / 125	=		25.6	mm	
		Continuous	;	span / 250	=		12.8	mm	
		Continuous	end span	span / 250	=		12.8	mm	
	Deflectior	n utilisatio	$n = \delta_{SLS} / I$	max deflec	tion limit	=	0.000		OK

	Cell Refer	ences						
	Steel Grad	de			1	1		
	S275 (43)	265	265					
	S355 (50)	345	345					
	S460 (55)	440	440					
	. ,							
	Section					87		
	Support fo	or Deflecti	ons			1		
	Simply sup	ported						
	Cantilever							
	Continuous	5						
	Continuous	s end span						
	Section Ty	pe and Pr	ocess			1		
1	Rolled I							
2	Rolled RHS							
3	Rolled CHS							
4	Welded I							
5	Welded RH	s						
6	Solid Bar							
7	Plate							
8	Rolled Sing	le Angle						
9	Rolled Sing	le Channel						
10	Rolled Sing	ile T						
11	Rolled Dou	ble Angle						
12	Rolled Dou	ble Channe						
13	Rolled Dou	ble T						
	Hot Finish	ed or Cold	Formed F	Rolled RHS	and Rolle	1		
	Hot finishe	d						
	Cold forme	d						
	Rolled Do	uble Angle	Orientati	on		3		
	One side of	r support, s	hort side co	onnected				
	Une side of	support, lo	ong side co	nnected				
		or support,	snort side	connected				
	DUCH SIDES	oi support,	iong side c	onnected				
	Dollad Da	uble Char		ation		-		
	Roth sides			ctod		1		
	DOLT SILLES	or support,						
	Rolled Do	uhle T Oria	ntation			1		
	Both sides	of support	flance con	nected		<u>ــــــــــــــــــــــــــــــــــــ</u>		
	Sour Sides	Si Support,	hange com					
	Bolted or	Welded Co	nnection	Type		2		
	Bolted			- 7 8 9				
	Welded							
	7							
	Rolled I a	nd Welded	I Axial Ca	apacity Co	nnection C	4		
	Web conne	cted						
	Both flange	es connecte	d					
	Web and si	ngle flange	connected					
	Web and b	oth flanges	connected					

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	NEERS	Consulting	J Calculatio Fngineers	n Sneet		iXXX		26	
ENGI	NEEKS	consulting	Engineers			]////	2	-0	
						Member/Location			
Job Title	Member De	esign - Stee	l BeamColu	mn BS5950	0 v2015.01	Drg. Ref.			
Member D	esign - Stee	l BeamColu	mn			Made by XX	Date <b>21</b>	/11/2021	hd.
Web Bear	ing and Bu	ıckling							<u>BS5950</u>
	Applicabil	ity of chec	k for parti	cular sect	ion ?		Applicable		
	Local com	pressive f	orce, F <sub>x</sub> =	V <sub>x</sub> =			0	kN	
	Note $F_x$ is	the reactior	n or shear f	orce at the	supports of	f simply sup	ported bea	ms, extern	ally
	applied loa	ds or the re	action (not	shear force	e) at interna	al supports	of continuo	us beams;	
	Unstiffene	ed web bea	aring and l	buckling c	apacity uti	ilisation =	0.000		OK
	Stiffened	web beariı	ng and buo	ckling cap	acity utilis	ation =	0.000		ОК
	Web stiffer	ier steel gra	ide (usually	grade 43)	=	S27	75 (43) 🔻		
	Web stiffer	ner design s	trength, p <sub>ys</sub>	5 =			265	N/mm <sup>2</sup>	
	Section Ty	уре	$N_1$	N <sub>2</sub>			d		
	Rolled I		1	2	d =	$D-2T-2r_i =$	290.2	mm	
	Rolled RHS		N/A	N/A	d =	D-3or5T =	N/A	mm	
	Rolled CHS		N/A	N/A		N/A =	N/A	mm	
	Welded I		N/A	N/A	(	d = D-2T =	N/A	mm	
	Welded RH	S	N/A	N/A	(	d = D-2T =	N/A	mm	
	Solid Bar		N/A	N/A		N/A =	N/A	mm	
	Plate		N/A	N/A		N/A =	N/A	mm	
	Rolled Sing	le Angle	N/A	N/A		d = D =	N/A	mm	
	Rolled Sing	le Channel	N/A	N/A	d =	$D-2T-2r_i =$	N/A	mm	
	Rolled Sing	jle T	N/A	N/A		d = D =	N/A	mm	
	Rolled Dou	ble Angle	N/A	N/A		d = D =	N/A	mm	
	Rolled Dou	ble Channe	N/A	N/A	d =	$D-2T-2r_i =$	N/A	mm	
	Rolled Dou	ble T	N/A	N/A		d = D =	N/A	mm	
	Number o	t webs, $N_1$	=				1		
	Number o	f sides for	each web	, N <sub>2</sub> =			2		
	Web dept	h, d =					290.2	mm	
	<u></u>								
	Stiff bearin	ig length (al	long length	or web), b	1 = 		300	mm	
	Continuous	over beari	ng or end b	earing ?	End b	earing			
		Distance, D	e =	/2			150	mm	
	Nota bia	bistance, a	$e = D_e + D_1$	/Z =	hooring to	the nearar	150	mm du	
	Note D <sub>e</sub> is		e from the	contro of lo	od or roact	ion to the n	opror mom	u; bor ond:	
	Note a e is							Der enu,	
	Number of	wob stiffon	orc N -				2		
	Noto wob c	web suiten	$ers, N_s -$	coction is a	ancidarad			wan if	
	constant	by multiple	webc and/	section is (		as une weD	sunener, e		
	Thickness	of web stiffs	ner + -	n multiple s		05,	20.0	mm	
	Total longt	h of web cti	ffener por c	ross soctio	 n h –		20.0	mm	
	Note for de		of case 2	and case ?	and for $dor$	hle T sectio	450	oubled	
	Outstand 10	andth of wo	h stiffenor	h - h /			ກາວ, ບ <sub>ຣ</sub> າຣ u ວາ⊑	mm	
	Outstand		fener ler	$D_{S,0} = D_S /$	tilication	 h (/- 13	220 0.950		OK
	Note that t	he effective	ness of the	outstand o	of the stiffer	oer is limita	$d$ to $13 \circ t$	,	1510
	Note for ch	annel certi	ns heel ra	dius reduct	tion factors	K, and K	have heen	ianored:	7.3.1.2
								ignoreu,	

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ENGI	NEERS	Consulting	Engineers	in Sheet		jXXX		27	I
					1	Member/Location			
1. h. <b>T</b> itle	Marahara	char				Dra Ref			
Job litle	Member De	esign - Stee		Imn BS595	U V2015.01	Made by	Date 31	(11 /2021)	dbd
Member D	esign - Stee	BeamColl	umn		1	XX	21	/11/2021	
									<u>BS5950</u>
	Pearing C		Unatifiana	d Wah					
А.	bearing C		Unstinene						
	Bearing c	anacity P.	- Phone	$= (b_1 + nk)$	tp		2416	LN .	
	Note t in th	he above P	w equation	is multiplie	d by N <sub>1</sub> :		2410		
		Stiff bearin	a length (a	lona lenath	of web), b	1 =	300	mm	
		Factor, n =	:				2.0		-
		,	Continuous	s over beari	ng, n = 5.0	) =	N/A		
			End bearin	g, n = 2.0	+ 0.6b <sub>e</sub> /k (	<=5.0) =	2.0		
		Factor, k =	•				51.7	mm	-
			Root radius	s, r <sub>i</sub> =			15.2	mm	
		Section T	уре			Factor, k			
		Rolled I				$T + r_i =$	51.7	mm	
		Rolled RHS	5			t =	N/A	mm	
		Rolled CHS	5			N/A =	N/A	mm	
		Welded I				T =	N/A	mm	
-		Welded RH	IS			t =	N/A	mm	
		Solid Bar				N/A =	N/A	mm	
		Plate				N/A =	N/A	mm	
		Rolled Sing	gle Angle			$T + r_i =$	N/A	mm	
		Rolled Sing	gle Channel			$I + r_i =$	N/A	mm	
		Rolled Sing				$I + r_i =$	N/A	mm	
		Rolled Dou	ble Angle			$1 + 1_i =$	N/A	mm	
		Rolled Dou		1		$T \pm r_i =$	N/A	mm	
		Kulleu Duu				1 + 1; =	IN/A		
	Unstiffen	ed web be	aring capa	citv utilisa	tion = F.	/ P =	0 000		OK
						- DW	0.000		
									-
								-	
								+	
								-	
								+	
								+	+
								-	1
		1		1			1	_	



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	71. 71	NEERS	Consulting	Engineers	in Sheet		iXXX	2	9	
							J			
					50505		Member/Location			
Job Title		Member De	esign - Stee		imn BS5950	) v2015.01	Made by	Date 31	/11/2021	thd
Member	De	sign - Stee	el BeamColl	Imn			XX	21	/11/2021	
										<u>BS5950</u>
	D	Pooring C	anacity of	Stiffonod	Wah					
7 in	<b>D</b> .	Bearing C	арасну ог	Sumeneu	VVED					
ed in		Note (each	) web stiffe	ner refers t	n stiffeners	hoth sides	(if annlicat	le) of each	web	
nace.		hut not of	all webs (if	annlicable)		both sides			WCD,	
		Required	(each) we	b stiffener	bearing c	apacity, M	AX(0, F <sub>x</sub> -	0	kN	
		(Each) we	eb stiffene	r bearing o	capacity, P	$= P_s =$	$A_{s,net}p_{y}$	2385	kN	
			Area of (ea	nch) web sti	ffener, A <sub>s,ne</sub>	$t_{st} = t_s \cdot D_s / N_1$	-	90	cm <sup>2</sup>	
		Stiffened	web beari	ng capacit	y utilisatio	n = [MAX	(0, F <sub>x</sub> - P <sub>bv</sub>	0.000		ОК
	_									
	-									

CON	SULTINC	г.		a Calaulatia	n Ch	0.0±			Job No.	Sheet No.			Rev.
	NEERS		onsultina	y Calculatio Fngineers	11 5116	eet			iXXX		30		
LIGI		<u> </u>	onouncing	Linginicero					JXXX		50		
									Member/Location				
Job Title	Member De	esi	gn - Stee	l BeamColu	ımn E	3S595	) v2015.	01	Drg. Ref.	1			
Member De	esign - Stee	el E	BeamColu	ımn					Made by XX	Date 21	/11/20	<b>21</b> <sup>0</sup>	hd.
													<u>BS5950</u>
C.	Buckling (	са	pacity of	t Unstiffen	ed W	/eb							
	<b>Dualding</b>									2472	LANI		
	Duckling o	od		' <sub>x</sub> = ckling can:	acity	utilie	ation –	F	/ P	2473	KIN		OK
	Unstinent	J	web bu	cking cap	acity	utilis		'x	/ F <sub>x/xr</sub> =	0.000			UK
C.(i)	Section(s	) F	Rolled I.	Welded I.	Roll	ed Sir	ale Ana	le	Rolled Si	ngle Chan	nel		
(-)	Rolled Sin	, gl	le T, Roll	ed Double	Ang	le, Ro	lled Dou	ıbl	e Channe	, Rolled D	ouble T		
	Applicabil	ity	y ?							Applicabl	e		
	Buckling o	ca	pacity, P	x/xr = Case	B: Rec	luced bu	uckling cap	acit	у 🗸 🗸	2473	kN		
	Case A: U	nr	educed l	buckling c	apaci	ity, P,	_ =			3533	kN		
	If the flange	th	rough whic	h the load or r	eactio	n is app	lied is effe	ctiv	ely restraine	l against both	1:		
	a) rotation	ı re	lative to th	e web; 									
	b) lateral i	mo	vement rela	ative to the ou	ier na	nge;	d hoovi		(	- 0 74)	-		
			οπτιπμοι	is over bea		orer	id beari	ng	(case a <sub>e</sub> ,	>= 0.7a)			
		ł	P =	$25\varepsilon t P_1$	_					N/A	LN.		
			x (b	(1 + nk)d	w					N/A	KIN		
		E	nd beari	ng (case a	 、< 0	.7d)							
				9 ( )	e		1						
		1	$P_x = \frac{a_e + a_e}{1}$	-0.7 <i>a</i> 2(	5et	$= P_{bw}$				3533	kN		
			~ 1	.4 <i>a</i> ( <i>b</i> <sub>1</sub>	+ nk)	d							
	Note t in th	ne	above P <sub>x</sub>	above $P_x$ equation need			ultiplied l	by	N <sub>1</sub> since a	lready inco	rporated	wit	hin P <sub>bw</sub> ;
					P =				$0.7d_{\rm P}$				
	Case B: R	ed	uced bu	ckling cap	acity	<b>, P</b> <sub>xr</sub> =	P <sub>xr</sub>	=	$\frac{1}{L_{\rm E}}P_{\rm x}$	2473	kN		
				a atta d	6			_					
		ET	Tective le	ngtn, L <sub>E,w</sub> =	= TUNC	on-sway	1.00d	-		290.2	mm		
				Table 22	— No	minal e	effective l	eng	gth L <sub>E</sub> for a o	ompression	member		
			Restraint (	în the plane u	nder c	onsider	ation) by o	the	r parts of the	structure		$L_{\rm E}$	-
			Effectively both ends	held in positi	on at	Effecti	vely restra	ine	d in direction	at both ends		0.7	L
			Sour Chus			Restra	iy restrain	ed 1 ecti	on at one end	both ends		0.8	5L
				-		Not res	strained in	dir	ection at eith	er end		1.0	L
			One end	IC .		Other (	end					$L_{\rm E}$	F
			Effectively	held in position	on	Not he	ld in positi	on	Effectively	restrained in	direction	1.2	L
			and restra	mea m airecti	on				Partially re Not restrain	strained in di red in directio	rection	1.5.20	
		L							1		*	1	
		-											

CONSULTING		Engineerin	a Calculatio	n Chaot		Job No.	Sheet No.		Rev.
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						Member/Location			
Job Title	Member De	esign - Stee	el BeamColu	imn BS5950	) v2015.01	Drg. Ref.			
Member De	esign - Stee	el BeamColu	ımn			Made by XX	Date <b>21</b>	/11/20	21 <sup>Chd.</sup>
									<u>BS5950</u>
	Table K.1	— Effectiv	e lengths ،	and slender	ness ratios	s of an unst	iffened we	b acting	g as a column
	Diagra represer deform	mmatic ntation of mation		Restraint	conditions		Effective	length, l	Slenderness ratio, l/r
	7		Web ends re relative late:	strained aga ral movemen	iinst both ro it	tation and	0.7D		2.4 <i>D</i> /t <sub>w</sub>
	[	-	Web ends re movement b	strained aga ut not again	inst relative st rotation	ə lateral	1.0D (but see )	Note 2)	3.5D/t <sub>w</sub>
		<b>Г</b>	Web ends re against relat	strained aga tive lateral r	inst rotation novement	n but not	1.2D		4.2 <i>D</i> / <i>t</i> <sub>w</sub>
	NOTE 1 l the D is fl r is fl L <sub>w</sub> is fl	effective length he overall depth he radius of gyn he web thickne	one web end against relat web end rest relative late: a of the section ation (in mm); ss (in mm).	(in mm);	ned against novement ar nst both rota it	rotation nor nd the other ation and	(but see )	Note 2)	7.0D/I <sub>W</sub>
	NOTE 2 rotation,	Where the end which may need	ls are not restra ssitate taking (	ined against ro effective length	tation, <i>Ur</i> shou s greater than	ld be based on t 1.0D or 2.0D.	he distance be	tween the e	ffective centres of
		_							

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	NEEDS	Consulting	Fnaineer	s silver		iVV	v		20	Ī
ENGI	NEEKS	consulting	Engineer	5		]///	^		52	
						Member/Lo	cation			
Job Title	Member De	esign - Ste	el BeamCo	olumn BS595	50 v2015.01	Drg. Ref.				
Member De	esign - Stee	el BeamCol	Jmn			Made by	ХХ	Date 21	/11/2021	Shd.
										<u>BS5950</u>
7										
C.(ii)	Section(s	) Rolled R	HS, Weld	led RHS						
	<b>\</b>									
	Applicabi	litv ?						N/A		
	Buckling	capacity, I	$\mathbf{P}_{\mathbf{v}/\mathbf{v}\mathbf{r}} = \mathbf{C}$	ase B: Reduced I	ouckling capacit	v	-	N/A	kN	
						, 				
	Case A: U	nreduced	bucklina	capacity,	$P_x = (b_1$	$+ n_{1}$ ) 2 i	t p.	N/A	kN	
		Stiff bearing	na lenath	(along lengt	h of web), b	1 =	10	N/A	mm	
		Length, n.	$= b_1 + D/2$	2+MIN((ab	$\frac{1}{2}$ ,	1		Ν/Δ	mm	
		Note n . is	the lengt	h obtained P	y 45 ° disne	rsion a	t hal	f denth (al	ong length (	of web):
		Note for o	ontinuous	over hearing	, the exnrec	sion MI	N// 2	-h / / 2) r	)/2) herome	s D/2·
						7	(a	e 51/2/,L		
		Slenderne	 ες λ —	λ =15	$\begin{bmatrix} D-2t \end{bmatrix} \sqrt{3}$			N/A		
		Sichachie		1.0				11/71		
		Eulor ctro		-2E/2 $2$ (vali	$d$ for $\lambda > (-$	$\frac{1}{2}$	/2	N/A	N/mm <sup>2</sup>	
			Pobortec	$\pi L/\lambda_w$ (value)	$\frac{1}{2} = (curve)$	$(L/P_y)$	) -		IN/11111	
				trongth n -		()) – J	.5 –		$N/m^2$	
		Limiting of	Design s	r = 0.2(-0.2)	$\frac{2}{2}$					
		Limiting Si		$S_{1} = 0.2(\pi)$	$(z/p_y) =$	(but a	<u> </u>	N/A		
				$L(n, \eta_w = a(n))$	$\frac{1}{1}$	(Dut η <sub>ν</sub>	, >=	N/A	N1 /	
		Compress	$ \varphi_w - [P_y] $	+(1/w+1).PE,w	<u>]/2 –</u>	2 2	- <sup>10</sup>		N/mm	
		Compress	ve streng	$\frac{\text{tn, } \text{p}_{\text{cw}} = \text{p}_{\text{E},\text{v}}}{ }$	<u>γ,ρ_γ / [φ_w+(¢</u>	<u>w -Ре,w</u>	.p <sub>y</sub> )	N/A	N/mm	
	Casa Bi D	oduced by	akling of			(D.b				
				apacity, P <sub>xr</sub>	- 48 + 48/	$D.D_1 -$	-	N/A	KIN	
	Unless los	ads or react	ions are a	applied throug	sh welded fla	inge pla	ites,	the addition	nal	
	which will	moments in l result in lo	wer buckli	due to eccenta	ric loading m	ust be t	aken	into accou	int,	
	which wh	result in it	WEI UUCKI	ing values.		-				
			026 B	0.0784 1.0.0	02.0			NI / A		
		<i>e</i> = (	0.026 <i>B</i> +	$0.9781 \pm 0.0$	02D			N/A		
		M/D	-	$B_{a}\left[B-t-e\right]$	1			NI / A		
		M	= /	B-t	]			N/A	11110	
								N1 / A		
		a = 1						N/A	11110	
		M /D -	, (	0.5M(3+a)				N1 / A		
		M	y = -	$a^2 + 4a + 3$				N/A	11110	
		D	D	$t^2 p_y p_c$				N1 / A	L-NI	
		r	210 +	$12 \left[ M / P \right] p$				N/A	KIN	
		<b>I</b>	Py	- c-y- 1Pe	Ц					
					-					



CON	CUI TINC	En eine enin	e Calaulatia	n Chast		Job No.	Sheet No.		Rev.
	NFFPS	Consulting	g Calculatio Fngineers	n Sneet		iXXX	-	24	
ENGI		eeneurig				JAAA	~		
						Member/Location			
Job Title	Member D	esign - Stee	el BeamColu	imn BS595	0 v2015.01	Drg. Ref.	-		
Member De	esign - Stee	el BeamColu	ımn		1	Made by XX	<sup>Date</sup> <b>21</b>	/11/2021	Ind.
									<u>BS5950</u>
D.	Buckling	Capacity o	fStiffened	Web					
	Noto (oper	) web stiffs	nor roford t	a atiffanara	hath aidea	(if applicab	la) of each	wah	
	Note (each	i) web stille		o suneners	Doth sides		le) of each	weD,	
	Required	(each) we	h stiffener	buckling	canacity 1	F(F /P /	0	٧N	
	(Each) w	eb stiffene	r buckling	capacity.	$P_{v} = P$	$= A_{-} p_{-}$	4415	kN	
	(	Interior or	end web st	iffener, n <sub>™</sub>	=	End 🗸	1		
		Note n IF d	etermines t	he extent c	of web which	h is to conti	ribute to th	e	
		buckling ca	apacity by a	ffecting ter	ms within A	$I_s$ and $I_s$ ;			
		Area of (ea	ach) web sti	ffener, A <sub>s</sub> =	$t_s.b_s/N_1 +$	t.n <sub>IE</sub> .15t =	167	cm <sup>2</sup>	
		Slendernes	ss, $\lambda_s = L_{E,s}$	′r <sub>s</sub> =			2.1		
			Web depth	, d =			290.2	mm	
			Effective le	$ength, L_{E,s} =$	fu Non-sway:	0.70d 🔻	203.1	mm	
			Second mo	ment of ar	ea of (each)	) web stiffe	15220	cm <sup>4</sup>	
			Note $I_s =$	1/12.t <sub>s</sub> .(b <sub>s</sub>	$(N_1)^3 + 1$	/12.n <sub>IE</sub> .15	t.t <sup>3</sup> ;		
			Note calcul	ation of I <sub>s</sub>	is simplified	d, but conse	ervative;		
			Radius of g	iyration, r <sub>s</sub>	$= \sqrt{(I_s/A_s)}$	=	9.6	cm	
		Euler force	$P_{E,s} = \pi^2 E_{I}$	[ <sub>s</sub> /L <sub>E,s</sub> <sup>2</sup> (vali	$\frac{d}{d} \text{ for } \lambda_s > (\gamma)$	$\frac{\pi^2 E/p_y)^{1/2}}{\pi^2 (1/2)} =$	7462434	kN	
		Euler stres	s, $p_{E,s} = \pi^2 E$	$\frac{1}{\lambda_s}$ (valid	for $\lambda_s > (\pi^2)$	$E/p_{y})^{1/2} =$	447888	N/mm²	
			Robertson	constant, a	= (curve (	C)) = 5.5 =	5.5	NI / ma ma 2	
		Limiting sk	anderness	$\lambda = 0.2(\pi^2)$	- Ε/p ) <sup>0.5</sup> -		17.5		
			Perry facto	$r_{.} n_{c} = 0.2(\pi)$	$(-\lambda_0)/1000$ (	but $n_c >= 0$	0.000		
			$\phi_{s} = [p_{vs}+($	n₅+1).p <sub>E</sub> ₅]	/ 2 =		224076	N/mm <sup>2</sup>	
		Compressi	ve strength	$p_{cs} = p_{Fs}$	, p <sub>vs</sub> / [φ <sub>s</sub> +(φ	$p_{\rm Fs}^2 - p_{\rm Fs} p_{\rm Vs}^{0.}$	265	N/mm <sup>2</sup>	
	Stiffened	web buck	ing capaci	ty utilisati	on = IF(F,	/P <sub>x/xr</sub> >1,	0.000		ОК
		1	1		1	1	1	1	

	(	NOT	SIII TINC	Fraircarin	~ Col	ou lotio	n Chaot		Job No.	Sheet	No.			Rev.		
	FN		NEERS	Consultina	y Car Fnai	neers	in Sheet		iXXX		35			Ī		
		61		concurring	Lingi				]////		55					
									Member/Locati	on				-		
Jo	b Tit	le	Member D	esign - Stee	el Bea	amColu	ımn BS5950	0 v2015.01	Drg. Ref.							
M	embe	er De	esign - Stee	el BeamColu	ımn				Made by X	X Date	21/1	1/	<b>2021</b> <sup>0</sup>	3hd.		
So	chen	ne D	esign											<u>BS5950</u>		
	F	leme	nt			Τı	/pical Span/c	depth	Typics	al Span (m	1)					
					-+		pioar oparity	Jopan	Tjplot	n opan (n	.,					
	F	loor	Beams (UB'	S)	- 1		15-18		up	to 12m						
	(i	neluc	ling floor sla	ab)	- 1											
		late (	girder 	de al	- 1		10-12			0.0						
		urmic Joe tol	oor (steel on llotod LIP'e*	ily)	- 1		25-28		1	6-9M 2-20m						
		aster	airders (RS	SA's)+			12-15		י חוו	to 35m						
		attice	e airders (Tu	ubular)			15-18		up	to 100m						
_	R	oof t	russes (pitcl	h>20°)			14-15		up	to 17m						
	s	pace	Frames	-	- 1		20-24		up	to 60m						
Н	*	Av	oid if hiah	point load	ls: in	creas	e Ireq bv	1.3								
$\vdash$	+	Pre	camber b	y L/250												
H	_			-	_							_	_1			
-	Bea	am ty	pe	Span ran	ge (m	ר)			Notes							
	(0)	Ang	les	3-6	3	ι	Jsed for roof	purlins, she	etina rails	. etc., whe	ere only	/ lio	uht			
-	. ,					k	oads have to	be carried		,,	,					
	(1)	Cold sect	l-formed ions	4-8	3	L k	Jsed for roof bads have to	purlins, she be carried	eting rails	, etc., whe	ere only	/ lig	iht			
	(2)	Roll	ed	1-3	80	N	Nost frequen	tly used typ	e of section	on; propor	tions			<b>_</b>		
		sect	ions: UBs, BSJs			s	elected to e	liminate sev	eral possi	ble types	of failu	re				
		RSC	s s													
	(3)	Ope joist	n web s	4-4	ю	F	Prefabricated using angles or tubes as chords and round bar for web diagonals, used in place of rolled sections									
	(4)	Cas bea	tellated ms	6-6	60	L	Used for long spans and/or light loads; depth of UB increased by 50%; web openings may be used for									
	(5)	Соп	pound	5-1	5	ຣ ເ	services, etc. Used when a single rolled section would not provide									
		sect UB	ions e.g. + RSC			s	ufficient cap lorizontal be	acity; often nding streng	arranged gth as wel	to provide	enhan	ceo	1			
	(6)	Plat	e girders	10-1	00	N	lade by wel	ding togethe ; web depth	er 3 plates s up to 3-	sometime 4 m som	es etimes	nee	be			
H		_				s	tiffening	-	-							
Ħ	(7)	Trus	865	10-1	00	۲ م	leavier versi or if spanning	ion of (3); m g large dista	ay be ma inces, rolle	de from tu ed section	ubes,a s	ngl	es	<b> </b>		
	(8)	Box	girders	15-2	200	F	abricated from	om plate, us pridges due	sually stiffe to good to	ened; useo Insional ar	d for Ol nd	нт				
Ц						t	ansverse st	miess prop	enties			_		<b> </b>		
														<b> </b>		
$\vdash$														<u> </u>		
⊢														+		
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┢																
┢														+		
														1		



CON	ISULTIN	$\mathbf{G}$ Engineering (	alculatio	n Sheet		Job No.	Sheet N	No.		Rev.			
ENG	INEER	S Consulting Er	ngineers	II Sheet		jXXX		37					
	1					Member/Location							
loh Title	Memher	Design - Steel F	SeamColu	mn RS5	950 v2015 01	Drg. Ref.							
Member D	esian - St	cel BeamColum	n		550 72015.01	Made by	Date	21/11/2	2 <b>021</b> <sup>dr</sup>	nd.			
							-		_	BS:	5950		
Struts	and ties									Î			
Slende	mess lim	nits <sup>.</sup>											
(No lor	iger in BS	35950 (2000) b	ut still of	interest	t)								
_													
- mem	bers resis	sting load other	than win t and win	ld: λ≤18 ld.only:	30 3<250								
- mem	bers norn	nally acting as	a tie but :	subject	to load revers	al due to	wind: λ≤	350					
_		, ,		,									
Minimu	Im CHS s	sections which	satisfy sl	enderne	ess limits								
┤┍───										┓│			
Slend	lerness			Ef	ffective Lengt	ective Length (m)							
_   <sup>∟</sup>	IIIII	4	6	6	8		10	12	2				
_┨┡━━━━┓	00	70.40.0	4440		400 7 5 2	100		400.7		┩╿			
	80	76.1 X 3.2 60.6 X 3.2	76.1	x 3.6 x 3.2	139.7 X 5.0	5 139	3 X 5.0 7 X 5.0	193.7	X 5.0 X 5.0				
	350	42.2 x 4.6	60.3	x 3.2	76.1 x 3.2	88.9	x 3.2	114.3	x 3.6				
BEAN	I DESIG	N											
Ultimat	e strengt	th in bending											
Comp	contenge			1	Commercedi	n flonge u	prostroin	a di					
Comp	ression lia	ange restrained			Compressio	on liange u	nrestrain	ieu.					
Plasti	c & Comp	act			$M_b = p_b S_x$ $M_b = p_b Z_b$	(plastic &	compact	:)					
$M_{\sf cx}$ =	$p_{y}S_{x} \leq 1.5$	$5 p_{y}Z_{x}$			$p_{\rm D} = p_{\rm D} z$	(Serni-corn	pacty						
(simpl	y support	ed + cantilever)			Note : M <sub>b</sub> obt	tained directl	y from grap	h (P.5/23)					
M <sub>cx</sub> =	$p_{y}S_{x} \leq 1.2$	$2 p_y Z_x$			Requireme	ent :							
(conti	nuous)	1 ] ^			$M_{\rm b} \ge mM$	í <sub>max</sub> (for be	am not le	baded bet	ween				
Semi	compact				restrained	points)					-		
- Semi-	compact						$15M_{2}$	+ 0.5M <sub>3</sub>	+15/	M₄			
$M_{cx} =$	$p_yZ^*$				where: n	$n_{LT} = 0.2$	+	M					
*Note: (	> <sub>eff</sub> ≥ ∠ <sub>x</sub> ) Code allows	S <sub>eff</sub> to be used inste	ead of $Z$ for	I		_		ALSO,					
or H se	ctions, but t	his must be calculat	ted.		but: n	$n_{LT} \ge 0.4$	1						
_					The mome	ents $M_2$ an	d <i>M</i> ₄ are	e the value	es at		<b> </b>		
Requi	rement :				the quarte	r points an	d the mo	ment $M_3$	is the		<b> </b>		
M >	M				value at m	id-length.					<b> </b>		
191 CX 2	max												
									-+				
									-+				

										Job No	. S	heet N	lo.	Rev	
			Engine	ering C	alculat	ion Sh	eet			:222	~		20		
	ENGINEE	KS	Jonsun		gineers	>				JXX	× _		38		
										Member/Lo	cation				
Jol	o Title 🛛 Memb	er Des	sign - S	Steel B	eamCo	lumn E	3S595	0 v201	5.01	Drg. Ref.					
Me	mber Design -	Steel	Beam	Columr	1					Made by	XX D	ate	21/1	1/2021 <sup>Chd.</sup>	
														<u>BS</u>	5950
l r															-
П	BENDING														
П	Universal			GRAD	)E 43					GRAD	)E 50				
Н	Beams														
	D×b×Mass	Mex	L,	L <sub>2</sub>	L <sub>3</sub>	L <sub>4</sub>	Pv	M <sub>ex</sub>	L,	L <sub>2</sub>	L <sub>3</sub>	L4	P,	Intermediate	
Н	(mm×mm ×Ka/m)	KINM	m (1.0)	m (0.75)	m (0.5)	m (0.35)	KIN	KINM	m (1.0)	(0.75)	m (0.5)	m (0.35)	KIN	masses (kg/m)	
Н	914x419x388	4680	39	77	12.5	_	3150	6020	34	6.8	10.8	15.0	4100		┓┝
Н	914×419×343	4100	3.8	7.3	12.0	-	2810	5270	3.4	6.7	10.5	14.4	3660		
	914×305×289	3340	2.7	5.1	8.2	11.5	2890	4280	2.4	4.5	7.5	10.1	3760	253, 224	4 <b>–</b>
	914×305×201 838×292×226	2220 2430	2.5	4.7	7.2	9.7	2180 2180	2840 3110	2.2	4.3	6.4 6.8	8.5 9.2	2840 2840	194	1
$\vdash$	838×292×176	1800	2.4	4.6	7.0	9.4	1860	2320	2.1	4.2	5.3	8.2	2420	101	·
	762×267×197	1900	2.4	4.6	7.1	9.9	1910	2440	2.1	4.0	6.2	8.6	2490	173	3
	762×267×147	1370	2.2	4.3	6.4	8.6	1550	1760	2.0	3.7	5.7	7.8	2010	152 140	
	686×254×176	1060	2.1	4.0	6.3	8.3	1260	1360	1.9	3.7	5.6	7.3	1640	152, 140	<u> </u>
	610×305×238	1980	3.0	6.0	10.2	15.0	1870	2540	2.6	5.3	9.0	13.0	2440	179	9
	610×305×149	1460	2.8	5.6	9.0	13.0	1150	1550	2.5	4.9	7.5	10.3	1500	125 113	,
	610×229×140	794	1.9	3.6	5.5	7.5	1050	1020	1.0	3.3	5.0	6.6	1360	125, 115	·
	533×210×122	849	1.9	3.7	6.1	8.1	1110	1090	1.7	3.3	5.3	7.3	1440	109, 101, 92	2
	533×210×82	566	1.8	3.3	5.2	7.0	837	731	1.5	3.0	4.6	6.1	1080	00 00 7/	
H	457×191×67	405	1.6	3.1	4.9	6.6	636	523	1.4	2.9	4.3	5.8	821	09, 02, 74	*
	457×152×82	477	1.3	2.5	4.3	6.3	791	622	1.1	2.4	3.8	5.3	1030	74, 67, 60	)
	457×152×52	301	1.2	2.3	3.7	4.9	564 661	389 536	1.1	2.1	3.2	4.3	728	67.60	
H	406×178×54	289	1.5	2.9	4.5	6.2	505	373	1.4	2.6	4.5	5.4	652	07,00	'I —
	406×140×46	245	1.2	2.3	3.5	4.9	458	316	1.1	2.1	3.2	4.2	591		
	406×140×39	198	1.2	2.2	3.3	4.5	413	255	1.0	1.9	3.0	3.9	533	E7 E4	
	356×171×67	213	1.5	2.8	4.5	6.1	401	244	1.4	2.0	4.0	5.3	517	57, 51	
	356×127×39	180	1.1	2.0	3.3	4.4	378	232	0.9	1.7	2.9	3.8	488		
	356×127×33	148	1.0	2.0	3.0	4.1	339	192	0.9	1.8	2.8	3.6	438	40	,
	305×165×40	172	1.0	2.9	5.2 4.7	6.5	306	222	1.4	2.6	4.5	5.6	395	40	°
	305×127×48	194	1.1	2.3	3.7	5.5	456	251	1.0	2.0	3.2	4.7	588	42	2
	305×127×37	149	1.1	2.1	3.3	4.7	361	192	0.9	1.8	2.9	4.1	466		
	305×102×33 305×102×25	132 92.4	0.9	1.7	2.7	3.7	341 292	1/0	0.8	1.5	2.3	3.3	440 377	28	5
	254×146×43	156	1.4	2.8	4.9	7.3	313	202	1.2	2.5	4.2	5.4	404	37	-
	254×146×31	109	1.3	2.5	4.2	5.8	253	125	1.2	2.6	4.1	5.6	327		.
	254×102×28 254×102×22	97.4 71.6	0.9	1.7	2.8	4.0 3.4	243	93	0.8	1.6	2.5	3.5	355	25	·
	203×133×30	86.2	1.3	2.6	4.4	6.6	215	111	1.1	2.4	3.9	5.4	278		
	203×133×25	71.2	1.3	2.4	4.1	5.9	194	82	1.1	1.7	2.8	4.0	251		
	Universal			GRA	DE 43					GRA	DE 50				1⊢
Н	DebaMara													Intermediate	┨┠─
	(mm×mm	kNm	m L1	m L <sub>2</sub>	m L <sub>3</sub>	L₄ m	kN	kNm	L <sub>1</sub>	1 L <sub>2</sub>	L <sub>3</sub>	L4 m	kN	masses	
$\vdash$	×Kq/m)		(1.0)	(0.75)	(0.5)	(0.35)			(1.0	(0.75)	(0.5)	(0.35)		(kg/m)	┛┝─
	356×406×634	3490	8.7	-	-	-	3320	4520	6.8	-	-	-	4410	551, 467, 393	.
	356×406×235	1240	5.0	12.0	-	-	1120	1620	4.2	16.0	-	-	1460	& 340, 287	,
	356×368×202	1050	4.8	10.5	-	-	1000	1370	3.9	9.0	15.0	-	1300	177, 153	3
	305×305×283	1300	4.1	14.0	-	-	1500	1730	4.0	11.5	- 14.0		2000	240, 198, 158	3
	305×305×97	397	3.2	6.8	12.2	-	503	512	4.0	6.0	10.2	-	649	& 137, 118	3
П	254×254×167	641	3.3	10.3	-	-	883	834	3.0	8.7	-	-	1150	132, 107, 89	9
Η	254×254×73 203×203×86	272	2.3	7.0	11.0		459	318 338	3.4	5.9	10.6	15.0	465 598	71, 60, 52	2
Η	203×203×46	137	2.2	4.8	8.7	13.7	245	159	2.7	5.0	8.2	12.5	316		
Н	152×152×37	85	1.8	4.1	8.1	-	216	110	1.7	3.5	6.8	10.8	279	30	)
Н	102×102×23	45.4	1.5	3.3	5.6	0.8	153	0.50	2.0	3.5	5.6	0.2	198	ļ	→
$\vdash$															







	CON	SULTINC	Facino	pooring Calculation Shoot						Job N	lo.	Shee	t No.		Rev.	
F		NEEDC	Consult	ering Ca tina End	aicuiati aineers	UN Shee	εl			iV	xx		۷.	2		
	IN G I	NEEKS	consur		gineers					^ر	~~		т <i>,</i>	-		
										Member	Location					
Job	Title	Member De	esign - S	Steel Be	eamCol	umn BS	5950	v2015.	01	Drg. Ref						
Men	nber De	esign - Stee	l Beam	Column						Made by	XX	Date	21/	11/202	21 <sup>Chd.</sup>	
		5													BS5	950
-															000	<u></u>
H	сомр	RESSION														
ΗI	Circula	r Hollow		GR/	ADE 43 (	S275)				GRA	DE 50	(\$355)				1 ⊢
HI	Section	ns (CHS)														▮⊢
	Outside	e Thickness	P <sub>c max</sub>	L <sub>y1</sub>	L <sub>y2</sub>	L <sub>y3</sub>	L <sub>y4</sub>	P <sub>e max</sub>	<	L <sub>y1</sub>	L <sub>y2</sub>	L <sub>y3</sub>	L <sub>y</sub> ,	a Inter	rmediate	▮⊢
	diamete	er (mm)	kN	m	m (0.75)	m	m (0.25)	kN		m (1.0)	m	m	m	thick	nesses *	▮⊢
H١	(11111)			(1.0)	(0.75)	(0.5)	(0.30	,	┿	(1.0)	(0.75)	(0.5)	(0.3	5) (	,111112	۹ اـــ
Ш	88.9	3.2	237	0.4	2.3	3.3	4.1	306		0.4	2.1	3.0	3.7		4.0	
Ц	114.3	3.6	344	0.6	3.1	4.3	5.3	444		0.6	2.8	3.8	4.8	ŝ	5.0	
Ш	400 7	6.3	589	0.6	3.0	4.3	5.2	760		0.6	2.7	3.7	4.6	5		
	139.7	5.0	583	0.7	3.7	5.2	6.4	1440		U./ 0.7	3.4 3.3	4.6	5.8	7	6.3, 8.0	
	168.3	5.0	707	0.8	4.5	6.3	7.9	912		0.8	4.2	5.6	7.0	)	6.3, 8.0	
	102.7	10.0	1370	0.8	4.4	6.1	7.5	1760		0.8	4.0	5.7	6.7		80 400	
	193./	5.0	1960	0.9	5.2 5.0	7.0	9.0	2530	1	1.U 0.9	4.8 4.5	6.3	7.7	7 6.3	, o.u, 10.0	
H	219.1	5.0	924	1.1	6.0	8.3	10.0	1190		1.1	5.4	7.3	9.1	6.3	, 8.0, 10.0	
H	244 5	12.5	2230	1.1	5.7	8.0	9.9	2880		1.1	5.1 6.0	7.1	8.7	1 80	10.0 12.5	
H	244.5	16.0	3160	1.2	6.5	8.9	11.4	4080		1.2	5.8	7.9	9.7	7 0.0,	10.0, 12.3	
H	273.0	6.3	1450	1.4	7.6	10.3	12.7	1870	1	1.4	6.8	9.2	11.	3 8.0,	10.0, 12.5	
H	373.0	16.0	3550	1.3	7.2	9.9	12.3	4580		1.3	6.5	8.9	10.	9	10 0 12 5	
	323.5	16.0	4260	1.6	8.6	12.0	-	5500		1.6	7.7	10.6	13.	0 0.0,	10.0, 12.5	
H	355.6	8.0	2400	1.8	9.7	13.5	-	3100		1.8	8.7	12.0	-		10.0, 12.5	
Ц	t Oply pr	16.0	4700	1.8	9.5	13.1	-	6070	1	1.8 voilebl	8.5	11.7	-			┙┣
Ц	Univer	al Columno	e is given	. rorulei	arger se	CDAL		es may i	ic a	valiable	5.		CDADE	50		
Ш	Univers		-	<u> </u>		GRAL	JE 43			-			GRADE	50		
Ц		(mm×mm×Kc	s a/m)	P <sub>e</sub>	Max N	-yı L m r	92 n	m l	Ly4 m	⊢ P₀ k	max N	Ly1 m	L <sub>y2</sub>	L <sub>y3</sub> m	L <sub>y4</sub> m	
Ц			,		(	1.0) (0.	75)	(0.5) (	0.35	j)		(1.0)	(0.75)	(0.5)	(0.35)	
Ш і		356×406×6	34	198	300 2	2.0 5	.5	9.2	12.8	8 26	300	1.7	5.1	8.6	11.6	Í I
		356×406×5	51	172	200 2	2.0 5	.4	9.3	12.7	7 22	800	1.7	4.9	8.6	11.6	
		356×406×4	67 93	154	300 1	.9 5	.5	9.1	12.3 12.6	5 20. 5 170	200	1.7	4.9	8.3	11.0	
		356×406×3	40	110	000 1	.9 5	.6	9.4	12.5	5 14	700	1.9	4.8	8.1	10.7	
		356×406×2	87 35	96	90 1	.8 5	.9	9.6	12.7 12.7	7 12	500 300	1.7	5.4 5.4	8.5	11.2	
H		356×368×2	02	68	40 1	.8 5	.6	9.0	11.8	8 89	000	1.6	5.0	8.2	10.5	
H		356×368×1	77	59	80 1	.7 5	.7	8.9	11.7	7 77	80	1.7	5.0	8.1	10.5	
H		356×368×1 356×368×1	53 29	43	80 1 80 1	.8 5	.5	8.8	11.6 117	5 57	00	1.6	5.0	8.0	10.4	
H		305×305×2	83	91	90 1	.5 4	.6	7.5	9.9	12	300	1.3	3.8	6.4	8.7	⊢⊢
H		305×305×2	40	80	90 1 on 4	.5 4	.7	7.7	10.0	0 10	500	1.3	4.2	6.9	8.9	╎┠╴
H		305×305×1	58	53	20 1	.5 4	.7	7.4	9.8 9.7	69	30	1.3	4.2 4.1	6.7	0.0 8.7	⊢⊢
H		305×305×1	37	46	20 1	.4 4	.5	7.3	9.6	60	10	1.2	4.1	6.6	8.6	╎┠
$ \mathbf{H} $		305×305×1	18 97	39	90 1	3 4	.5	7.3	9.6	51	60 80	1.2	4.1 4.0	6.6	8.6 8.4	
$ \mathbf{H} $		254×254×1	67	56	30 1	.3 3	.9	6.3	8.3	73	30	1.1	3.6	5.8	7.5	
$ \mathbf{H} $		254×254×1	32	44	70 1	.2 3	.9	6.3	8.3	58	20	1.1	3.5	5.7	7.4	
Ц		254×254×1 254×254×8	07 89	36	20 1 10 1	.2 3	.8	6.2	8.1 8.1	47	20	1.1	3.5 3.5	5.6 5.6	7.2	
Ц		254×254×	73	25	60 1	.1 3	.7	6.0	7.9	33	00	1.0	3.5	5.5	7.0	$  \mathbf{L}$
Ш		203×203×8	B6	29	20 0	0.9 3	.1	5.0	6.6	38	00	0.9	2.8	4.5	5.8	
		203×203×1 203×203×6	60	24	90 0	).9 3 ).9 3	.0	4.9	6.3	31	40	0.9	2.7	4.5	5.7 5.6	
11		203×203×5	52	18	30 0	0.9 2	.9	4.7	6.2	23	60	0.8	2.7	4.4	5.6	
		203×203×4	46 37	16	20 0	0.9 2	.9	4.7	6.2 ⊿ 7	20	90	0.8	2.7	4.3	5.5	
		152×152×3	30	10	60 0	0.7 2	.2	3.5	4.6	13	60	0.6	2.0	3.2	4.2	
H I		152×152×2	23	81	16 0	).7 2	.1	3.4	4.5	10	50	0.6	2.0	3.1	4.0	┆┢╴
H			- (I_)	%												
H	NOTE:	L <sub>x</sub> ≈ 1.1	5   <u>T</u>	L <sub>y</sub>												∣┠
HL	<u> </u>		(1)													1
<u> </u>																

CONSULTING Engineering Colculation Shoot								Sheet No.		Rev.	
ENGINEERS Consulting			ng Engineers			iXXX		43		1	
					Member/L	ocation		-			
	Momber	ocian Ct-	ol Room Cali	Imp BCEOF	1 V201E 01	Dra. Ref	JoanOH				
JOD TILLE Member D	Momber Design Steel BeamColumn						vv	Date <b>71</b>	/11/2021	Ghd.	
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1 4 4 7											
4.4.1			INL 33								
	Serviceal	bility check									
			osed +	wine	d)						
	Deflection	n limits und	ler imposed	load:							
	Element	mit	_								
_	• Captilever							190	-		
—	Beam supp	porting plaste	r or brittle finish	n			- U	360	_		
$\vdash$	<ul> <li>Beams sup</li> </ul>	pporting mase	nry					500			
H	Other bear     Crane bea	ms						200 500			
Π	- Columna							200			
	Columns     Columns in	n multi-storev	construction w	ith movement	sensitive		H/	500			
Ц	cladding.				-						
	Portal frame	s					1400	L/200 +			
	Vertical at	apex				L/250 - L/500 *			_		
	* Depends on	cladding syst	em						_		
H	Load case			Minimum I t	o satisfy defle	ction limit					
			L/200 L/360			0 L/500					
		W	1.27 WL <sup>2</sup> 2.29		2.29 V	VL <sup>2</sup>	3.18 WL <sup>2</sup>				
Ц	↑	1									
	1	Р	2.03 PL <sup>2</sup> 3.6		3.66 F	12 5.08 PL2		5 08 PL 2			
H	1	<b>↑</b>				-			_		
H	D/2	D/D			_				_		
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—	Т	т									
	Note: For	castellated b	eams, assume	a 30% increas	se in deflection	n due to	prese	nce of web op	penings.		
	Lin	metres; W, P	' in kN; I in cm						I		
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CONSULTING		Engineerin	a Calaulatia	n Chaot		Job No.	Sheet No.		Rev.
ENGINEERS		Consulting	Engineers	in Sheet		jXXX	4	4	
						Member/Location			
Job Title	Member De	esign - Stee	el BeamColu	mn BS5950	) v2015.01	Drg. Ref.			
Member D	esign - Stee	el BeamColu	ımn			Made by XX	Date 21	/11/2021	hd.
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CONSULTING		Engineerin	a Calaulatia	n Chaot		Job No.	Sheet No.		Rev.
ENGINEERS		Consulting	Engineers	in Sheet		jXXX	4	.5	
						Member/Location			<u></u>
Job Title	Member De	esign - Stee	el BeamColu	imn BS5950	) v2015.01	Drg. Ref.			
Member D	esign - Stee	el BeamColu	ımn			Made by XX	Date 21	/11/2021	lhd.
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CONSULTING		Engineerin	a Calaulatia	n Chaot		Job No.	Sheet No.		Rev.
ENGINEERS		Consulting	Engineers	n Sneet		jXXX	4	6	
						Member/Location			
Job Title	Member De	esign - Stee	el BeamColu	imn BS5950	) v2015.01	Drg. Ref.			
Member De	esign - Stee	el BeamColu	ımn			Made by XX	Date 21	/11/2021	hd.
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CONSULTING		Engineerin	a Calaulatia	n Chaot		Job No.	Sheet No.		Rev.
ENGINEERS		Consulting	Engineers	in Sheet		jXXX	4	7	
						Member/Location			<u> </u>
Job Title	Member De	esign - Stee	el BeamColu	imn BS5950	) v2015.01	Drg. Ref.			
Member D	esign - Stee	el BeamColu	ımn			Made by XX	Date 21	/11/2021	lhd.
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CONSULTING		Engineerin	a Calaulatia	n Chaot		Job No.	Sheet No.		Rev.
ENGINEERS		Consulting	Engineers	n Sneet		jXXX	4	8	
						Member/Location			
Job Title	Member De	esign - Stee	el BeamColu	imn BS5950	) v2015.01	Drg. Ref.			
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CONSULTING		Engineerin	a Calaulatia	n Chaot		Job No.	Sheet No.		Rev.
ENGINEERS		Consulting	Engineers	in Sheet		jXXX	4	.9	
						Member/Location			<u> </u>
Job Title	Member De	esign - Stee	el BeamColu	imn BS5950	) v2015.01	Drg. Ref.			
Member D	esign - Stee	el BeamColu	ımn			Made by XX	Date 21	/11/2021	lhd.
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