Brace On Demand

A Cloud Service for Seismic Design of Buckling Restrained Braces and Connections

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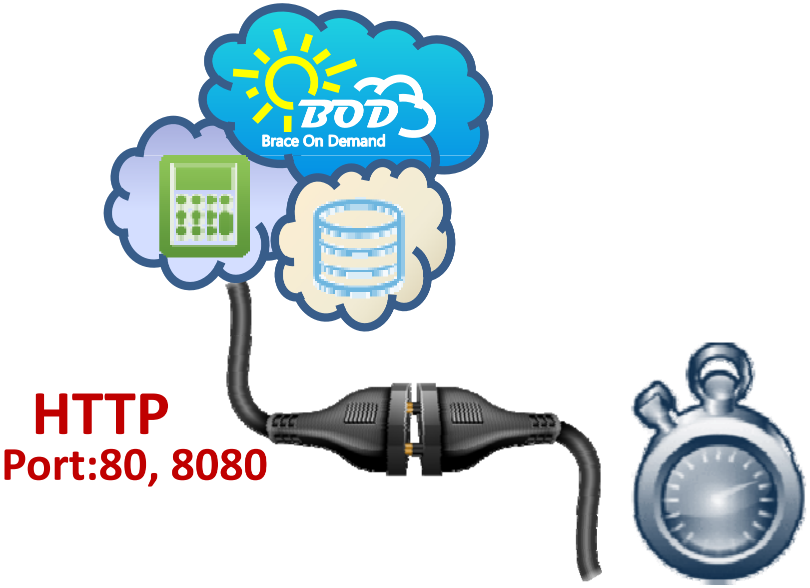
Using WES-BRBs for An Improved Seismic Resisting Performance of Buildings

Auckland/ Wellington/Christchurch, New Zealand. Nov. 12~14, 2013

BOD Cloud Service



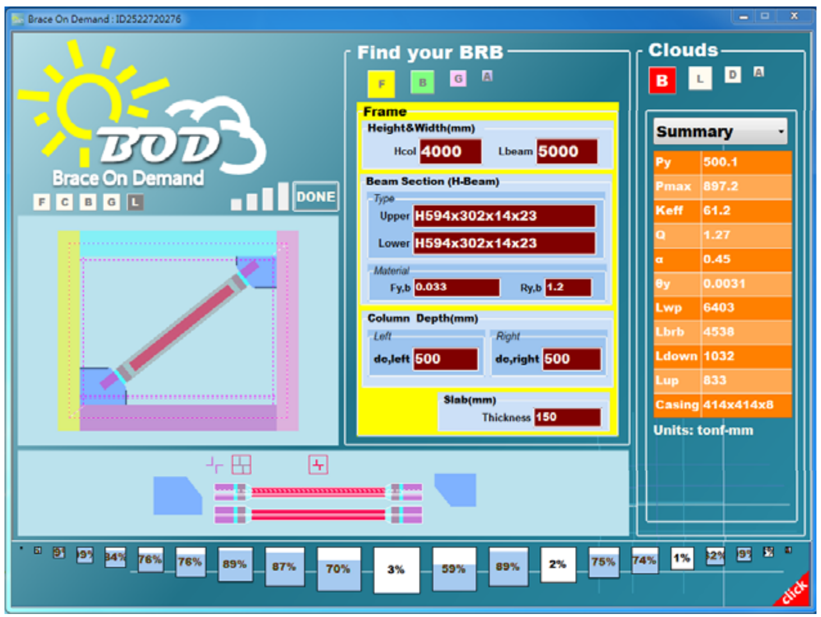
Server

On-demand service

Space, Strength and Stiffness

Diagonal & Chevron Config. BRBFs

< 0.1sec. (in Taiwan)



Client

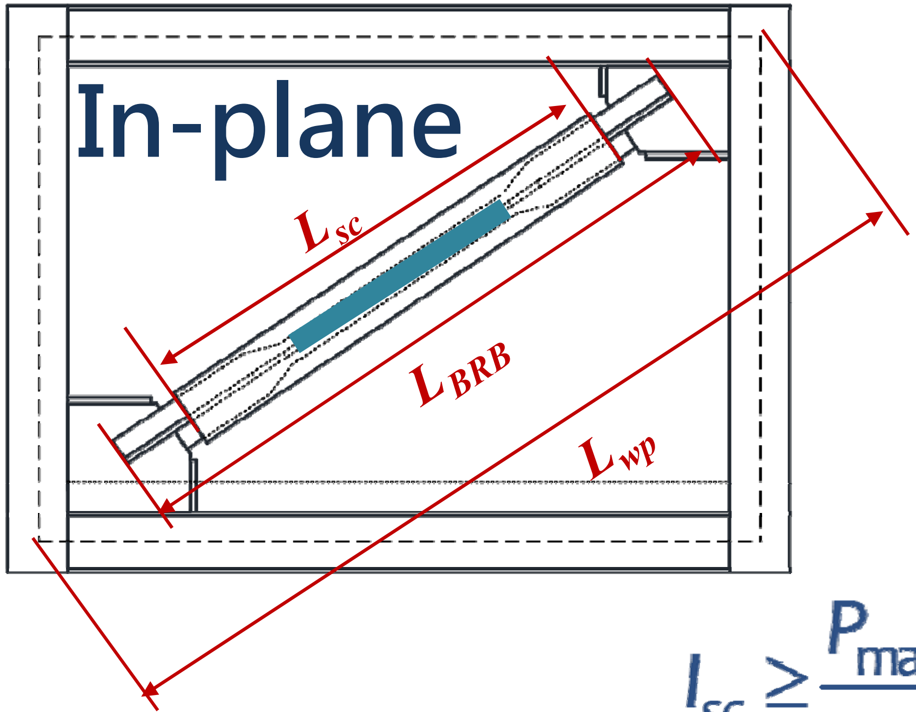
bod.ncree.org.tw

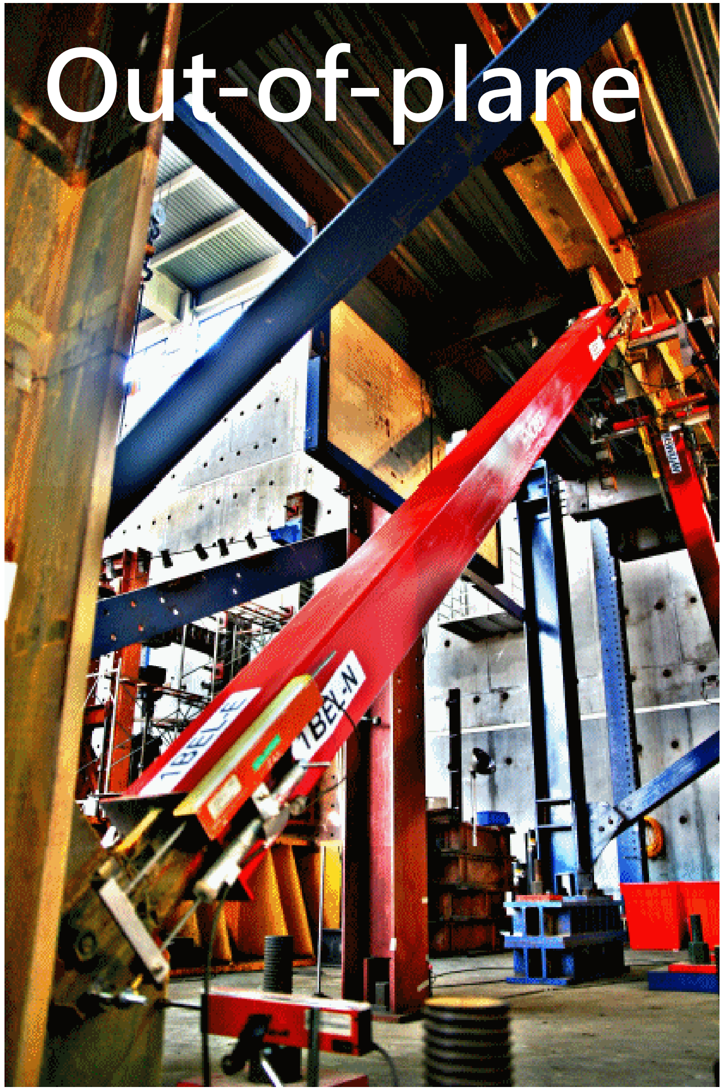
No set up required!

Friendly user interface

Portal to download structural calculations

Space Demand (Frame geometry)





$$I_{sc} \geq \frac{P_{max} L_{sc}^{2}}{\pi^2 E}$$

In-plane:

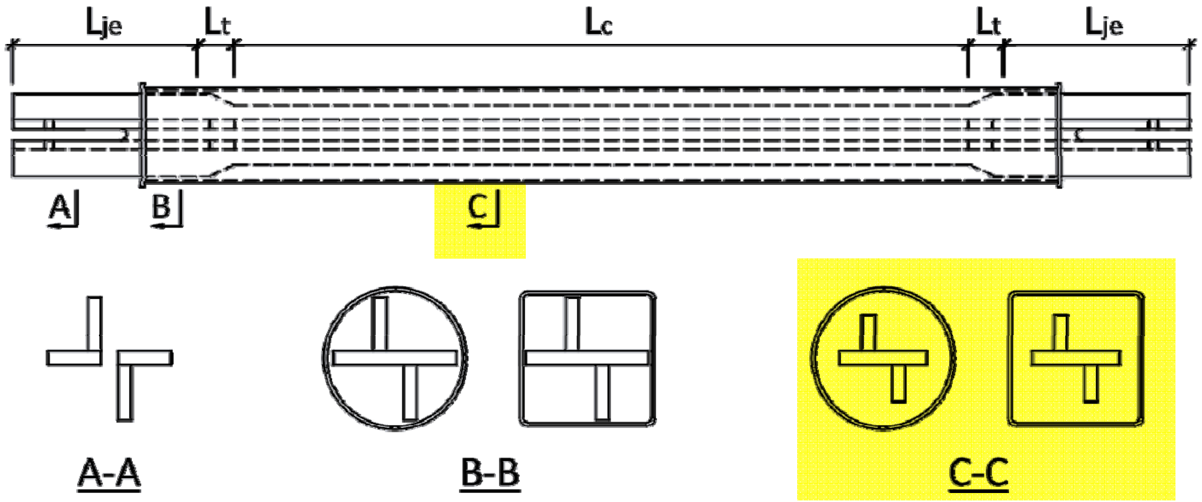
The longest L_{BRB}, L_c and L_{sc}

The best fatigue life (max. α_c)

The minimum K_{eff}

Out-of-plane: The casing size (Width)

Strength Demand (P_y=75~1500tonf)



4 characters to customize your WES-BRB.

Steel Material

A36

A572 GR50

SN490B/CM

X

Core Type

Cruciform

Flat

X

Yield Strength

(25 *Py* levels)

Min/Max

100/1500

75/250

tonf

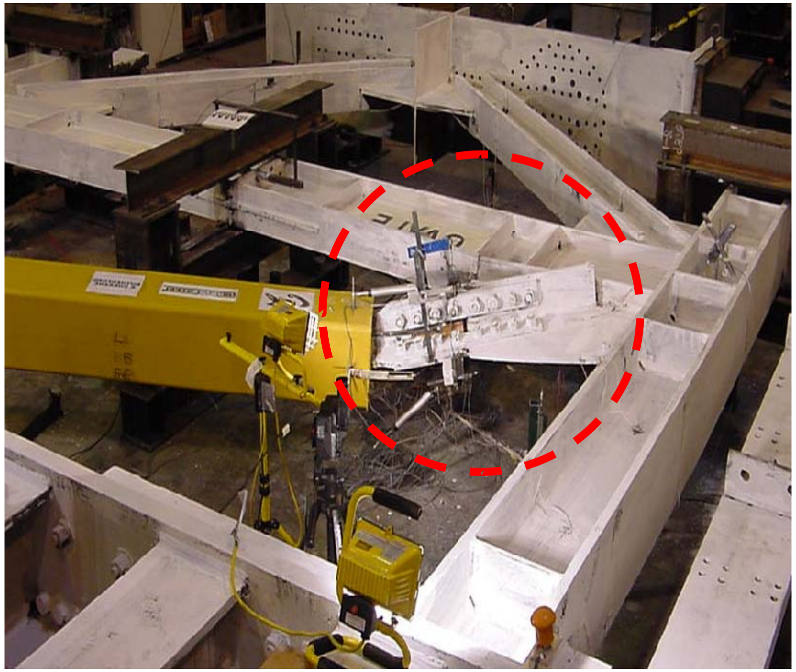
X

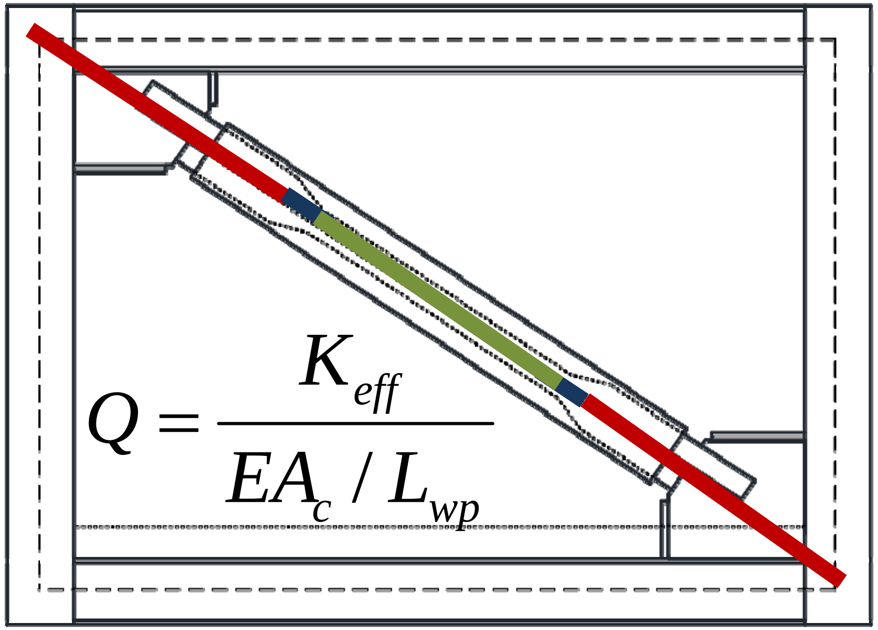
Type of Casing

Pipe

Tube

Stiffness Demand (User-specified K_{eff})



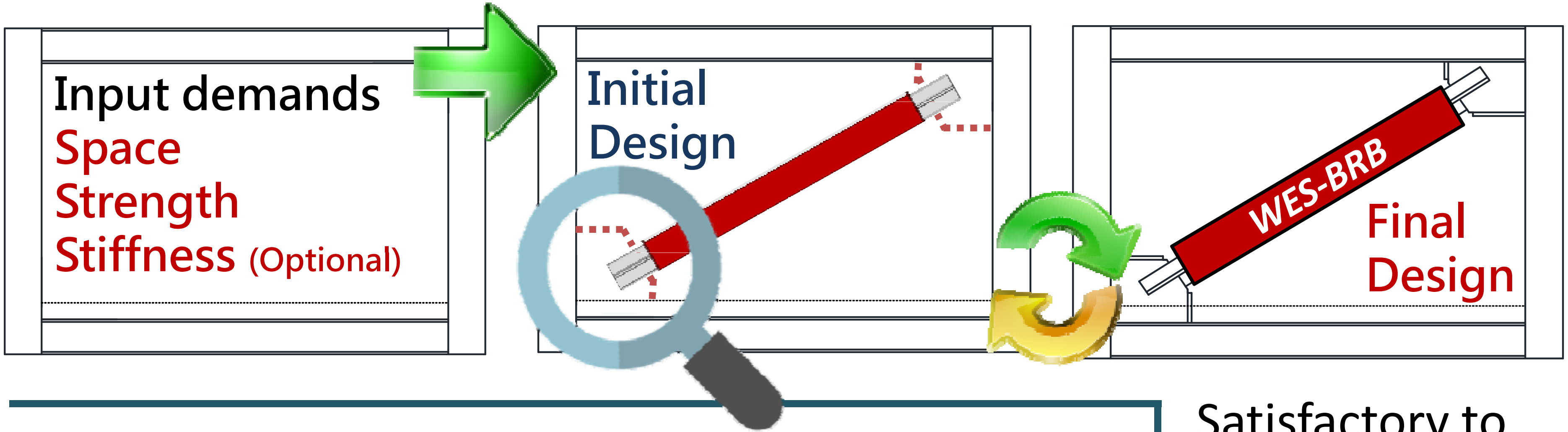


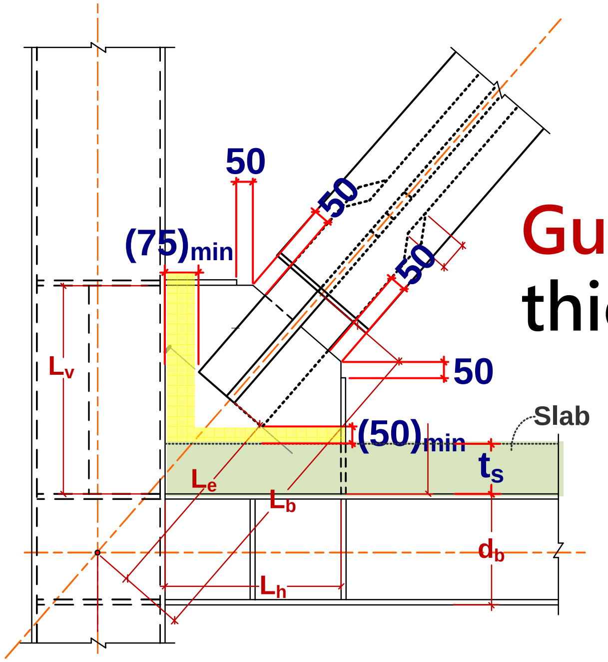
*By default setting, BOD can find the minimum K_{eff}.

*In general, Q value is ranging from 1.2~1.5.

*BOD allows you to increase the K_{eff} when $Q<1.6$ & $\alpha_c > 0.3$.

Automated Design Procedure





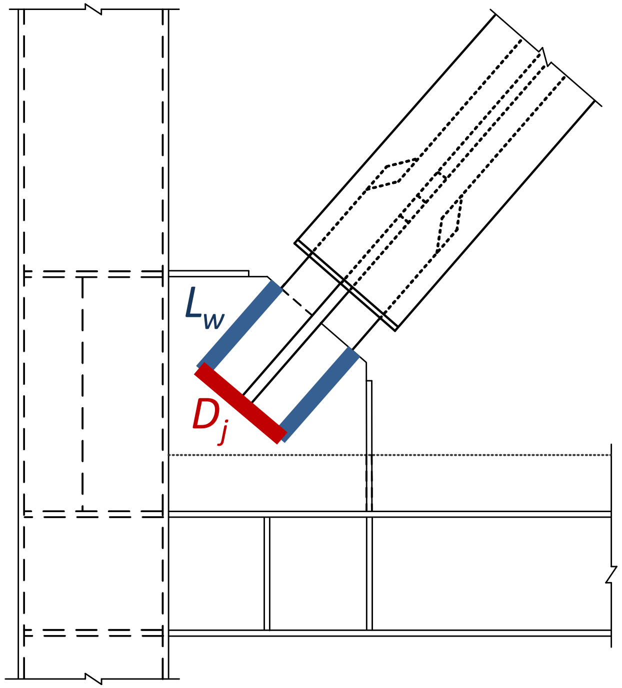
Gusset Plate thickness t_g = Core Plate thickness t_c

Satisfactory to

1. **21** limit states
2. K_{eff} User-specified

Strategies for Improving Design

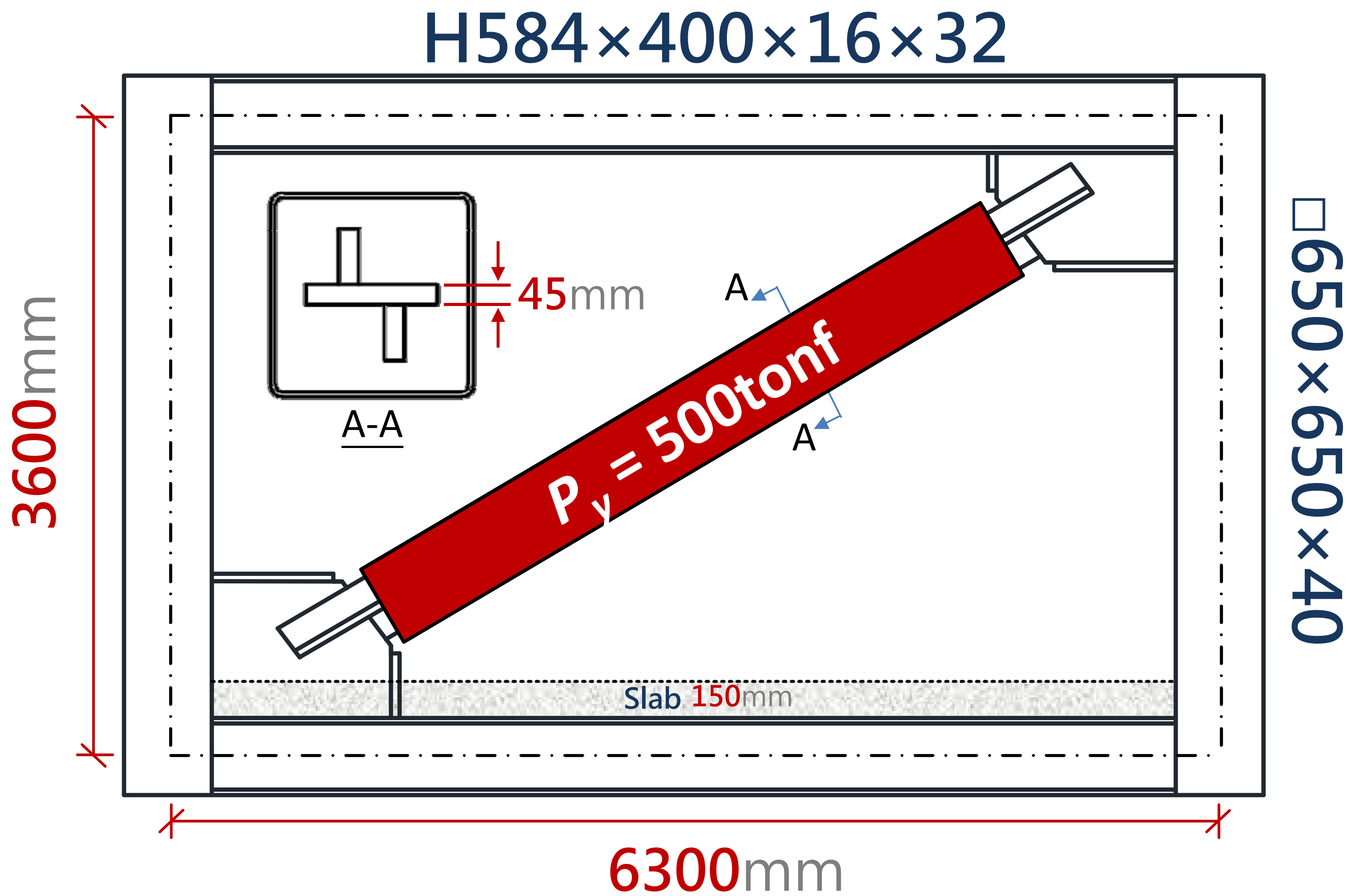
BOD Brace On Demand



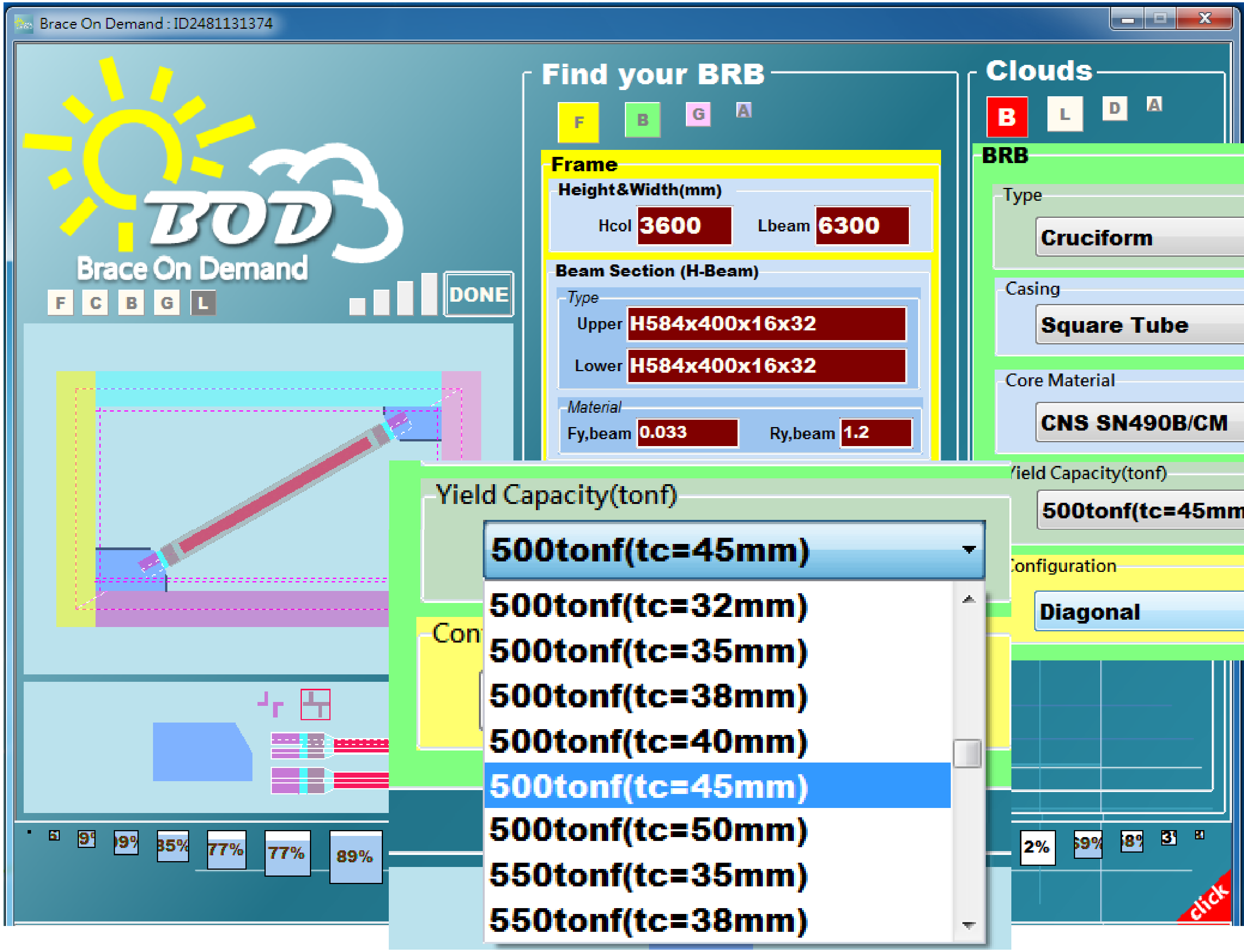
	Enlarge the Joint Region Size (D_j)	Increase the Welded Connection Length (L_w)	Increase the Gusset Thickness (t_g)
1. Steel Casing Buckling			
2.Joint Region Yielding	◎		
3.Joint Region Buckling	◎		
4.Gusset Plate Block Shear		◎	◎
5.Gusset Plate Yielding		◎	◎
6.Gusset Plate Buckling			◎
7.Gusset to Beam/ Column interface Strengths			◎
Effects on K_{eff}	+	+	-

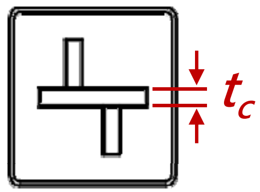
Notable Tradeoffs

The Example Case (SN490CM)

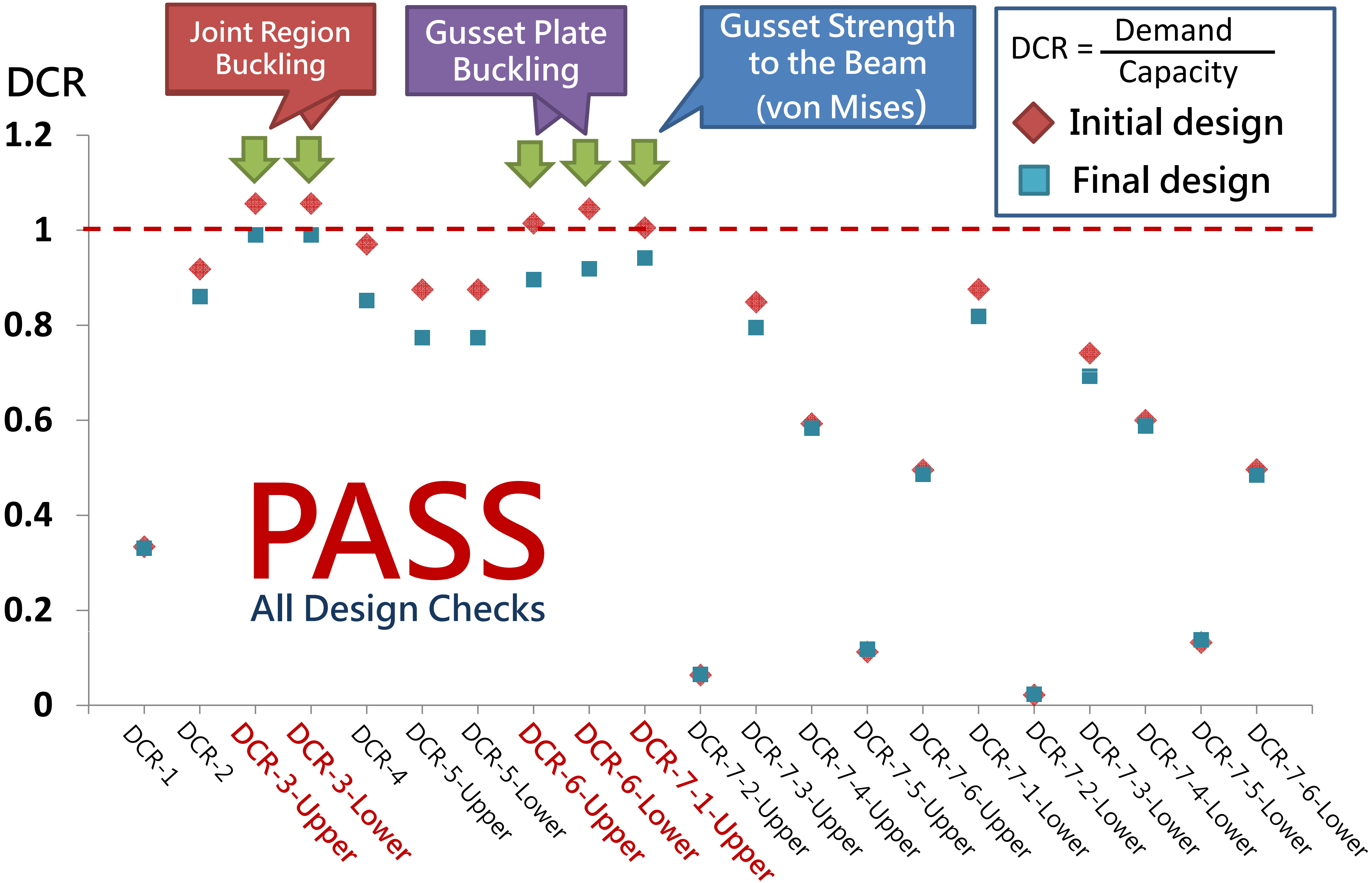


The Example Case (SN490CM)

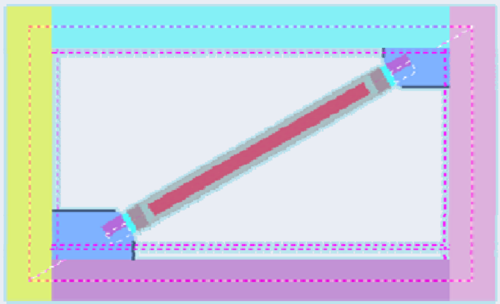
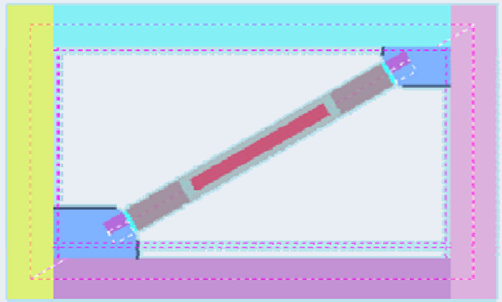
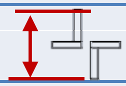




Results of Final Design (OK)

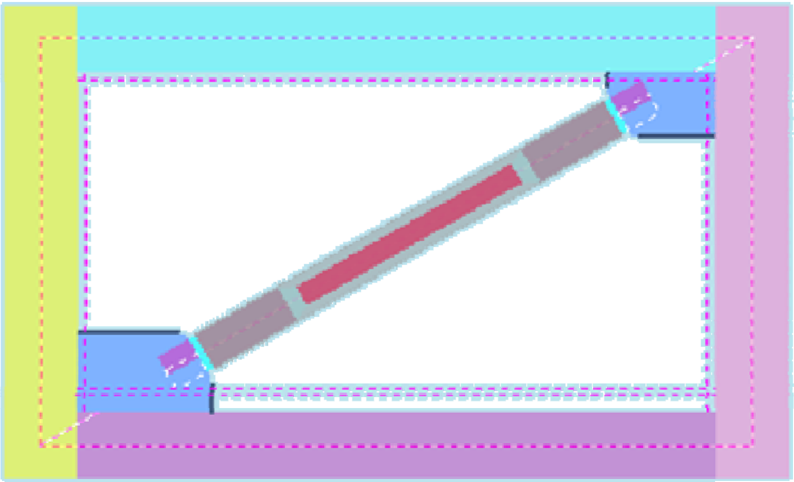


Results of User-specified K_{eff}

SN490CM	**Default Final Design**	**User-specified K_{eff}**
H_{col}: 3,600mm L_{beam}: 6,300mm **Beams**: H584×400×16×32 **Columns**: □650×650×40 **BRB**: P_y = 500tonf ; t_c = 45mm		
L_{BRB} (mm)	4989	4939 -1%
L_c (mm)	3535	2193 -38%
α_c (L_c/L_{wp})	0.49	**0.30** -38%
D_j 	305	333 9%
Q	1.33	**1.60** 20%
K_{eff} (tonf/mm)	**57**	**68** 20%
Steel casing size (mm)	350×350×9	**370×370×8** 6%
Gusset plate thickness (t_g)	50	50
Upper gusset plate weight (kgf)	185	196 6%
Lower gusset plate weight (kgf)	288	302 5%

BOD Design Capabilities

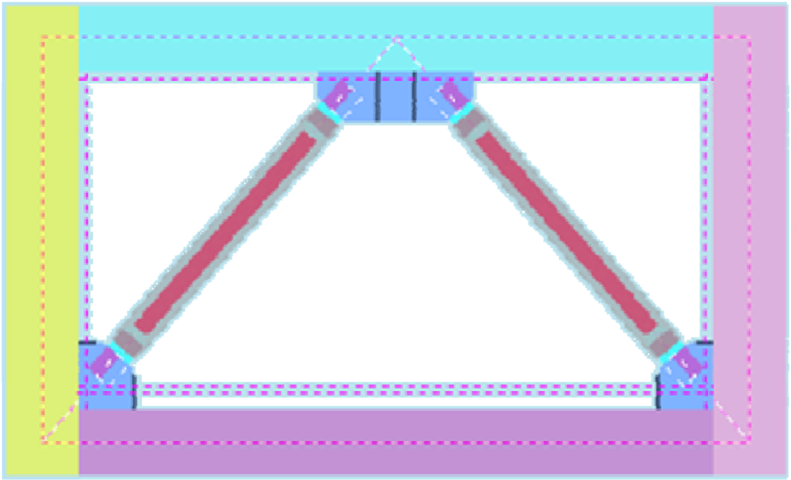
Not only



21

limit states

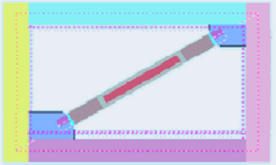
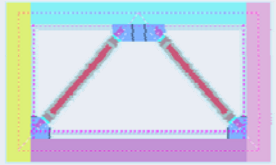
But also



33

limit states

Alternative of Chevron Configuration

SN490B/CM	User-specified K_{eff}	Chevron Configuration
Φ (degree)	 29.7	 48.8
P_y (tonf)	500 (t_c = 45mm)	350 (t_c=40mm)
L_{BRB} (mm)	4939	2744
L_c (mm)	2193	1690
α_c	0.30	0.37 ↑ 23%
Q	1.60	1.44 ↓ -10%
K_{eff} (tonf/mm)	68	61
Steel casing (mm)	370×370×8	300×300×4.5 ↓ -19%
θ_y (% radian)	0.28	0.29
t_g (mm)	50	50
Horizontal stiffness $K_h = K_{eff}\cos^2\varphi$ (tonf/mm)	51.3	52.5
Horizontal strength $V_y = P_y\cos\varphi$ (tonf)	434	461

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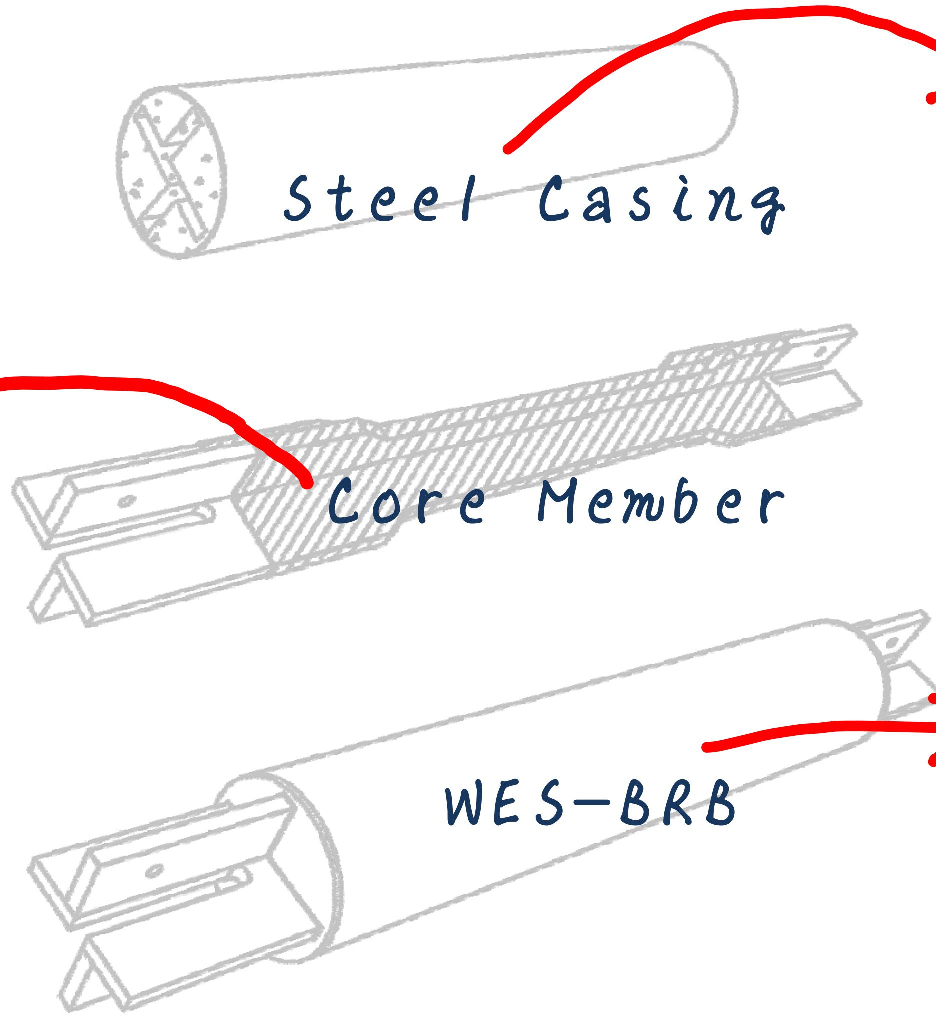
WES-BRB Details

Core

Core	
Lc	3535
tc	45
Bc	191
Dc	191
Ac	15165
Transition	
Lt	115
At	20303
Joint	
Lj	612
Lx	192
Ln	96
Lw	324
Tw	36
tj	45
Bj	305
Dj	305
Aj	25441
End Slot	
Ls	349
tg,s	53

Units: tonf-mm



Casing

Type	350x350x9
Product	Available
Dt,req	343.2
Dt	350
t	9
Isc,req	7.68E+07
Isc	2.32E+08
Lsc	4149

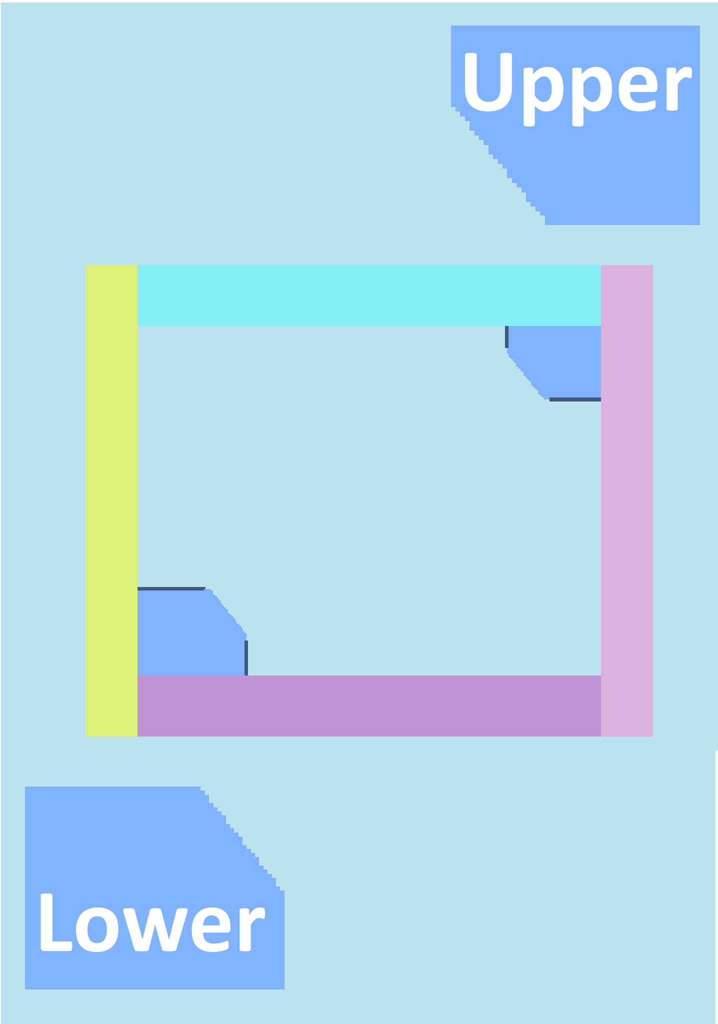
Units: tonf-mm

Summary

Py	500.4
Pmax	897.8
Keff	56.9
Q	1.33
α	0.49
θy	0.0034
Lwp	7256
L_BRB	4989
Le,lower	1259
Le,upper	1008
Casing	350x350x9

Units: tonf-mm

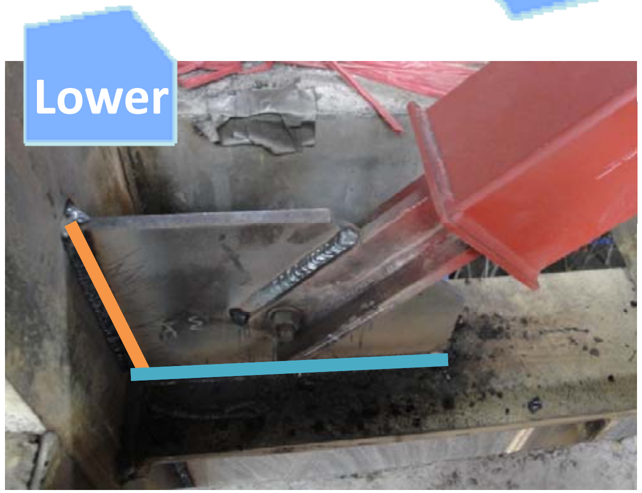
Details of Gussets



Gusset

Lower	
tg	40
Lh	1062.3
Tb	29
Lv	832.5
Tc	23
tsf	20
Lsf,h	658.3
Lsf,v	340
Upper	
tg	40
Lh	906.3
Tb	32
Lv	707.7
Tc	25
tsf	20
Lsf,h	502.1
Lsf,v	215

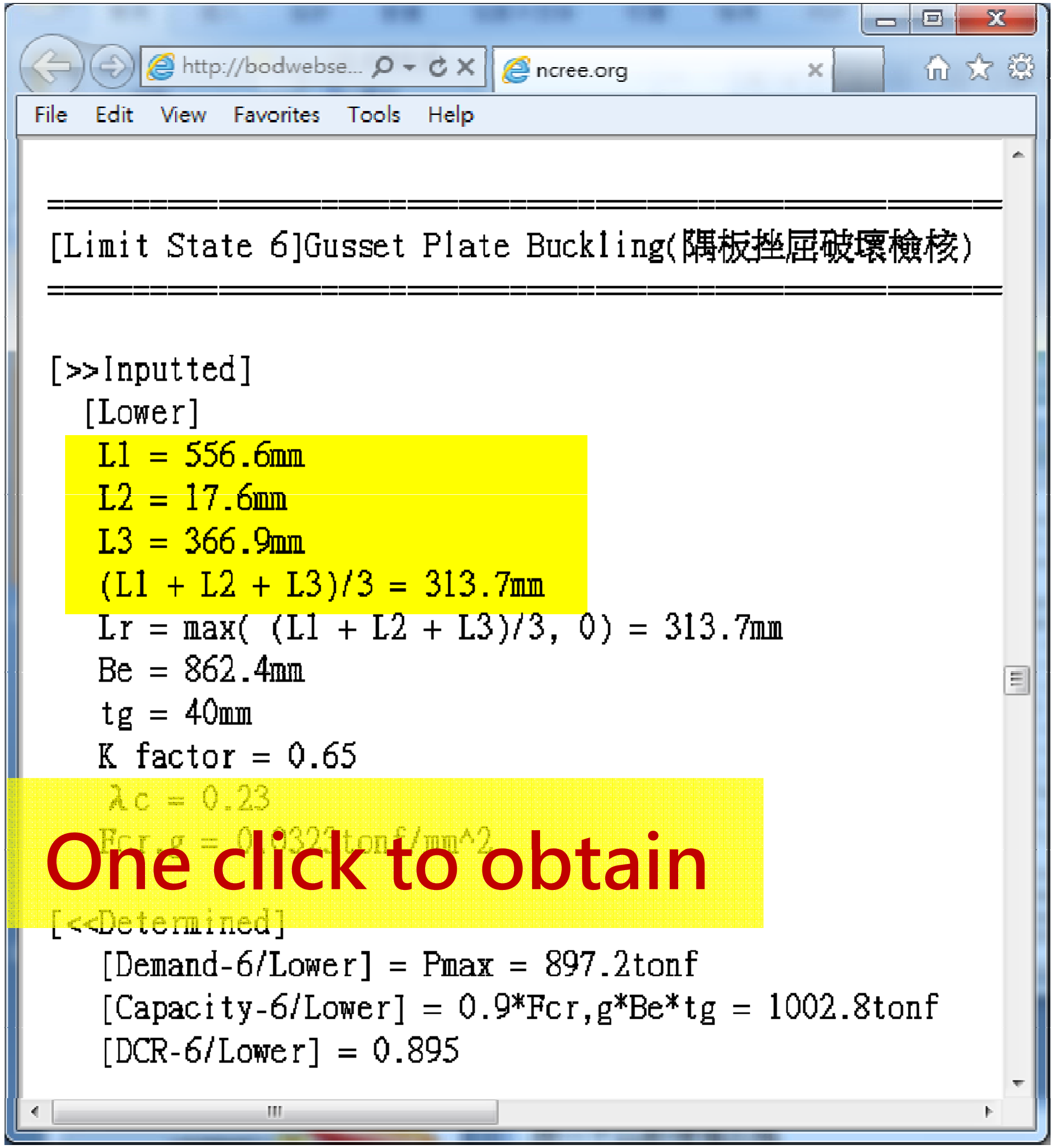
Units: tonf-mm



Archives & Standard Drawings

txt	xls	dwg	pdf
Structural Calculations	Spreadsheet	Standard Drawing	Standard Drawing

Structural Calculations



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```
==============================================================
[Limit State 6]Gusset Plate Buckling(隅板挫屈破壞檢核)
==============================================================

[>>Inputted]
  [Lower]
   L1 = 556.6mm
   L2 = 17.6mm
   L3 = 366.9mm
   (L1 + L2 + L3)/3 = 313.7mm
   Lr = max( (L1 + L2 + L3)/3, 0) = 313.7mm
   Be = 862.4mm
   tg = 40mm
   K factor = 0.65
   λc = 0.23
   Fcr,g = 0.0323tonf/mm^2

[<<Determined]
   [Demand-6/Lower] = Pmax = 897.2tonf
   [Capacity-6/Lower] = 0.9*Fcr,g*Be*tg = 1002.8tonf
   [DCR-6/Lower] = 0.895
```

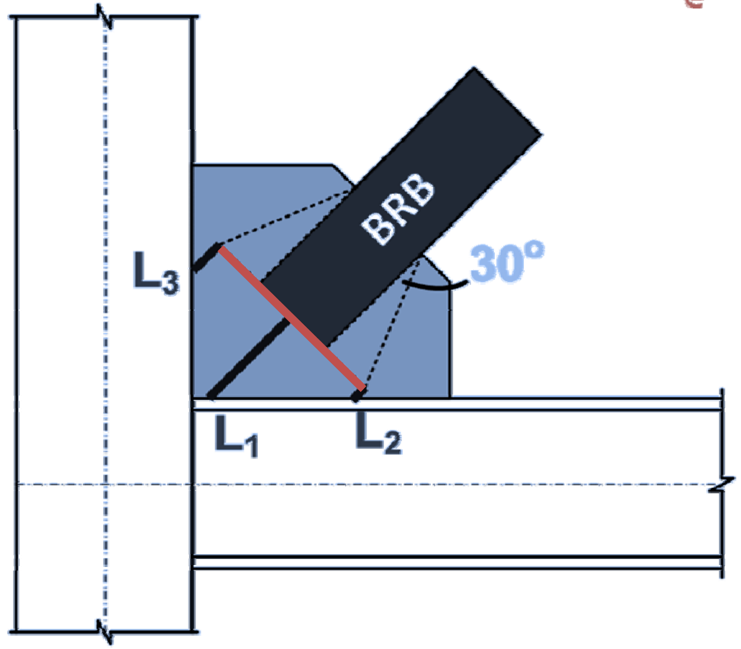
One click to obtain

Gusset Plate Buckling

$$L_r = \frac{L_1 + L_2 + L_3}{3} \qquad \lambda_c = \frac{KL_r}{\pi r}\sqrt{\frac{F_{y,g}}{E}}$$

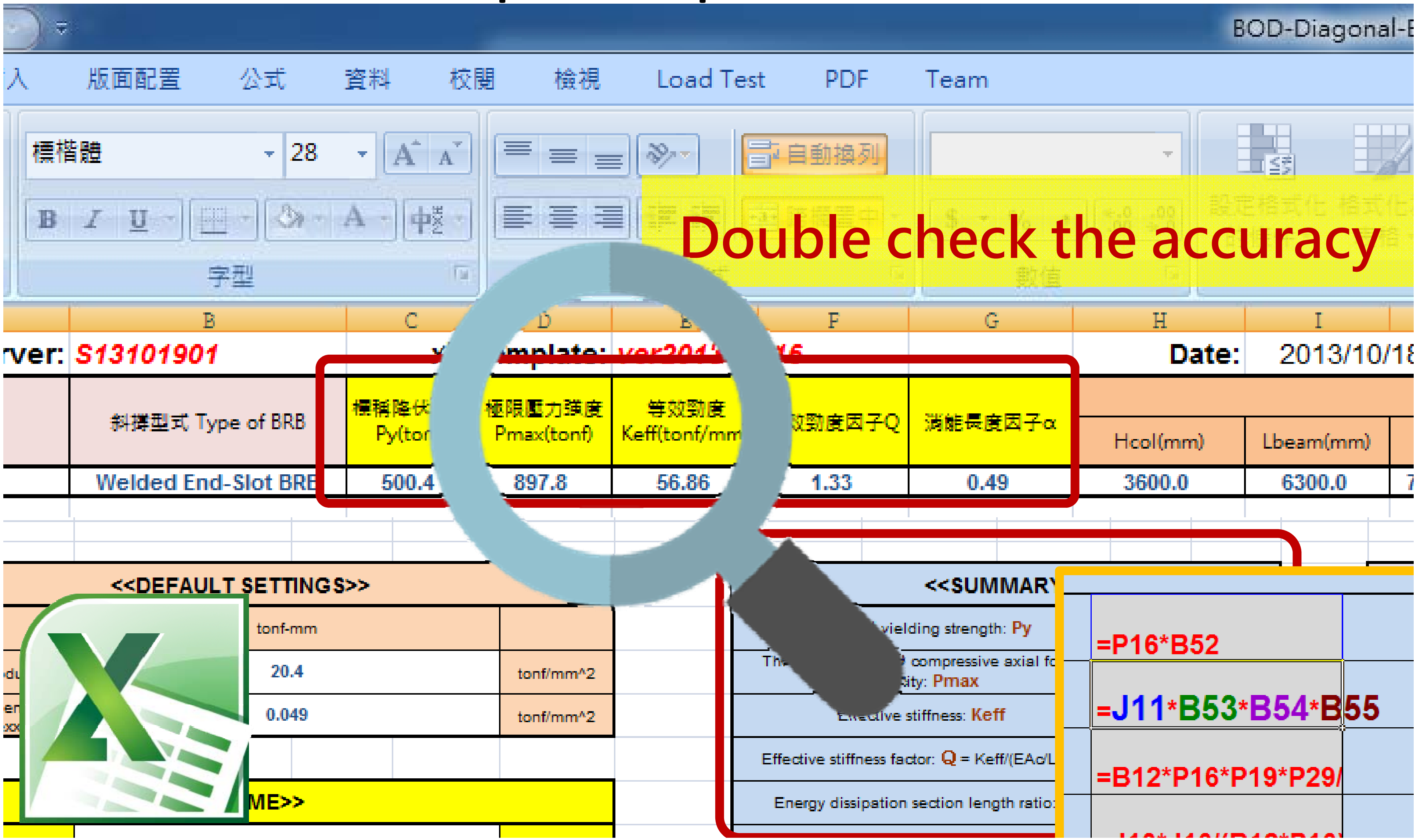
$$\begin{cases} \lambda_c \le 1.5, & F_{cr,g} = 0.658^{\lambda_c^2} F_{y,g} \\ \lambda_c > 1.5, & F_{cr,g} = \dfrac{0.877}{\lambda_c^2} F_{y,g} \end{cases}$$

Width of Whitmore section=B_e



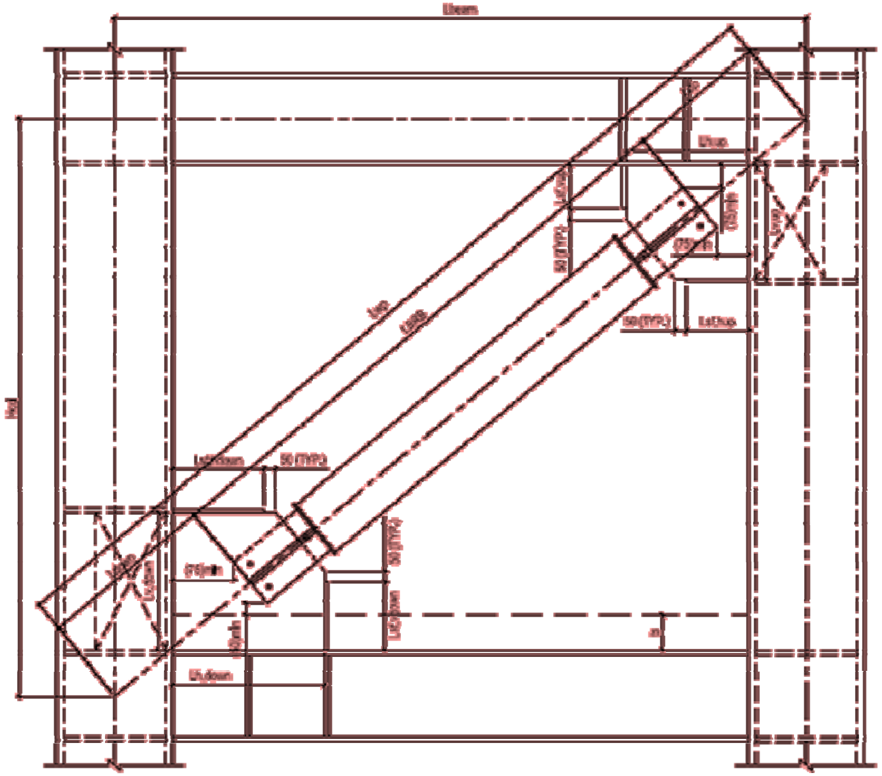
Insights through EXCEL

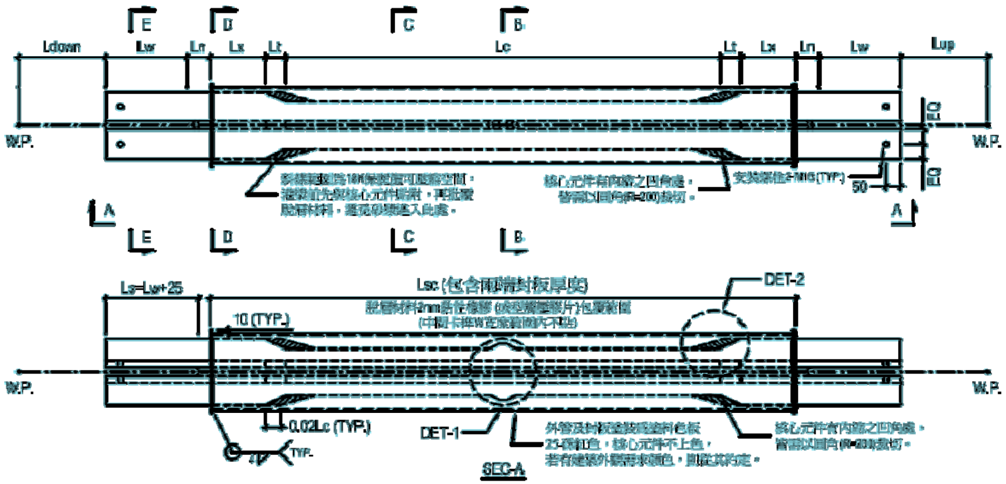
Make the complete spreadsheet. To a BOD.



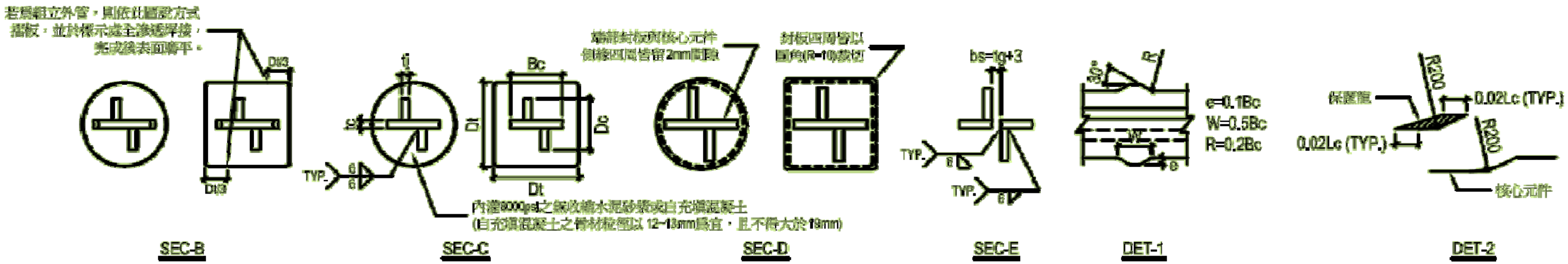
Standard Drawings

BOD
Brace On Demand





http://BOD.ncree.org.tw



Conclusions

BOD could reduce the iteration work, and enhance the engineers' productivity.

The innovative archives using EXCEL make the computing "transparent".

By using cloud computing, any up-to-date service can be achieved.

Thank you

Brace On Demand

http://BOD.ncree.org.tw