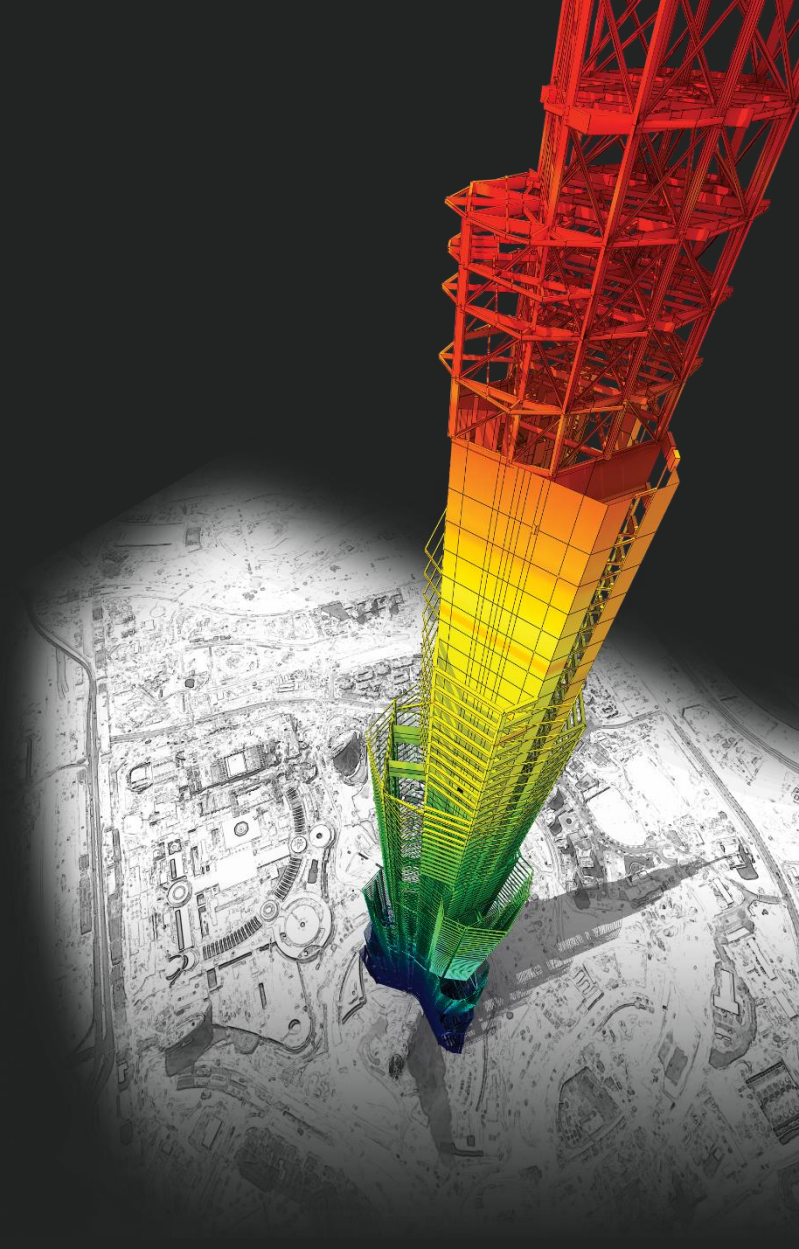
Release Note

Release Date : April. 2020

Product Ver. : midas Design+2020(v2.1)



DESIGN OF General Structures

Integrated Design System for Building and General Structures

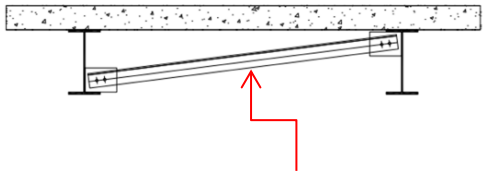
Enhancements

- *midas Design+*

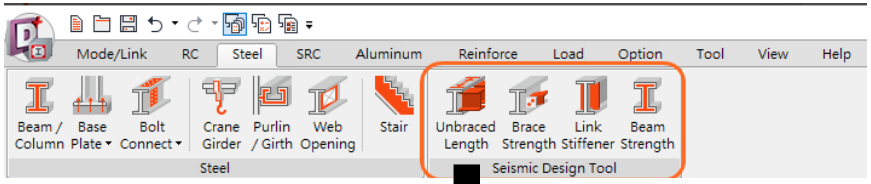
midas Design+

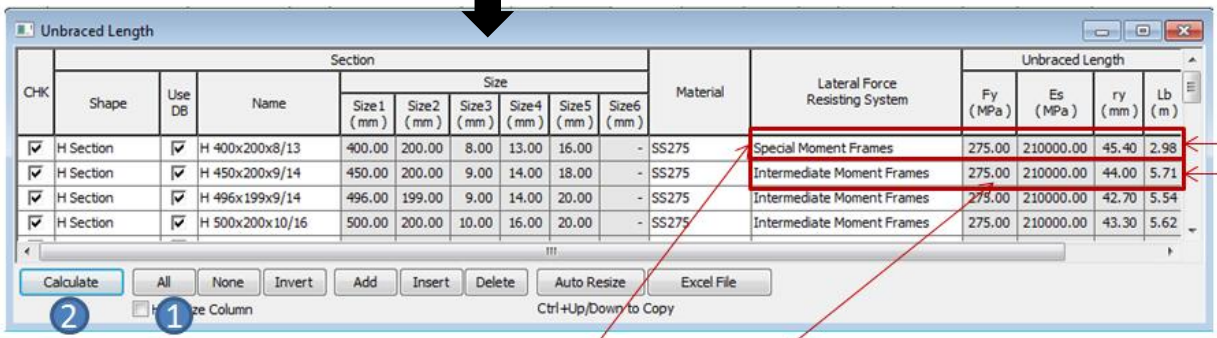
1. 新增鋼構耐震設計工具

計算梁構件最大無支撐長度



Beam bracing





AISC 341-16

(c) Beam bracing shall have a maximum spacing of

$$L_b = 0.19 r_y E/(R_y F_y) \qquad \text{(D1-2)}$$

where

r_y = radius of gyration about y-axis, in. (mm)

**Ry = 1.1 usually.*

2b. Highly Ductile Members

In addition to the requirements of Sections D1.2a.1(a) and (b), and D1.2a.2(a) and (b), the bracing of highly ductile beam members shall have a maximum spacing of $L_b = 0.095 r_y E/(R_y F_y)$. For concrete-encased composite beams, the material properties of the steel section shall be used and the calculation for r_y in the plane of buckling shall be based on the elastic transformed section.

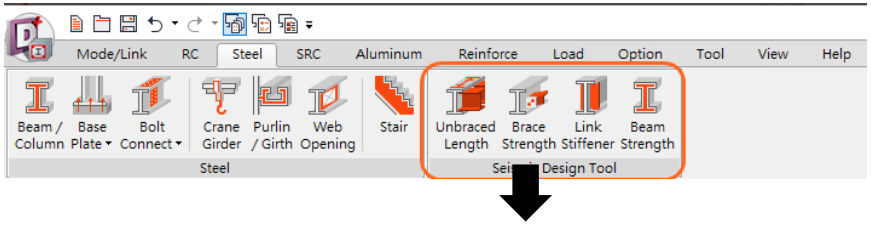
Korean code

Intermediated Moment
→ Lb = 0.17ry E/Fy

Special Moment Frames
→ Lb = 0.085ry E/Fy

1. 新增鋼構耐震設計工具

計算側向支承之軸力強度



AISC

1b. Point Bracing

In the direction perpendicular to the longitudinal axis of the beam, the required strength of end and intermediate point braces is

$$P_{br} = 0.02\left(\frac{M_r C_d}{h_o}\right) \qquad \text{(A-6-7)}$$

and, the required stiffness of the brace is

$$\beta_{br} = \frac{1}{\phi}\left(\frac{10M_r C_d}{L_{br} h_o}\right) \text{ (LRFD)} \qquad \text{(A-6-8a)}$$

$$\beta_{br} = \Omega\left(\frac{10M_r C_d}{L_{br} h_o}\right) \text{ (ASD)} \qquad \text{(A-6-8b)}$$

$\phi = 0.75$ (LRFD) $\quad \Omega = 2.00$ (ASD)

where

L_{br} = unbraced length adjacent to the point brace, in. (mm)

M_r = largest of the required flexural strengths of the beam within the unbraced lengths adjacent to the point brace using LRFD or ASD load combinations, kip-in. (N-mm)

When the unbraced lengths adjacent to a point brace have different M_r / L_{br} values, the larger value shall be used to determine the required brace stiffness.

For intermediate point bracing of an individual beam, L_{br} in Equations A-6-8a or A-6-8b need not be taken less than the maximum effective length, L_b, permitted for the beam based upon the required flexural strength, M_r.

(a) When $\frac{P_r}{P_c} \geq 0.2$

$$\frac{P_r}{P_c} + \frac{8}{9}\left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}}\right) \leq 1.0 \qquad \text{(H1-1a)}$$

(b) When $\frac{P_r}{P_c} < 0.2$

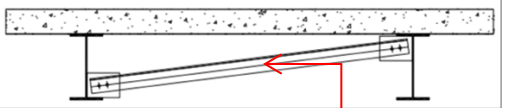
$$\frac{P_r}{2P_c} + \left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}}\right) \leq 1.0 \qquad \text{(H1-1b)}$$

Koran code (LSD)

③ 횡지지가새 부재 검토 및 상세 – 0713.9.8

- 소요강도 $P_{br} = 0.02 M_r C_d / h_0$
- 소요강성 $\beta_{br} = \frac{1}{\phi}\left(\frac{10 M_r C_d}{L_b h_0}\right)$

(여기서 Ø=0.75, $M_r = M_u = R_y Z F_y$, $C_d = 1.0$)



(a) When $\frac{P_r}{P_c} \geq 0.2$

$$\frac{P_r}{P_c} + \frac{8}{9}\left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}}\right) \leq 1.0$$

(b) When $\frac{P_r}{P_c} < 0.2$

$$\frac{P_r}{2P_c} + \left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}}\right) \leq 1.0$$

Beam bracing as point bracing

Brace Design Variables					Brace Strength	
øMn (kN.m)	ho (mm)	ø	Pbr (kN)	βbr (kN/m)	øPn (kN)	Ratio
248.82	387.00	0.75	25.72	3429.00	195.93	OK(0.066)
418.27	436.00	0.75	38.37	25582.57	195.93	OK(0.098)
472.73	482.00	0.75	39.23	26153.53	195.93	OK(0.200)
539.55	484.00	0.75	44.59	29727.27	195.93	OK(0.228)

1. 新增鋼構耐震設計工具

計算側向支承之軸力強度

Flexural strength of beam (it is defined by the user)

CHK	Beam					Brace					Bracing Type	Force					Brace Design Variables					Brace Strength	
	Shape	Use DB	Name	Material	Lb (m)	Shape	Use DB	Name	Material	Lb (m)		Use Sect. øMn	Cb	Mr (kN.m)	Cd	øMn (kN.m)	ho (mm)	ø	Pbr (kN)	βbr (kN/m)	øPn (kN)	Ratio
☑	H Section	☑	H 400x200x8/13	SS275	4.00	Angle	☑	L 100x7	SS275	2.00	Nodal Bracing	☑	1.00	1000.00	2.000	277.60	387.00	0.7	28.69	4782.0	148.38	OK(0.097)
☐	H Section	☑	H 450x200x9/14	SS275	1.00	Angle	☑	L 100x7	SS275	1.00	Nodal Bracing	☑	1.00	0.00	2.000	418.27	436.00	0.75	28.37	25582.57	195.93	OK(0.098)
☐	H Section	☑	H 496x199x9/14	SS275	1.00	Angle	☑	L 100x7	SS275	1.00	Nodal Bracing	☑	1.00	0.00	2.000	472.73	482.00	0.75	39.23	26153.53	195.93	OK(0.200)

Axial strength of brace
(it is defined by the user)

Nodal Brace → $P_{br} = 0.02\left(\frac{M_r C_d}{h_o}\right)$

Relative Brace → $P_{br} = 0.02\left(\frac{M_r C_d}{h_o}\right)$

0.008

[Combination stress check]

(a) When $\frac{P_r}{P_c} \geq 0.2$

$$\frac{P_r}{P_c} + \frac{8}{9}\left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}}\right) \leq 1.0$$

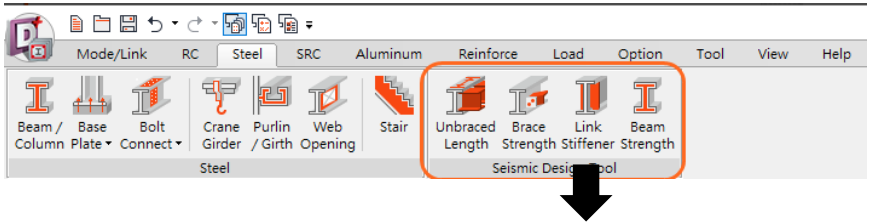
(b) When $\frac{P_r}{P_c} < 0.2$

$$\frac{P_r}{2P_c} + \left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}}\right) \leq 1.0$$

In here,
Mr/Mc = 0 Because a brace does not have a moment
Pr = Pbr
Pc = ϕPn

1. 新增鋼構耐震設計工具

設計連桿梁加勁板



4. Link Stiffeners for I-Shaped Cross Sections

Full-depth web stiffeners shall be provided on both sides of the link web at the diagonal brace ends of the link. These stiffeners shall have a combined width not less than $(b_f - 2t_w)$ and a thickness not less than the larger of $0.75t_w$ or ⅜ in. (10 mm), where b_f and t_w are the link flange width and link web thickness, respectively.

Links shall be provided with intermediate web stiffeners as follows:

(a) Links of lengths $1.6M_p/V_p$ or less shall be provided with intermediate web stiffeners spaced at intervals not exceeding $(30t_w - d/5)$ for a link rotation angle of 0.08 rad or $(52t_w - d/5)$ for link rotation angles of 0.02 rad or less. Linear interpolation shall be used for values between 0.08 and 0.02 rad.

(b) Links of length greater than or equal to $2.6M_p/V_p$ and less than $5M_p/V_p$ shall be provided with intermediate web stiffeners placed at a distance of 1.5 times b_f from each end of the link.

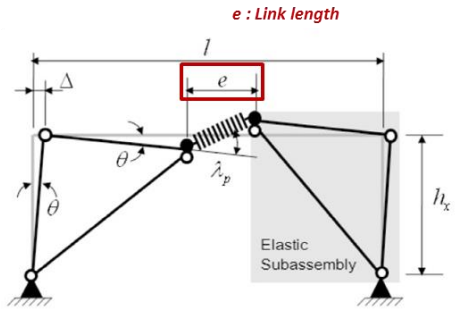
(c) Links of length between $1.6M_p/V_p$ and $2.6M_p/V_p$ shall be provided with intermediate web stiffeners meeting the requirements of (a) and (b) in the preceding.

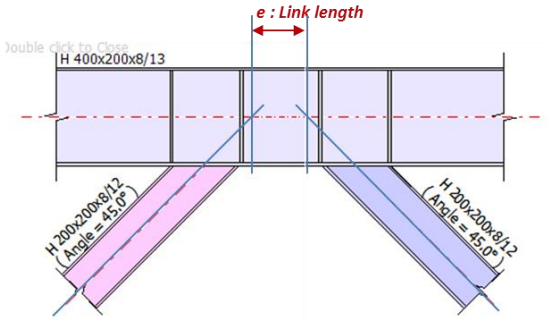
Intermediate web stiffeners shall not be required in links of length greater than $5M_p/V_p$.

Seismic Provisions for Structural Steel Buildings, July 12, 2016
American Institute of Steel Construction

Sect. F3.] ECCENTRICALLY BRACED FRAMES (EBF) 9.1-75

Intermediate web stiffeners shall be full depth. For links that are less than 25 in. (630 mm) in depth, stiffeners shall be provided on only one side of the link web. The thickness of one-sided stiffeners shall not be less than t_w or ⅜ in. (10 mm), whichever is larger, and the width shall not be less than $(b_f/2) - t_w$. For links that are 25 in. (630 mm) in depth or greater, intermediate stiffeners with these dimensions shall be provided on both sides of the web.





1. 新增鋼構耐震設計工具

設計連桿梁加勁板

Link Length = 'e'

CHK	Section			Material	Link		Link Stiffener								
	Shape	Use DB	Name		Length (m)	Angle (Deg.)	Zx (mm³)	Aweb (mm²)	Fy (MPa)	Mp (kN.m)	Vp (kN)	Mp/Vp (mm)	breq (mm)	treq (mm)	sreq (mm)	Dbl Stif.
☑	H Section	☑	H 400x200x8/13	SS275	1.00	45.00	1330000.00	2992.00	275.00	365.75	493.68	740.86	184.00	10.00	160.00	No

$A_{lw} = (d - 2t_f)t_w$ for I-shaped link sections (F3-4)

$M_p = F_y Z$ for $\alpha_s P_r / P_y \le 0.15$ (F3-8)

$V_p = 0.6 F_y A_{lw}$ for $\alpha_s P_r / P_y \le 0.15$ (F3-2)

$V_n = 2M_p / e$ (F3-7)

Minimum [Vp, Vn]

Full-depth web stiffeners shall be provided on both sides of the link web at the diagonal brace ends of the link. These stiffeners shall have a combined width not less than $(b_f - 2t_w)$ and a thickness not less than the larger of $0.75t_w$ or ⅜ in. (10 mm), where b_f and t_w are the link flange width and link web thickness, respectively.

Links shall be provided with intermediate web stiffeners as follows:

(a) Links of lengths $1.6M_p/V_p$ or less shall be provided with intermediate web stiffeners spaced at intervals not exceeding $(30t_w - d/5)$ for a link rotation angle of 0.08 rad or $(52t_w - d/5)$ for link rotation angles of 0.02 rad or less. Linear interpolation shall be used for values between 0.08 and 0.02 rad.

(b) Links of length greater than or equal to $2.6M_p/V_p$ and less than $5M_p/V_p$ shall be provided with intermediate web stiffeners placed at a distance of 1.5 times b_f from each end of the link.

(c) Links of length between $1.6M_p/V_p$ and $2.6M_p/V_p$ shall be provided with intermediate web stiffeners meeting the requirements of (a) and (b) in the preceding.

Intermediate web stiffeners shall not be required in links of length greater than $5M_p/V_p$.

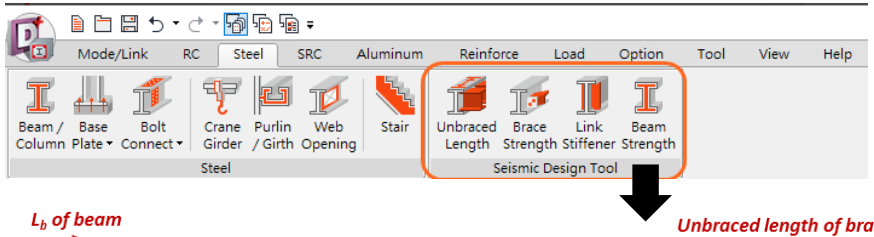
"No" : To provide on one side is possible
"Yes" : To provide on one side is not possible
**** it is just to inform whether one side is possible.*
And all results is for both side.

Link		Link Stiffener									
Length (m)	Angle (Deg.)	Zx (mm³)	Aweb (mm²)	Fy (MPa)	Mp (kN.m)	Vp (kN)	Mp/Vp (mm)	breq (mm)	treq (mm)	sreq (mm)	Dbl Stif.
5.00	45.00	-	-	-	-	-	-	-	-	-	-

If e>5Mp/Vp, "-" will be output

1. 新增鋼構耐震設計工具

計算V型斜撐構架梁強度



L_b of beam

Unbraced length of brace

CHK	Beam						Brace1					Ry				Brace2					Ry			
	Section			Material	Length (m)	Cb	Section			Material	Type	User	Ry	Length (m)	Cb	Angle (Deg.)	Section			Material	Type	User	Ry	Length (m)	Cb	Angle (Deg.)
	Shape	Use DB	Name				Shape	Use DB	Name								Shape	Use DB	Name							
☑	H Section	☑	H 400x200x8/13	SS275	2.00	1.00	H Section	☑	H 200x200x8/12	SS275	Tension Brace	☐	1.100	1.00	1.00	45.00	H Section	☑	H 200x200x8/12	SS275	Compression Brace	☐	1.100	1.00	1.00	45.00

Design Force							Check Result of Brace								Check Result of Beam								
Dead Load			Live Load			Seismic Load	Brace1				Brace2				Design Forces			Design Strength			Strength Ratio			
Factor	Mux (kN.m)	Vuy (kN)	Factor	Mux (kN.m)	Vuy (kN)		Fy (MPa)	Pn (kN)	Qb (kN)	Qc (kN)	Fy (MPa)	Pn (kN)	Qb (kN)	Qc (kN)	Fy (MPa)	Pux (kN)	Mux (kN.m)	Vuy (kN)	øPn (kN)	øMn (kN.m)	øVn (kN)	Pux / øPn	Mux / øMn	Vuy / øVn	Comb.
1.20	100.00	100.00	0.50	150.00	150.00	1.00	275.00	2271.20	1605.98	1605.98	275.00	512.70	362.53	362.53	275.00	1968.51	195.00	2163.51	1869.26	329.18	528.00	NG(1.053)	OK(0.592)	NG(4.098)	NG(1.580)

F_D Mux_D Vuy_D F_L Mux_L Vuy_L

In case of Tension,
*Pn = Fy*Area*Ry (Tension)*

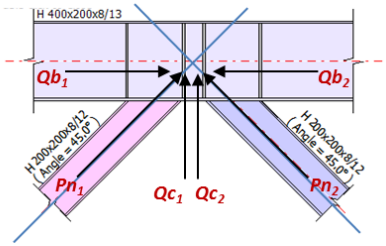
In case of compression,
Pn is the value considered the buckling

Qb = Qc = Pn / sqrt(2)
** Angle is reflected only with 45.0°*

$Pux = Qb_1 + Qb_2$

$Mux = F_D*Mux_D + F_L*Mux_L$

$Vuy = F_D*Vuy_D + F_L*Vuy_L + Qc_1 + Qc_2$



[Combination stress check]

(a) When $\frac{P_r}{P_c} \geq 0.2$

$$\frac{P_r}{P_c} + \frac{8}{9}\left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}}\right) \leq 1.0$$

(b) When $\frac{P_r}{P_c} < 0.2$

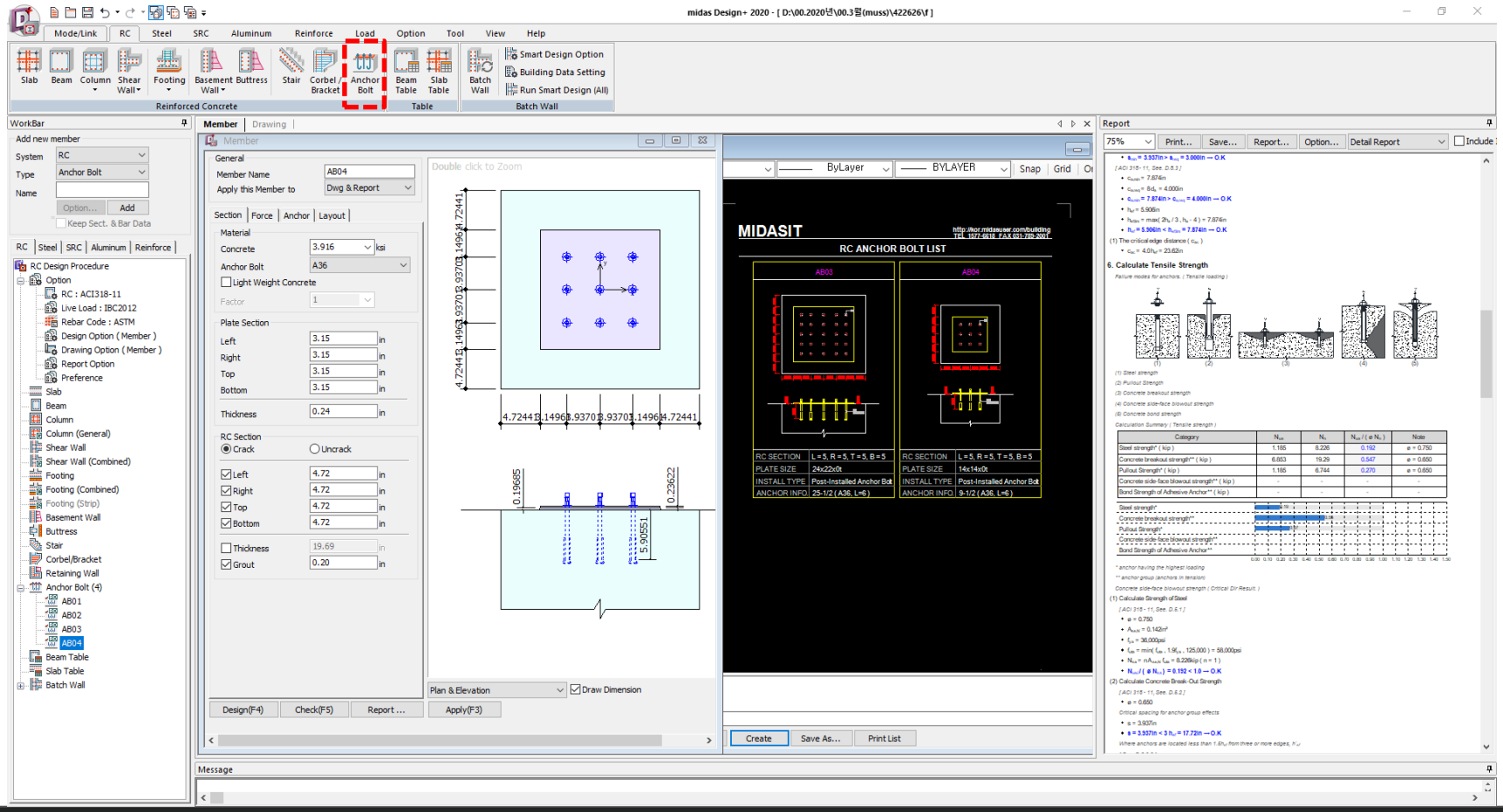
$$\frac{P_r}{2P_c} + \left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}}\right) \leq 1.0$$

0.0

In here,
Pr = Pux, Pc = ϕPn
Mrx = Mux, Mcx = ϕMn

2. 新增錨定螺栓設計模組 (ACI 318)

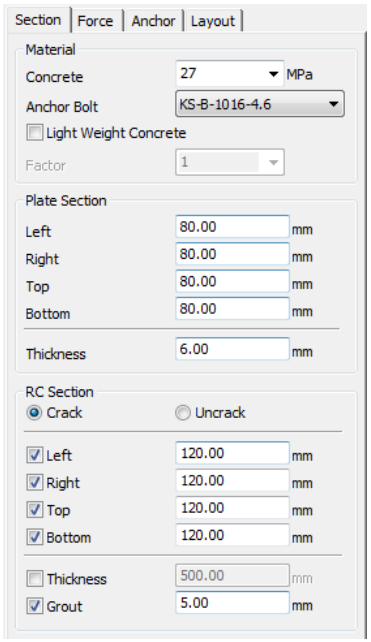
- *適用規範 : ACI318-14(M),11(M),08(M),NSR-10*
- *預埋式/後置式錨栓之間距、抗拉與抗剪強度以及組合應力比檢核*



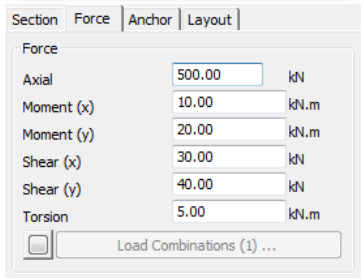
2. 新增錨定螺栓設計模組 (ACI 318)

錨定螺栓設計程序

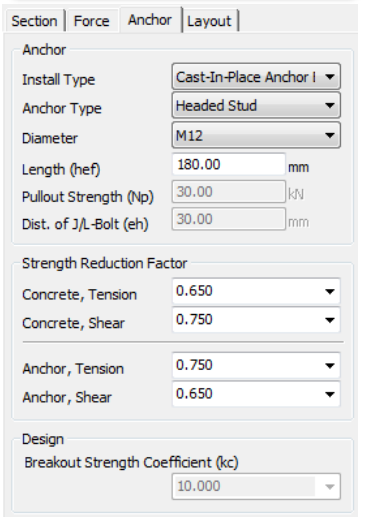
Section | **Force** | **Anchor** | **Layout**



Step 1.
定義混凝土與錨栓材料以及構件配置資訊

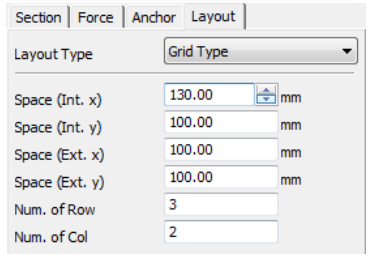


Step 2.
定義設計外力.
(Axial, Moment, Shear, Torsion)

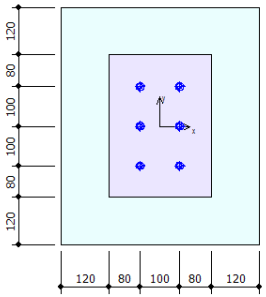


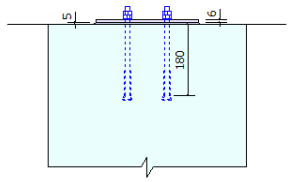
Step 3.
定義錨栓資訊.

預埋式錨栓：Headed Stud / Headed Bolt/Hooked Bolt(L/J)
後置式錨栓：
Expansion(Torque, Displacement), Undercut, Adhesive anchors



Step 4.
定義錨栓的佈置方式以及數量與間距





2. 新增錨定螺栓設計模組 (ACI 318)

Summary Calculation Report

7. Calculation Summary

(1) Required edge distances, spacings, and thicknesses to preclude splitting failure

Category	Value	Criteria	Ratio	Note
Minimum spacing of anchors (mm)	100	72.00	0.720	s_{req} / s_{min}
Minimum edge distances (mm)	-	-	-	-
Limit of embedment depth (mm)	-	-	-	-

(2) Tensile strength

Category	N_{ua}	N_n	N_{ua} / (ø N_n)	Note
Steel strength* (kN)	0.000	33.72	0.000	ø = 0.750
Concrete breakout strength** (kN)	0.000	0.000	0.000	ø = 0.650
Pullout Strength* (kN)	0.000	50.38	0.000	ø = 0.650
Concrete side-face blowout strength** (kN)	-	-	-	-

** anchor having the highest loading*

*** anchor group (anchors in tension)*

(3) Shear strength

Category	V_{ua}	V_n	V_{ua} / (ø V_n)	Note
Steel strength* (kN)	8.333	26.98	0.475	ø = 0.650
Concrete breakout strength** (Dir. X) (kN)	15.00	41.67	0.480	ø = 0.750
Concrete breakout strength** (Dir. Y) (kN)	13.33	34.73	0.512	ø = 0.750
Concrete pryout strength** (kN)	-	-	-	-

** anchor having the highest loading*

*** anchor group (relevant anchors)*

(4) Combined Ratio

Category	Value	Criteria	Ratio	Note
Combined Ratio	0.512	1.000	0.512	

Detail Calculation Report

11. Required edge distances, spacings, and thicknesses to preclude splitting failure

[KDS 14 20 54 : 2016, See. 4.6(2)]

Calculation Summary (Required edge distances, spacings, and thicknesses to preclude splitting failure)

(1) Minimum center-to-center spacing of anchors

s_{min}	s_{req}	s_{req} / s_{min}
100mm	72.00mm	0.720

- s_{min} = 100mm
- s_{req} = 6 d_a = 72.00mm
- **s_{min} = 100mm > s_{req} = 72.00mm → O.K**

(2) Check Distance from Concrete Edge to Center of Anchor Bolt

Post-installed anchors only.

(3) The limitations on the value of h_{ef}

Expansion or undercut post-installed anchors only.

(4) The critical edge distance (c_{ac})

Post-installed anchors only.

13. Calculate Shear Strength

Failure modes for anchors. (Shear loading)

(1) Steel strength

(2) Pullout Strength

(3) Concrete breakout strength

Calculation Summary (Shear strength)

(1) Calculate Strength of Steel

[KDS 14 20 54 : 2016, See. 4.4.1, ref. ACI 318-14 17.5.1]

- ø = 0.650
- f_{uta} = min(f_{uta} , 1.9f_{ya} , 860.0) = 400MPa
- $A_{se,V}$ = 84.30mm²

For cast-in headed stud anchor

- V_{sa} = n $A_{se,V}$ f_{uta} = 33.72kN (n = 1)

Where anchors are used with built-up grout pads

- $V'_{sa,grout}$ = 0.8 V_{sa} = 26.98kN
- **$V_{ua,l}$ / (ø V_{sa}) = 0.475 < 1.0 → O.K**

(2) Calculate Concrete Break-Out Strength

[KDS 14 20 54 : 2016, See. 4.4.2]

- ø = 0.750
- d_a = 12.00mm
- λ = 1.000

Where l_e is the load-bearing length of the anchor for shear.

- l_e = min(8d_a , h_{ef}) = 96.00mm

- *提供 設計摘要/詳細計算 等不同格式的報表內容。*
- *報表中列出規範章節便於檢視計算內容。*