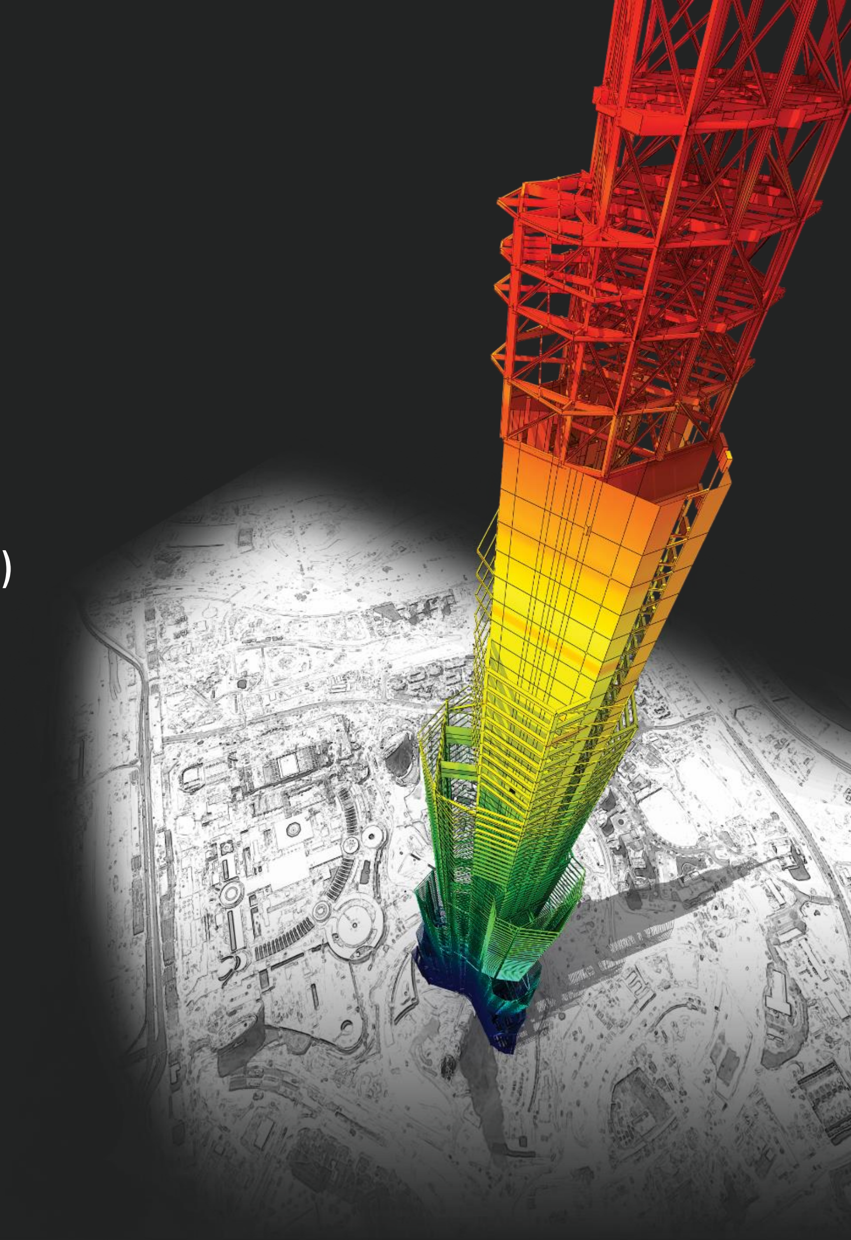
Release Note

Release Date : April. 2020

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



DESIGN OF General Structures

Integrated Design System for Building and General Structures *midas* ***Gen***

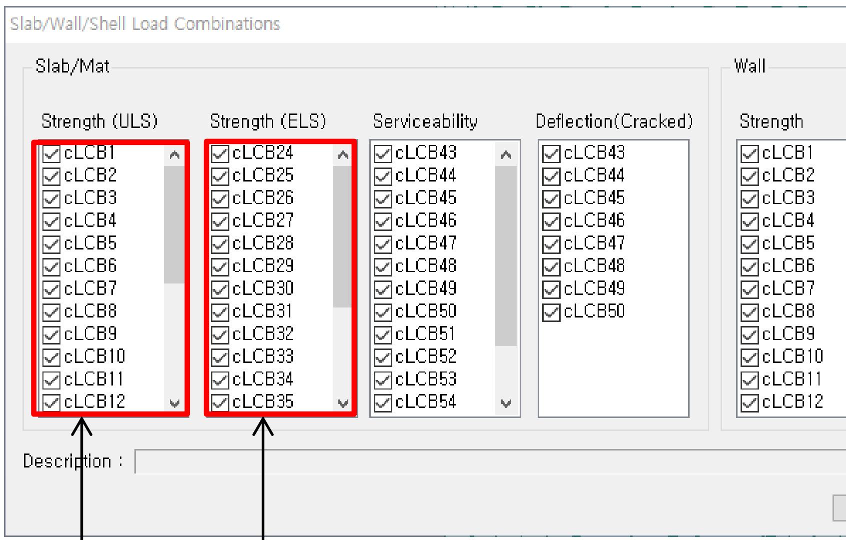
Enhancements

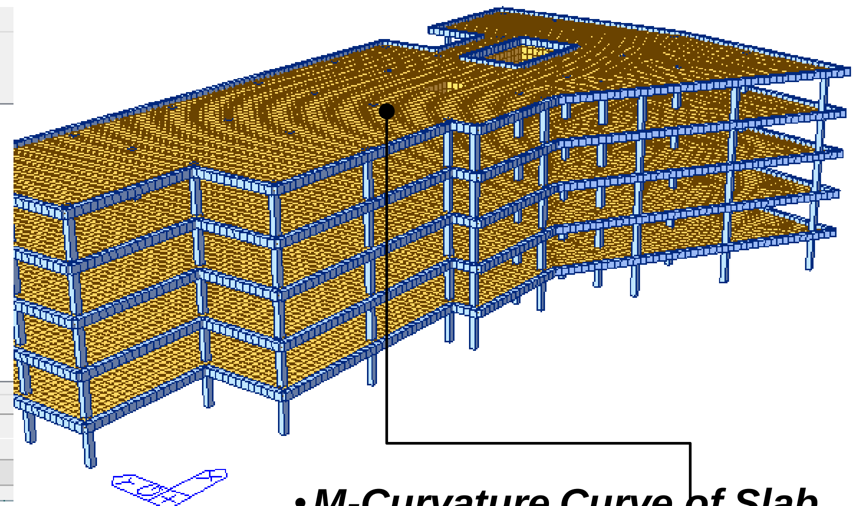
• midas Gen

• midas Design+

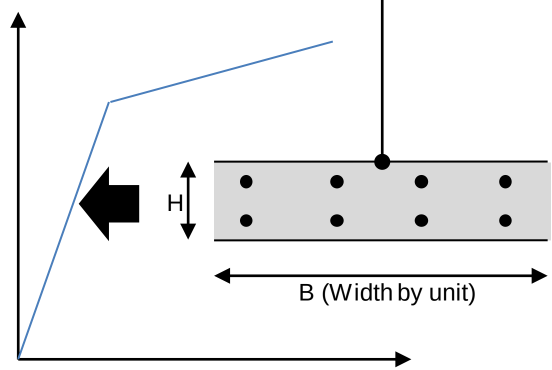
1. Non-dissipative element design for slab as per NTC2018

Add Non-dissipative element design for Slab.





- ***M-Curvature Curve of Slab***



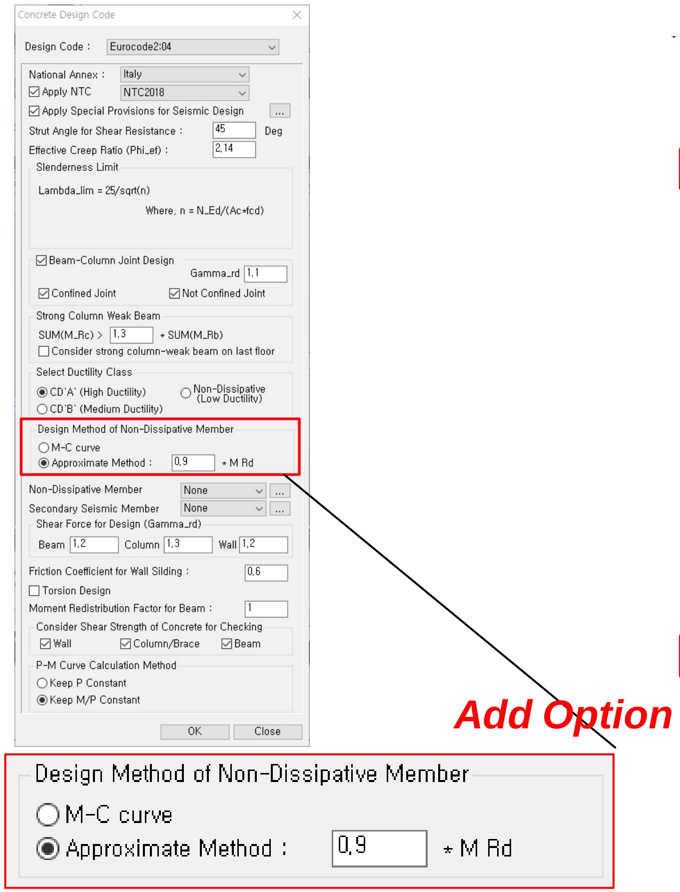
- ***Slab Design as Non-dissipative element***

Strength (ULS)
: Shear design uses only load Comb. Of Gravity loads

Strength (ELS) (Add)
: Flexural design uses only ELS load Comb..

2. Improvement of design Speed for Non-dissipative element

Improvement of design Speed for Non-dissipative element
→ Add Approximate Method



. Bending Moment Capacity

	END-I	MID	END-J
(-) Load Combination No.	21	21	5
Moment (M_Ed)	141604.88	59413.77	134663.44
Factored Strength (M_Rd)	152013.72	84276.96	123768.52
Check Ratio (M_Ed/M_Rd)	0.9315	0.7050	1.0880
Neutral Axis (x/d)	0.1670	0.1172	0.1445
(+) Load Combination No.	5	5	21
Moment (M_Ed)	99836.64	63882.84	96479.04
Factored Strength (M_Rd)	84427.01	84276.96	84489.36
Check Ratio (M_Ed/M_Rd)	1.1825	0.7580	1.1419
Neutral Axis (x/d)	0.1150	0.1172	0.1157

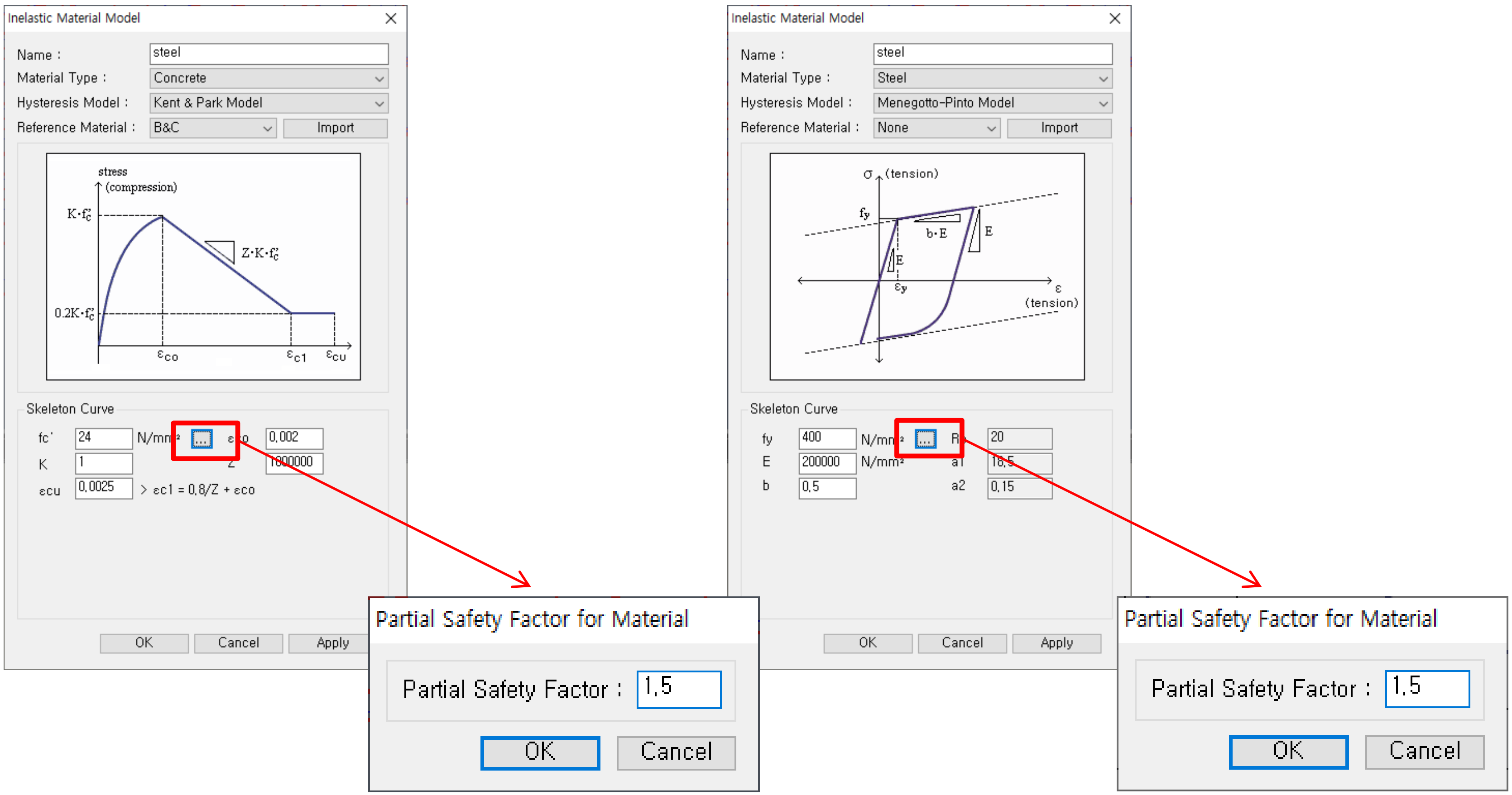
M_yd' = 0.9 * M_Rd

Elastic Bending Moment Capacity (for Non-Dissipative Element)

	END-I	MID	END-J
(-) Load Combination No.	53	53	37
Moment (M.Ed)	101482.80	38922.76	96260.94
Elastic Strength (M.yd')	143255.27	74502.94	112471.78
Check Ratio	0.7084	0.5224	0.8559
(+) Load Combination No.	37	37	53
Moment (M.Ed)	59714.55	43391.82	58076.53
Elastic Strength (M.yd')	74757.76	74502.94	74901.73
Check Ratio	0.7988	0.5824	0.7754

3. Apply partial safety factor in inelastic material model

Apply "Partial Safety Factor" in Inelastic Material Model



** Default : 1.0*

** Default : 1.0*

4. Add Column Design by Constant P

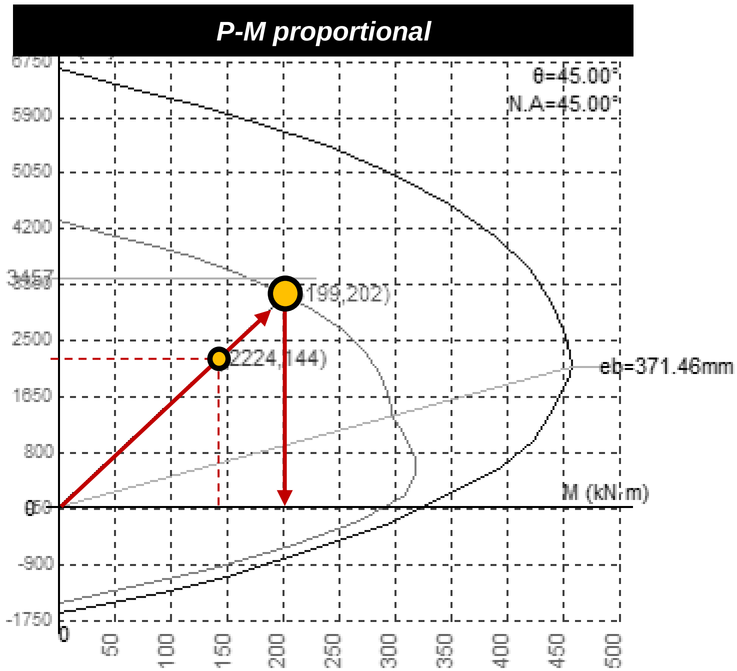
Add Column Design by Constant P

→ Add P-M Curve Calculation Method Option

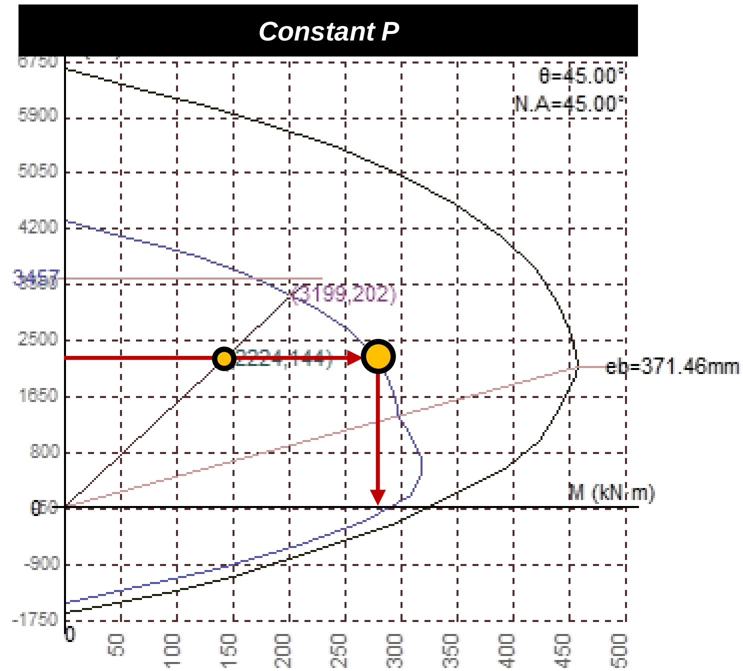
Add Option

P-M Curve Calculation Method

- (●) Keep P Constant
- ( ) Keep M/P Constant



Gen 2020 v1.1

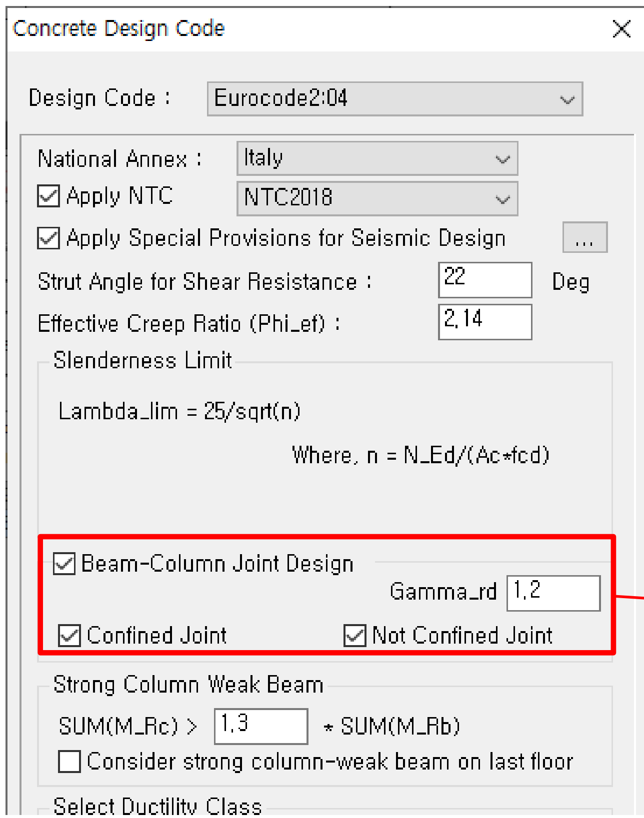


Gen 2020 v2.1

5. Improvement of Joint design as per EC2 and NTC

Joint Design as per EC and NTC

→ It is possible to skip a Joint design for "Not confined" condition



Add Option

5. Improvement of Joint design as per EC2 and NTC

Add Hoop Spacing of Joint in Design

Detail report

```
( ). Compute horizontal hoops
     -. Ash.req   =  Ash.req2 =        0.002 m^2.
     -. Legs      =  2
     -. Num       = 20
     -. Ash.use   = Av1*Legs*Num        =          0.003 m^2.
     -. Rat.Ash   = Ash.req / Ash.use   = 0.838  <   1.000  ---> O.K.

( ). Check space of horizontal hoops.
     -. sh.min = MAX[ Bar Dia, Gravel Dia, 20mm ] + Bar Dia =      0.0345 m.
     -. sh.use =       0.0308 m. < s.min ---> AN INCONGRUENT SPACING !!!
```

If applied spacing s < s,min, Printout "AN INCONGRUENT SPACING !!!" In Detail report

Design result table

nn Checking Result Dialog

Code : Eurocode2:04,NTC2018 Unit : kN , m

Sorted by: (•) Member ( ) Property — Results: (•) Strength ( ) Serviceability — Primary Sorting Option: ( ) SECT (•) MEMB

MEMB	SEL	Section		fck	fyk	CHK	LCB	V-Rebar	N_Rdmax	Uc	N_Ed	M_Edy	M_Edz	V_Rdc.end	V_Rds.end	V_Rdc.mid	V_Rds.mid	LCB	V_Ed.end	Rat-V.end	Ash.req
SECT		Bc	Hc	Height	fyw					Rat-Uc	Rat-N	Rat-My	Rat-Mz	Rat-Vc.end	Rat-Vs.end	Rat-Vc.mid	Rat-Vs.mid		V_Ed.mid	Rat-V.mid	Rat-J
253	☑	C1		24000.0	400000	J	4	26-7-D22	19339.7	0.019	267.920	579.245	7.40708	425.238	1134.57	431.760	1134.57	7	1082.58	0.954	0.00239
103		1.000	1.000	4.0000	400000					0.000	0.315	0.313	0.314	2.546	0.954	2.507	0.954	7	1082.58	0.954	0.838
335	☐	C1		24000.0	400000	J	6	26-7-D22	19339.7	0.012	81.5272	74.5034	11.2563	397.202	1134.57	403.725	1134.57	7	1027.76	0.906	0.00241
103		1.000	1.000	4.0000	400000					0.000	0.032	0.032	0.031	2.588	0.906	2.546	0.906	7	1027.76	0.906	0.845

Printout "J" in red color In Design result table

Graphic result

[JOINT]	y : 6 (I)	z : 6 (I)
Ash.req / Ash.use	0.00239 / 0.00285 = 0.838	0.00239 / 0.00285 = 0.838
Joint Ratio	0.838 < 1.000 .... O.K	0.838 < 1.000 .... O.K
Ash.jnt	Check Spacing	Check Spacing

Printout "Check Spacing" In graphic,

5. Improvement of Joint design as per EC2 and NTC

Joint Design as per EC and NTC

→ Improvement to check a hoop area and spacing in Joint design

Detail report

```
( ). Compute maximum spacing of ties/spirals.
     -. Smax  =    0.100 m. (Hoop spacing for shear)

( ). Compute horizontal shear force in local-z direction.
     ( LCB =    4,  POS = I )
     [ NTC2018, 7.4.4.3.1 ]
     -. Applied axial force       : Pu  =      798.87 kN.
     -. Applied shear force       : Vcz =       20.090 kN.
     -. Beam Top Reinforcement    : As1 =     0.0015 m^2.
     -. Beam Bottom Reinforcement : As2 =     0.0015 m^2.
     -. Gamma_rd = 1.2000
     ( Interior Column )
     -. Vjhdz = Gamma_rd * (As1+As2) * fyd - Vcz =      1248.863 kN.

( ). Check diagonal compression.
     [ NTC2018, 7.4.4.3.1 ]
     -. Eta  = 0.6 * (1-fck/250) = 0.5424
     -. Vjhd < Eta*fcd*sqrt(1-Nu_d/Eta)*bj*hjc =      6272.541 kN.
     -. Rat  = 0.199 < 1.0 ---> O.K!
```

```
( ). Compute horizontal hoops to limit the maximum diagonal tensile stress of concrete.
     [ NTC2018, 7.4.4.3.1 ]
     -. Nu_d      =    0.055
     -. fctd      =    1164.8469 KPa.
     -. fvj       = {Vjhd/(bj*hjc)}^2 / (fctd + Nu_d*fcd) =      1305.825 KPa.
     -. Ash.req.1 = (fvj-fctd)*bj*hjw/fywd              =    2.362e-004 m^2.

( ). Compute horizontal hoops to ensure integrity of the joint after diagonal cracking.
     [ NTC2018, 7.4.4.3.1 ]
     -. Gamma_rd  = 1.2000
     -. Beam Top Reinforcement    : As1 =     0.0015 m^2.
     -. Beam Bottom Reinforcement : As2 =     0.0015 m^2.
     -. Ash.req.2 = Gamma_rd*(As1+As2)*fyd*(1.0-0.8*Nu_d)/fywd =        0.003 m^2.

( ). Compute horizontal hoops
     -. Ash.req   =  MIN[ Ash.req1, Ash.req2 ] =    2.362e-004 m^2.
     -. Legs      =  2
     -. Num       =  12
     -. Ash.use   =  Av1*Legs*Num       =       0.002 m^2.
     -. Rat.Ash   =  Ash.req / Ash.use  = 0.138  <  1.000  ---> O.K.

( ). Check space of horizontal hoops.
     -. sh.min = MAX[ Bar Dia, Gravel Dia, 20mm ] + Bar Dia =      0.0345 m.
     -. sh.use =      0.0498 m. > s.min ---> O.K.
```

Design result table

Eurocode2:04 RC-Column Checking Result Dialog

Code : Eurocode2:04,NTC2018 Unit : kN , m

Sorted by: (•) Member ( ) Property — Results: (•) Strength ( ) Serviceability — Primary Sorting Option: ( ) SECT (•) MEMB

MEMB	SEL	Section		fck	fyk	CHK	LCB	V-Rebar	N_Rdmax	Uc	N_Ed	M_Edy	M_Edz	V_Rdc.end	V_Rds.end	V_Rdc.mid	V_Rds.mid	LCB	V_Ed.end	Rat-V.end	Ash.req
SECT		Bc	Hc	Height	fyw					Rat-Uc	Rat-N	Rat-My	Rat-Mz	Rat-Vc.end	Rat-Vs.end	Rat-Vc.mid	Rat-Vs.mid		V_Ed.mid	Rat-V.mid	Rat-J
80	☑	C2		24000.0	400000	OK	7	24-7-D22	17482.8	0.056	802.368	718.331	179.889	445.291	1021.12	451.896	1021.12	7	971.662	0.952	0.00116
202		0.900	1.000	4.5000	400000					0.000	0.363	0.358	0.342	2.182	0.952	2.150	0.952	7	971.662	0.952	0.679

Graphic result

[JOINT]	y : 6 (I)	z : 4 (I)
Ash.req / Ash.use	0.00116 / 0.00171 = 0.679	0.00024 / 0.00171 = 0.138
Joint Ratio	0.679 < 1.000 .... O.K	0.138 < 1.000 .... O.K
Ash.jnt	2-12 D10	2-12 D10

6. Improvement of slab design as per EC2 and NTC

Add “Check ratio of x/d” and “Check Stress by Quasi-permanent Load combinations”

Check x/d as per NTC2018 4.1.2.1.2.1

```
<< BOTTOM >>

-. Information of Parameters.
   Elem No.   : 52
   Thickness :    0.3000 m.
   Materials :  fck =    1631.5459 tonf/m^2.
                fcd =    1087.6973 tonf/m^2.
                fyk =   40788.6485 tonf/m^2.
   Covering   :  dB  =    0.0750 m.
                dT  =    0.0750 m.
   LCB No.    :     1

-. Information of Design.
   b          =   0.0010 m.  (by Code Unit Length).
   d          =   0.2250 m.
   lambda     =   0.800
   a          = lambda * x  =   0.021 m.
   eta        =   1.000
   Cc         = eta*fcd*b*a =      0.0233 tonf.
   M_Rd       = Cc*(d-a/2)  =       4.9982  tonf-m./m.

-. Information of Moments and Result.
   Rein. Bar :  D16 @300
   As_req =       0.0003 m^2/m.  (       0.0003 m^2/m.)
   M_Ed    =        1.6544  tonf-m./m.
   M_Rd    =        4.9982  tonf-m./m.
   RatM    = M_Ed / M_Rd =    0.331  <  1.0  --->  0.K !

-. Check ratio of neutral axis depth to effective depth.
   x/d         =    0.053
   Limit(x/d)  =    0.450  ( fck <= 50 MPa.)
   x/d ratio   =    0.053/    0.450 =    0.118  --->  0.K
```

4.1.2.1.2.1.

Per le travi continue, le travi di telai in cui possono essere trascurati gli effetti del secondo ordine e le solette, il rapporto x/d nelle sezioni critiche non deve comunque superare il valore 0,45 per $f_{ck} \leq 50$ MPa e 0,35 per $f_{ck} > 50$ MPa.

Add stress check by Quasi-permanent

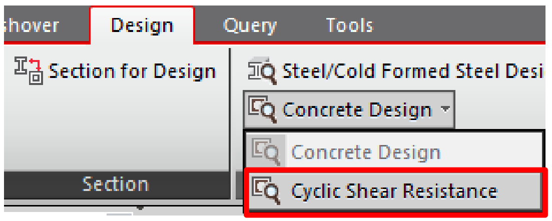
```
<< TOP >>

-. Information of Parameters.
   Elem No.  : 91
   LCB No.   :   44
   Materials :  fck =    1631.5459 tonf/m^2.
                fyk =   40788.6485 tonf/m^2.
   Thickness :     0.3000 m.
   Covering  :  dB  =    0.0750 m.
                dT  =    0.0750 m.

-. Information of Checking.
   gamma_c  =   1.500  (for Concrete)
   gamma_s  =   1.150  (for Reinforcement)
   fcd      = fck / gamma_c =  1087.69729 tonf/m^2.
   fyd      = fyk / gamma_s = 35468.39002 tonf/m^2.
   b        =   0.0010 m.  (by Code Unit Length).
   d        =   0.2250 m.
   As_use   =       0.0007 m^2/m.  (       0.0007 m^2/m.)

-. Information of Stress Checking Result.
   k1      =     0.60000
   k2      =     0.45000
   k3      =     0.80000

  ( Assumed Uncracked Section )
   M_Ed    =         3.95  tonf-m./m.
   n       =    13.98215( Long Term ).
   fctm    = 0.30 * fck^(2/3)       =   194.24383 tonf/m^2.
   fr1     = (1.6 - H/1000) * fctm  =   252.51698 tonf/m^2.
   fctm,fl= MAX[ fctm, fr1 ]        =   252.51698 tonf/m^2.
   ybar_t =       0.15209 m.
   Iyy     =      0.00230  m^4./m.
   Ss_con (Tens.) = M_Ed*(H-ybar_t)/Iyy =   254.61148 tonf/m^2.
   Ss_con (Tens.) > fctm,fl              ---> Check Cracked Section !!!

  [ Dead Load Cases ]
  M_Ed_D  =         2.56  tonf-m./m.
  n       =    13.98215( Long Term ).
  X       =       0.056 m.
  Icr     =        0.0003  m^4./m.
  ybar_t  =       0.056 m.
  Ss_conD = M_Ed_D*ybar_t/Icr        =   442.81327 tonf/m^2.
  Ss_stlD = M_Ed_D*(d-ybar_t)*n/Icr = 18688.77997 tonf/m^2.

  [ Live Load Cases : Quasi-permanent ]
  M_Ed_L  =         0.03  tonf-m./m.
  n       =    13.98215( Long Term ).
  X       =       0.056 m.
  Icr     =        0.0003  m^4./m.
  ybar_t  =       0.056 m.
  Ss_conL = M_Ed_L*ybar_t/Icr        =     4.84833 tonf/m^2.
  Ss_stlL = M_Ed_L*(d-ybar_t)*n/Icr =   204.62213 tonf/m^2.

  [ Etc. Load Cases ]
  M_Ed_E  =         1.37  tonf-m./m.
  n       =     6.99107( Short Term ).
  X       =       0.041 m.
  Icr     =        0.0002  m^4./m.
  ybar_t  =       0.041 m.
  Ss_conE = M_Ed_E*ybar_t/Icr        =   313.84428 tonf/m^2.
  Ss_stlE = M_Ed_E*(d-ybar_t)*n/Icr =  9765.27236 tonf/m^2.

  Ss_con  = Ss_conD + Ss_conL + Ss_conE =   761.50587 tonf/m^2.
  Ss_stl  = Ss_stlD + Ss_stlL + Ss_stlE = 28658.67446 tonf/m^2.
  Ss_con > k2*fck =   734.19567 tonf/m^2.   ---> Not Acceptable !!!
  Ss_stl < k3*fyk = 32630.91882 tonf/m^2.   ---> 0.K !
```


```
[ Live Load Cases : Quasi-permanent ]
M_Ed_L  =         0.03  tonf-m./m.
n       =    13.98215( Long Term ).
X       =       0.056 m.
Icr     =        0.0003  m^4./m.
ybar_t  =       0.056 m.
Ss_conL = M_Ed_L*ybar_t/Icr        =     4.84833 tonf/m^2.
Ss_stlL = M_Ed_L*(d-ybar_t)*n/Icr =   204.62213 tonf/m^2.

[ Etc. Load Cases ]
M_Ed_E  =         1.37  tonf-m./m.
n       =     6.99107( Short Term ).
X       =       0.041 m.
Icr     =        0.0002  m^4./m.
ybar_t  =       0.041 m.
Ss_conE = M_Ed_E*ybar_t/Icr        =   313.84428 tonf/m^2.
Ss_stlE = M_Ed_E*(d-ybar_t)*n/Icr =  9765.27236 tonf/m^2.

Ss_con  = Ss_conD + Ss_conL + Ss_conE =   761.50587 tonf/m^2.
Ss_stl  = Ss_stlD + Ss_stlL + Ss_stlE = 28658.67446 tonf/m^2.
Ss_con > k2*fck =   734.19567 tonf/m^2.   ---> Not Acceptable !!!
Ss_stl < k3*fyk = 32630.91882 tonf/m^2.   ---> 0.K !
```

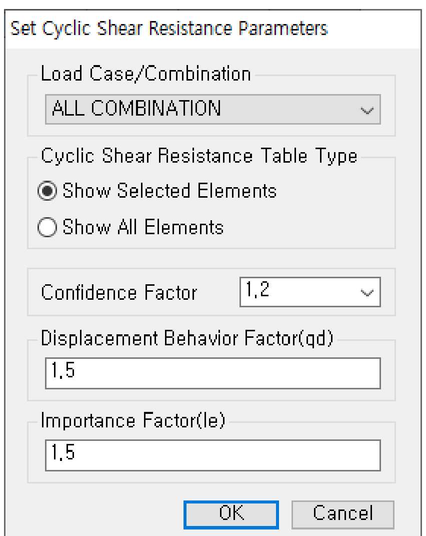
7. Cyclic shear resistance check as per NTC2018

Check of Cyclic shear Resistance as per NTC2018 in Existing RC building

- ULS Design



Set Cyclic Shear Resistance Parameters



Result Table for Cyclic shear Resistance checking

Elem	Location	Seismic Element	Load	Cyclic Shear Resistance					
				VRy			VRz		
				Demand	Capacity	Remark	Demand	Capacity	Remark
353	I-end	Primary	ALL COMB	18.0504	496.6250	OK	25.3188	430.5590	OK
353	J-end	Primary	ALL COMB	18.0504	382.5840	OK	25.3188	285.4860	OK

Confidence Factor = 1.20, qd = 1.50, Ie = 1.50

Press right mouse button and click 'Set Cyclic Shear Resistance Parameters' menu to change Load Case/Combination/Confidence Factor/Displacement Behavior Factor/Importance Factor

Demand : Design Shear Force

Capacity : Vr by Equation below

$$V_R = \frac{1}{\gamma_{el}}\left[\frac{h-x}{2L_V}\min(N;\, 0{,}55A_c f_c) + \left(1 - 0{,}05\min(5;\, \mu_\Delta^{pl})\right)\cdot\left[0{,}16\max(0{,}5;\, 100\rho_{tot})\left(1 - 0{,}16\min\left(5;\, \frac{L_V}{h}\right)\right)\sqrt{f_c}A_c + V_w\right]\right]$$

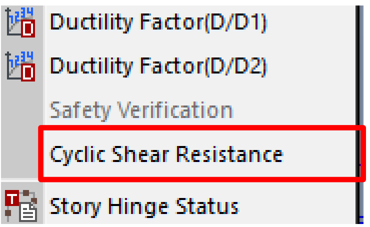
Demand ≤ Capacity → O.K

Demand > Capacity → N.G.

7. Cyclic shear resistance check as per NTC2018

Check of Cyclic shear Resistance as per NTC2018 in Existing RC building

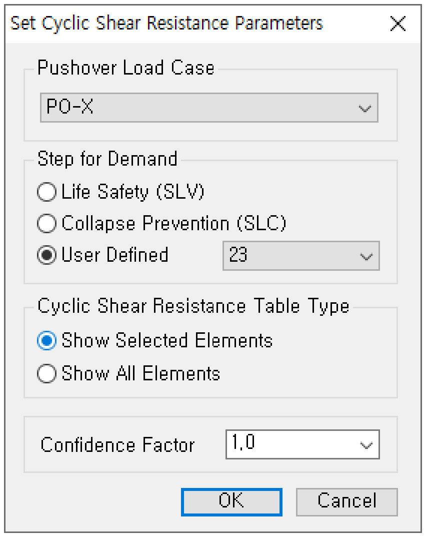
- Result of Pushover Analysis



Result Table for Cyclic shear Resistance checking

Elem	Location	Seismic Element	Load	Cyclic Shear Resistance VRy Demand	VRy Capacity	VRy Remark	VRz Demand	VRz Capacity	VRz Remark
Step for Demand = USER (Step 23), Confidence factor = 1.00									
Press right mouse button and click 'Set Cyclic Shear Resistance Parameters' menu to change step or loadcase									
95	I-end	Primary	PO-X	42166.900	137079.00	OK	3501.6800	149689.00	OK
95	J-end	Primary	PO-X	42166.900	147994.00	OK	3501.6800	136127.00	OK

Set Cyclic Shear Resistance Parameters



Demand : Shear Force in Step n

Capacity : Vr by Equation below

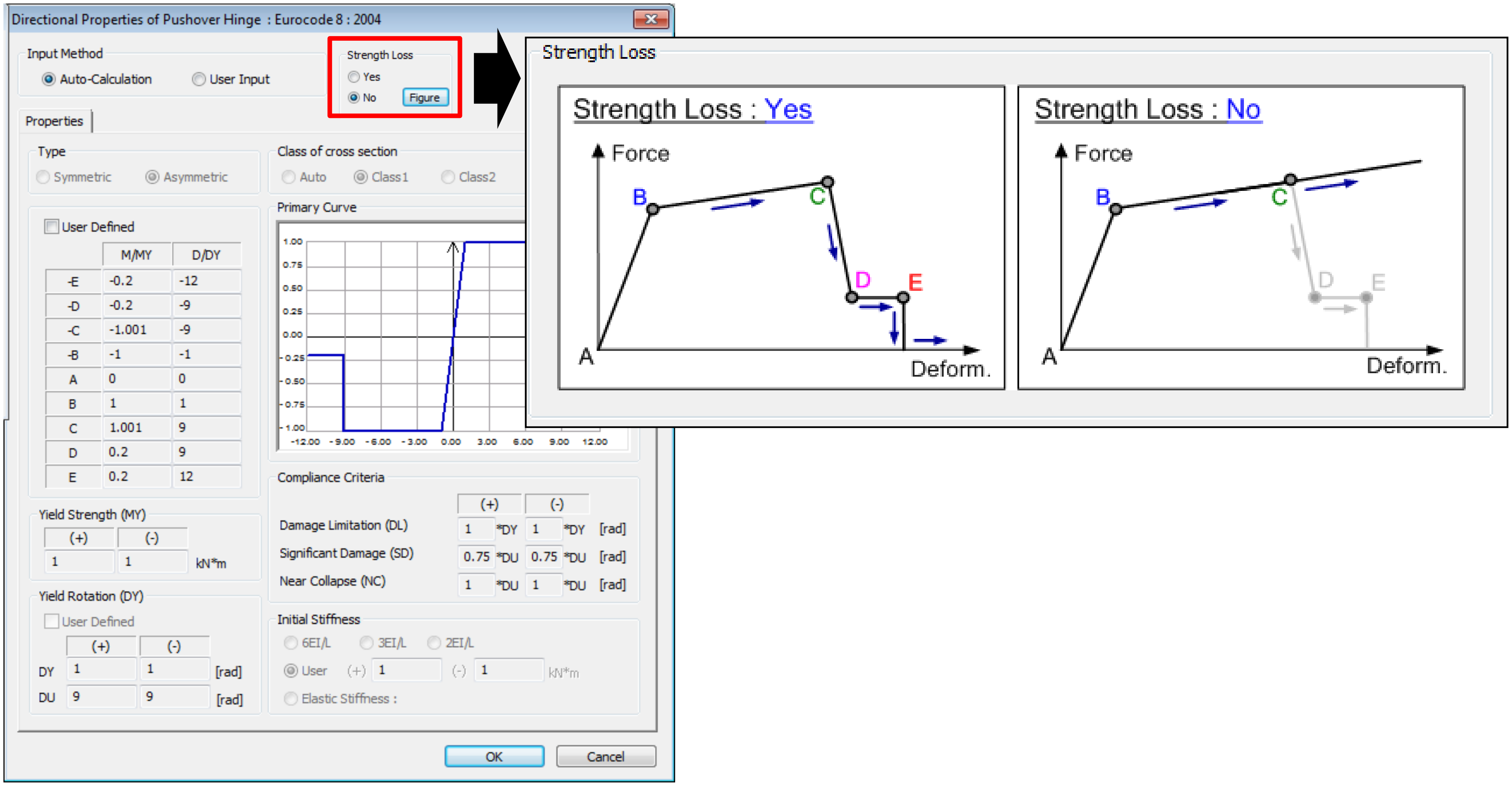
$$V_R = \frac{1}{\gamma_{el}}\left[\frac{h-x}{2L_V}\min(N;0{,}55A_c f_c)+\left(1-0{,}05\min(5;\mu_\Delta^{pl})\right)\cdot\left[0{,}16\max(0{,}5;100\rho_{tot})\left(1-0{,}16\min\left(5;\frac{L_V}{h}\right)\right)\sqrt{f_c}A_c+V_w\right]\right]$$

Demand ≤ Capacity → O.K

Demand > Capacity → N.G.

8. Insert strength loss option for EC8 hinge type

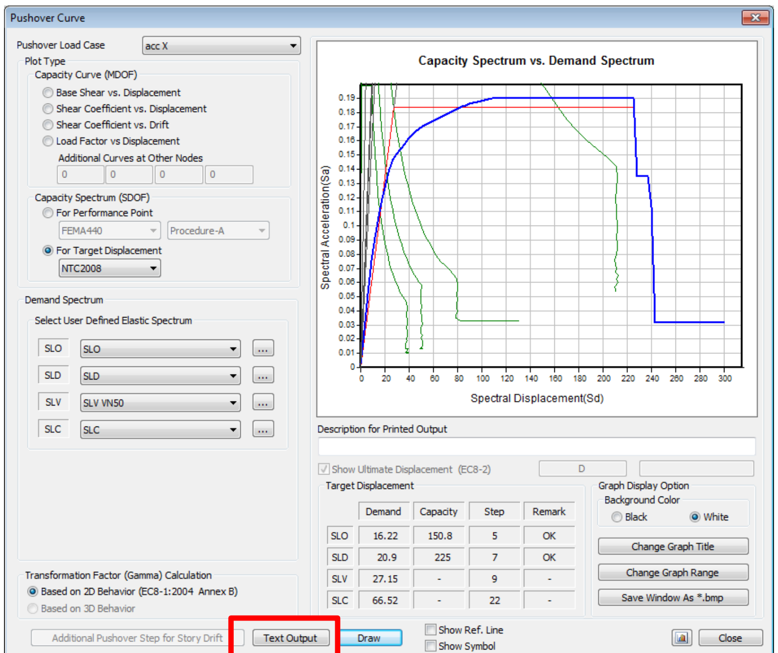
Insert Strength loss option for EC8 hinge type



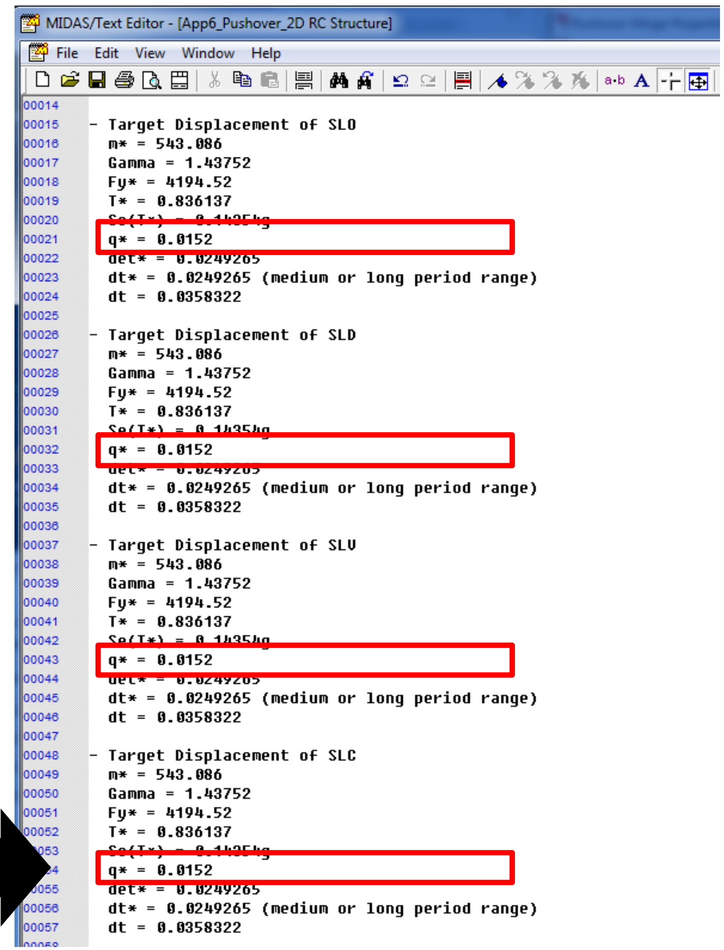
9. Improvement about masonry pushover analysis and post processing

Improvement about Masonry pushover analysis and post processing

→ Add "q" in Text Output*

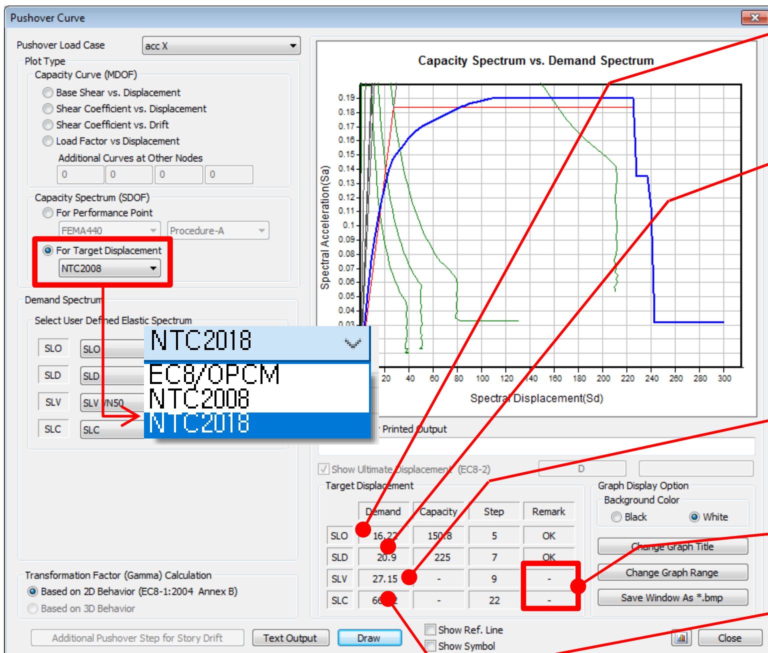


$$q^* = \frac{S_{Ae}(T^*)m^*}{F_y^*}$$



9. Improvement about masonry pushover analysis and post processing

Target Displacement Capacity of SLV and SLC in Masonry



SLO

Displacement of limit elastic dSLD x 2/3

SLD

Capacity of SLD
= Min.Displacement of Ve and ¾ Vu

*Ve = max shear of bilinear
*Vu = max shear of MDOF curve

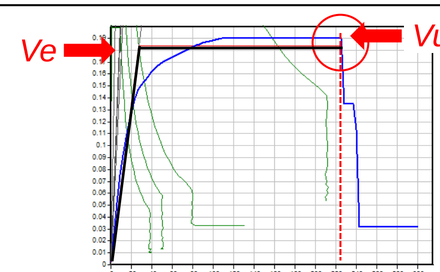
SLV

Last displacement of bilinear x 3/4

Add Remark here

SLC

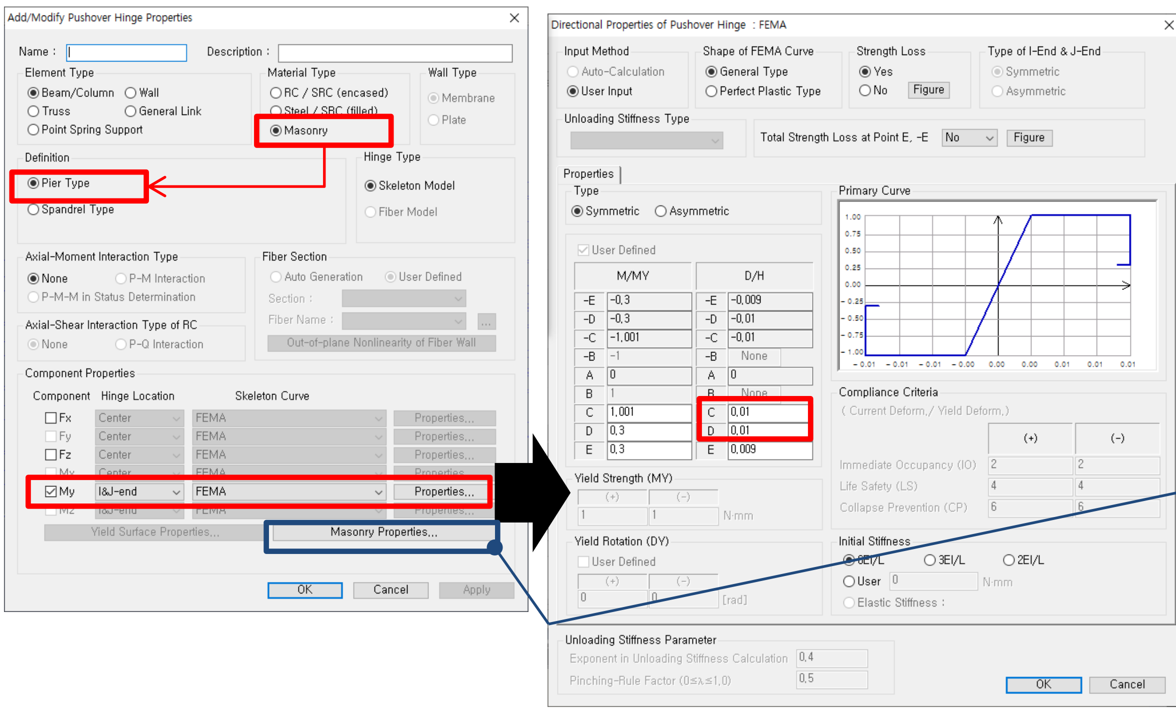
Last displacement of bilinear x gamma



9. Improvement about masonry pushover analysis and post processing

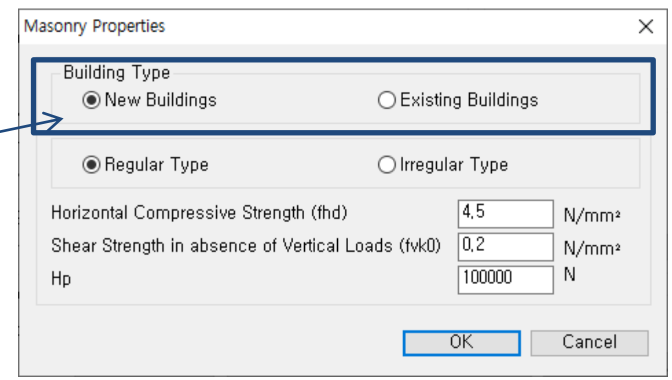
Updating My Masonry Pier hinge Type

→ Masonry > Pier Type



Values of D/H

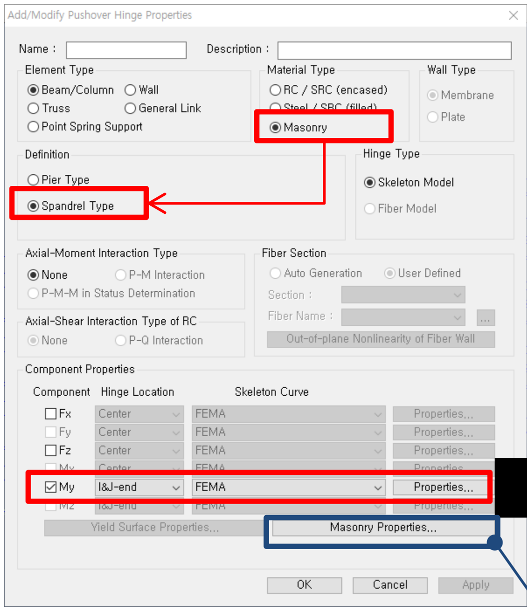
Point	New Building	Existing Building
C	0.01	0.01
D	0.01	0.01

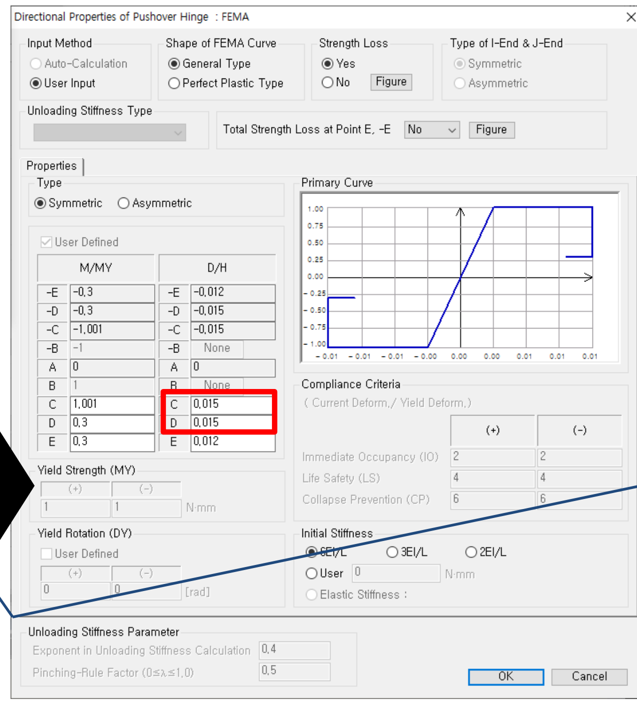


9. Improvement about masonry pushover analysis and post processing

Updating My Masonry Pier hinge Type

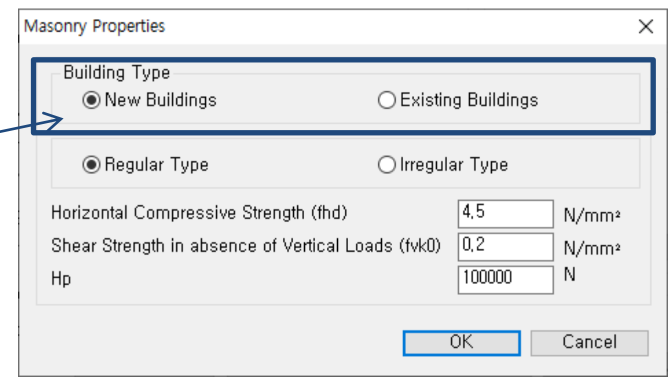
→ Masonry > Spandrel Type





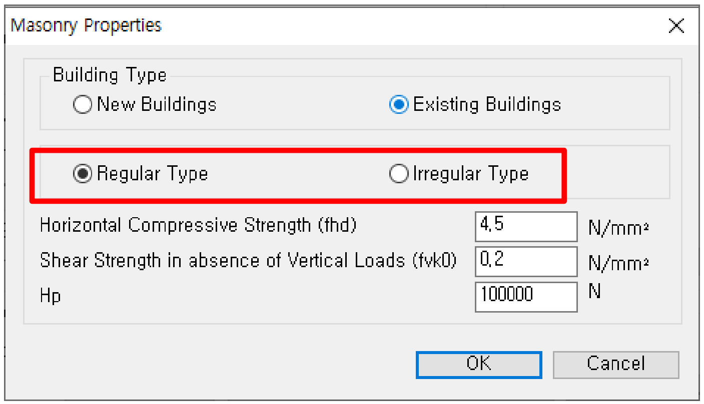
Values of D/H

Point	New Building	Existing Building
C	0.008	0.015
D	0.008	0.015



9. Improvement about masonry pushover analysis and post processing

Updating Fy Masonry Spandrel hinge Type



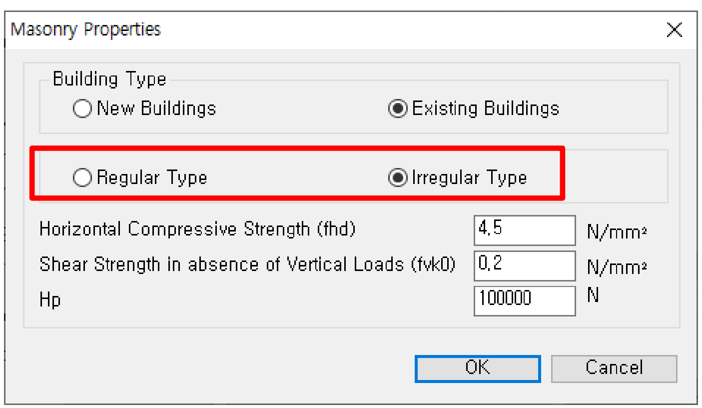
Shear Resistance =

Min. [$V_t = htf_{vko}, V_p = 2M_u/l$]

where $M_u = \frac{H_p \cdot h}{2}\left(1 - \frac{H_p}{0.85 \cdot f_{hd} \cdot h \cdot t}\right)$

Where,

$$H_p \begin{cases} i)\ 0.4 \cdot f_{hd} \cdot h \cdot t \\ ii)\ H_p : \text{User Defined Value} \\ \quad \text{minium value} \end{cases}$$



Shear Resistance =

Min. [$V_t = LT1.5f_{vko}/\beta \times \sqrt{1 + P/1.5f_{vko}}, V_p = 2M_u/l$]

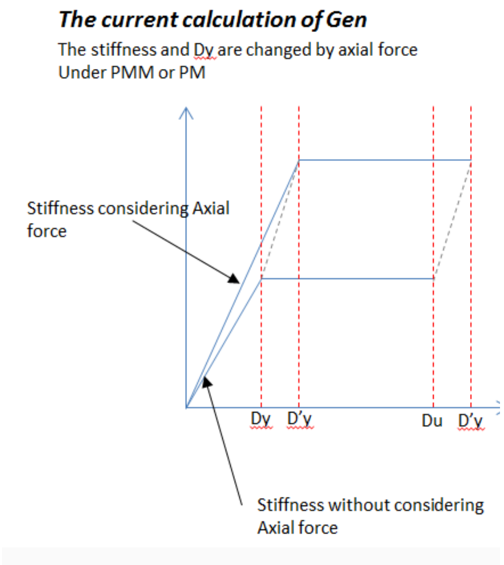
where

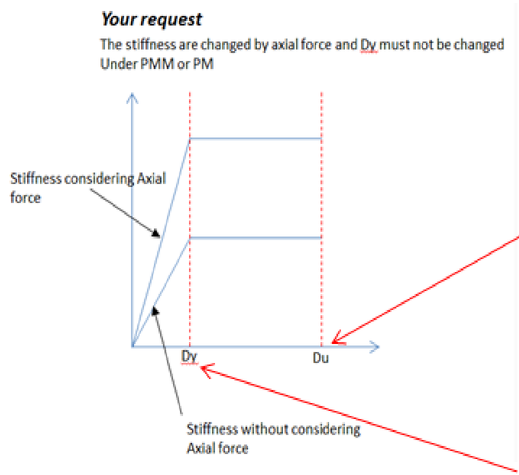
$$\beta \begin{cases} = 1.5\ ;\ 1.5 \le H/L \\ = H/L\ ;\ 1.0 < H/L < 1.5 \\ = 1.0\ ;\ H/L \le 1.0 \end{cases}$$

10. Improvement of hinge model as per EC

Improvement of Hinge model as per EC

Old version	New version





DU = Update step by step by follow formulas:

$$\theta_u = \frac{1}{\gamma_{el}} 0{,}016 (0{,}3^{\nu}) \left[\frac{\max(0{,}01; \omega')}{\max(0{,}01; \omega)} f_c \right]^{0{,}225} \left(\frac{L_v}{h} \right)^{0{,}35} 25^{\left(\alpha \rho_{sx} \frac{f_{yw}}{f_c} \right)} 1{,}25^{100 \rho_d}$$

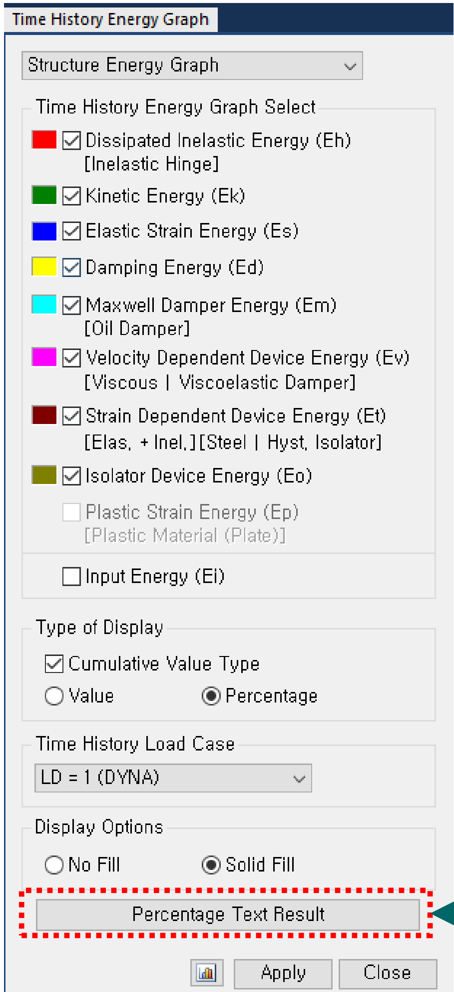
DY = constant value throughout the analysis (do not update) and calculated according to:

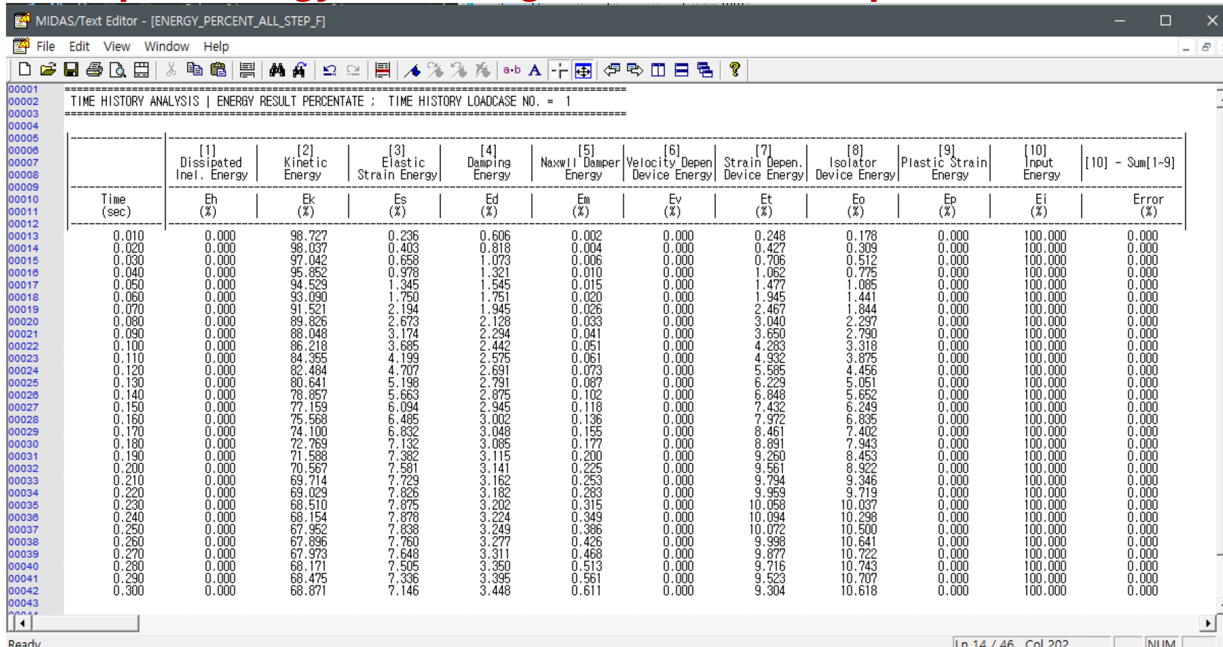
Phi_y = **k***Epsilon_y/D

	k				
	rectangular section			circular section	
hinge type	column	beam	wall	column	beam
none	2.1	1.7	2	2.25	-
PM e PMM	2.1	1.7	2	2.25	-
Displacemet based Seismic Design of Structures- pg 165					
Priestley; Calvi; Kowalsky					

11. Energy result graph & additional damping ratio in time-history analysis results

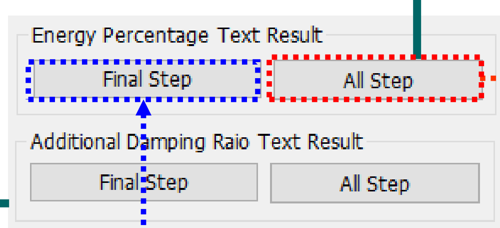
Improvement of Energy Result Graph : Energy Percentage Result of all step





TIME HISTORY ANALYSIS | ENERGY RESULT PERCENTATE ; TIME HISTORY LOADCASE NO. = 1

	[1] Dissipated Inel. Energy	[2] Kinetic Energy	[3] Elastic Strain Energy	[4] Damping Energy	[5] Naxwll Damper Energy	[6] Velocity Depen Device Energy	[7] Strain Depen. Device Energy	[8] Isolator Device Energy	[9] Plastic Strain Energy	[10] Input Energy	[10] - Sum[1~9]
Time (sec)	Eh (%)	Ek (%)	Es (%)	Ed (%)	Em (%)	Ev (%)	Et (%)	Eo (%)	Ep (%)	Ei (%)	Error (%)
0.010	0.000	98.727	0.236	0.606	0.002	0.000	0.248	0.178	0.000	100.000	0.000
0.020	0.000	98.037	0.403	0.818	0.004	0.000	0.427	0.309	0.000	100.000	0.000
0.030	0.000	97.042	0.658	1.073	0.006	0.000	0.706	0.512	0.000	100.000	0.000
0.040	0.000	95.852	0.978	1.321	0.010	0.000	1.062	0.775	0.000	100.000	0.000
0.050	0.000	94.529	1.345	1.545	0.015	0.000	1.477	1.085	0.000	100.000	0.000
0.060	0.000	93.090	1.750	1.751	0.020	0.000	1.945	1.441	0.000	100.000	0.000
0.070	0.000	91.521	2.194	1.945	0.026	0.000	2.467	1.844	0.000	100.000	0.000
0.080	0.000	89.826	2.673	2.128	0.033	0.000	3.040	2.297	0.000	100.000	0.000
0.090	0.000	88.048	3.174	2.294	0.041	0.000	3.650	2.790	0.000	100.000	0.000
0.100	0.000	86.218	3.685	2.442	0.051	0.000	4.283	3.318	0.000	100.000	0.000
0.110	0.000	84.355	4.199	2.575	0.061	0.000	4.932	3.875	0.000	100.000	0.000
0.120	0.000	82.484	4.707	2.691	0.073	0.000	5.585	4.456	0.000	100.000	0.000
0.130	0.000	80.641	5.198	2.791	0.087	0.000	6.229	5.051	0.000	100.000	0.000
0.140	0.000	78.857	5.663	2.875	0.102	0.000	6.848	5.652	0.000	100.000	0.000
0.150	0.000	77.159	6.094	2.945	0.118	0.000	7.432	6.249	0.000	100.000	0.000
0.160	0.000	75.568	6.485	3.002	0.136	0.000	7.972	6.835	0.000	100.000	0.000
0.170	0.000	74.100	6.832	3.048	0.155	0.000	8.461	7.402	0.000	100.000	0.000
0.180	0.000	72.769	7.132	3.085	0.177	0.000	8.891	7.943	0.000	100.000	0.000
0.190	0.000	71.588	7.382	3.115	0.200	0.000	9.260	8.453	0.000	100.000	0.000
0.200	0.000	70.567	7.581	3.141	0.225	0.000	9.561	8.922	0.000	100.000	0.000
0.210	0.000	69.714	7.729	3.162	0.253	0.000	9.794	9.346	0.000	100.000	0.000
0.220	0.000	69.029	7.826	3.182	0.283	0.000	9.959	9.719	0.000	100.000	0.000
0.230	0.000	68.510	7.875	3.202	0.315	0.000	10.058	10.037	0.000	100.000	0.000
0.240	0.000	68.154	7.878	3.224	0.349	0.000	10.094	10.298	0.000	100.000	0.000
0.250	0.000	67.952	7.838	3.249	0.386	0.000	10.072	10.500	0.000	100.000	0.000
0.260	0.000	67.896	7.760	3.277	0.426	0.000	9.998	10.641	0.000	100.000	0.000
0.270	0.000	67.973	7.648	3.311	0.468	0.000	9.877	10.722	0.000	100.000	0.000
0.280	0.000	68.171	7.505	3.350	0.513	0.000	9.716	10.743	0.000	100.000	0.000
0.290	0.000	68.475	7.336	3.395	0.561	0.000	9.523	10.707	0.000	100.000	0.000
0.300	0.000	68.871	7.146	3.448	0.611	0.000	9.304	10.618	0.000	100.000	0.000



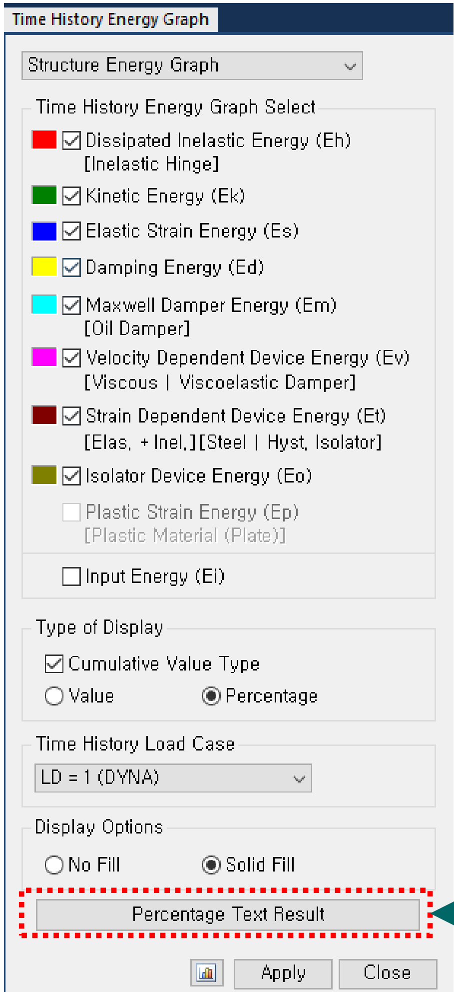
[New] Energy Percentage Result of all step

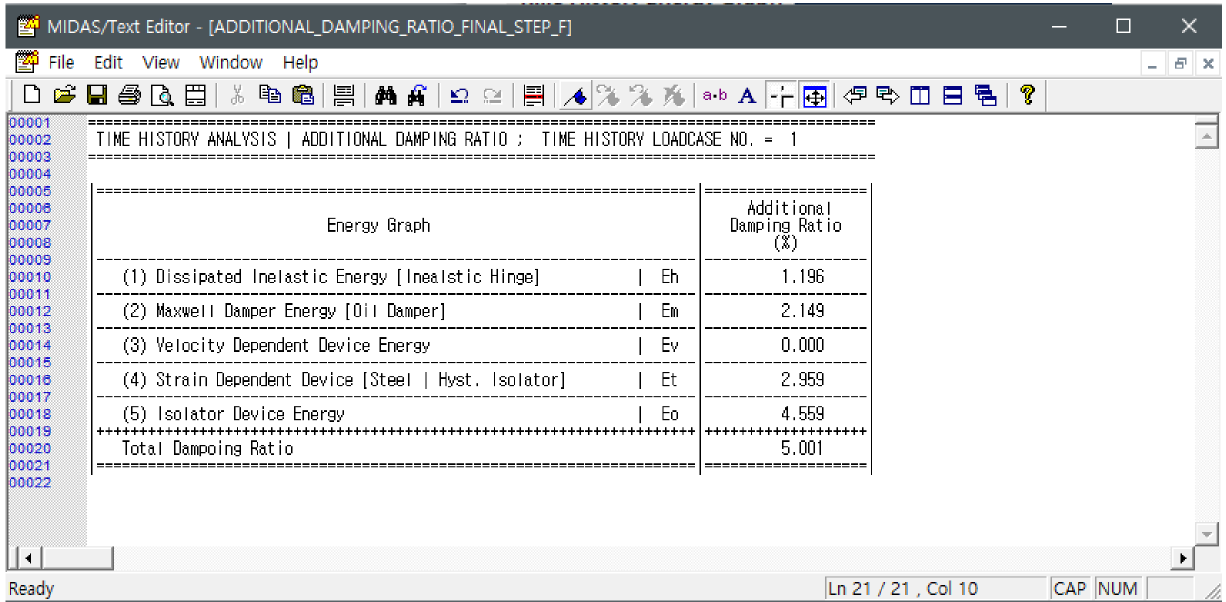
→ Click to display text window

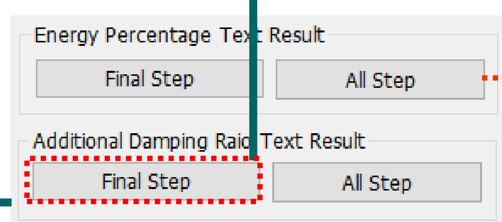
[Exiting] Energy Percentage Final Step Result

11. Energy result graph & additional damping ratio in time-history analysis results

Add Additional Damping Ratio of Energy Dissipation System





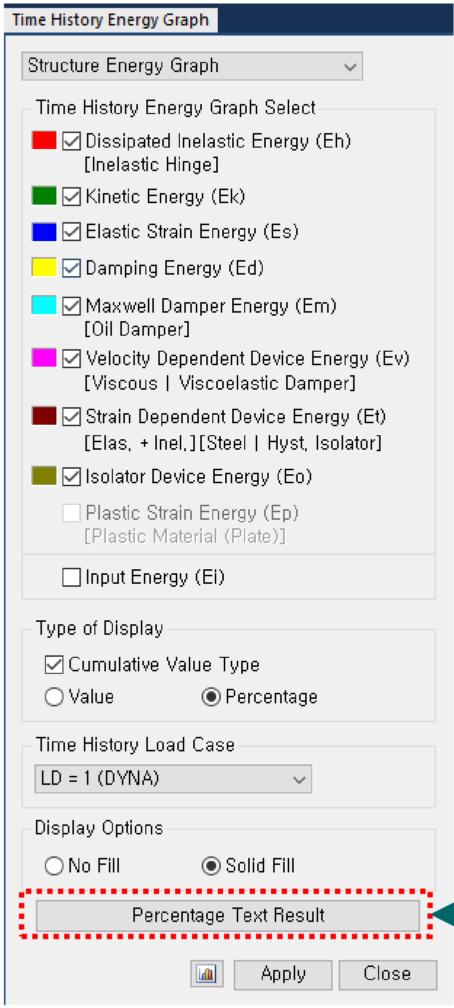


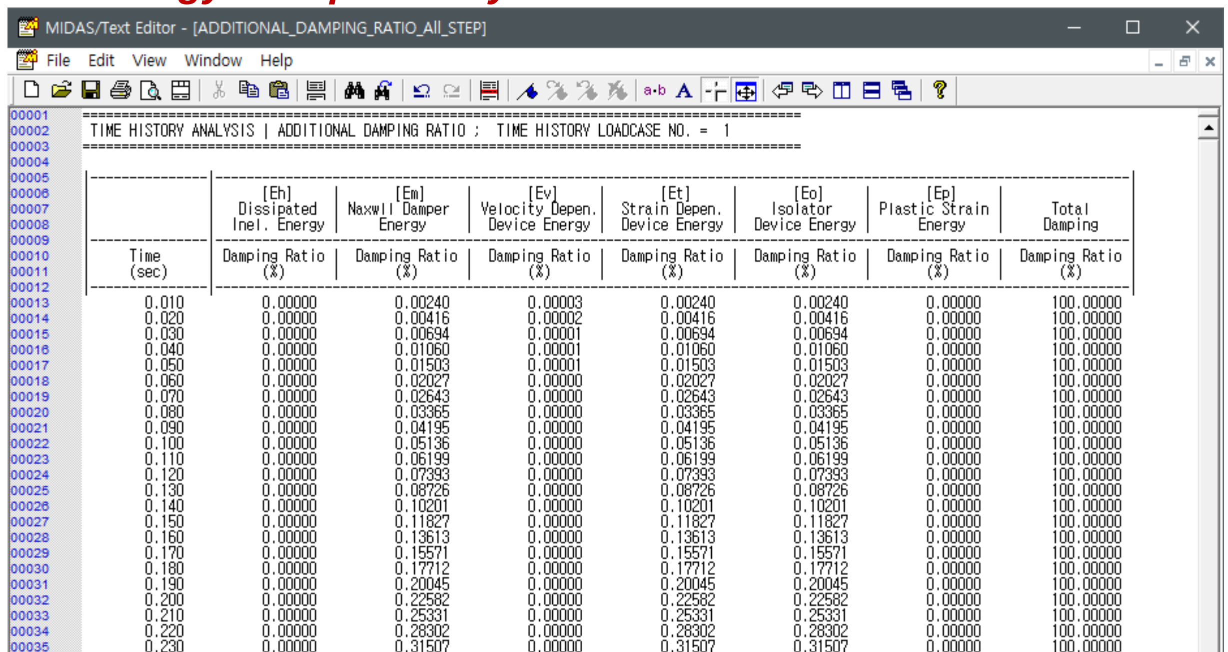
[New] Additional Damping Ratio Result of final step

→ Click to display text window

11. Energy result graph & additional damping ratio in time-history analysis results

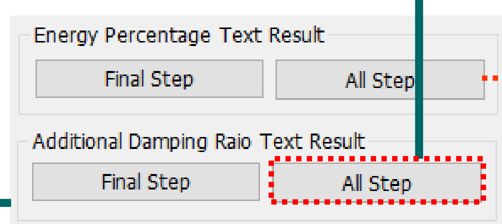
Add Additional Damping Ratio of Energy Dissipation System





TIME HISTORY ANALYSIS | ADDITIONAL DAMPING RATIO ; TIME HISTORY LOADCASE NO. = 1

Time (sec)	[Eh] Dissipated Inel. Energy Damping Ratio (%)	[Em] Naxwll Damper Energy Damping Ratio (%)	[Ev] Velocity Depen. Device Energy Damping Ratio (%)	[Et] Strain Depen. Device Energy Damping Ratio (%)	[Eo] Isolator Device Energy Damping Ratio (%)	[Ep] Plastic Strain Energy Damping Ratio (%)	Total Damping Damping Ratio (%)
0.010	0.00000	0.00240	0.00003	0.00240	0.00240	0.00000	100.00000
0.020	0.00000	0.00416	0.00002	0.00416	0.00416	0.00000	100.00000
0.030	0.00000	0.00694	0.00001	0.00694	0.00694	0.00000	100.00000
0.040	0.00000	0.01060	0.00001	0.01060	0.01060	0.00000	100.00000
0.050	0.00000	0.01503	0.00001	0.01503	0.01503	0.00000	100.00000
0.060	0.00000	0.02027	0.00000	0.02027	0.02027	0.00000	100.00000
0.070	0.00000	0.02643	0.00000	0.02643	0.02643	0.00000	100.00000
0.080	0.00000	0.03365	0.00000	0.03365	0.03365	0.00000	100.00000
0.090	0.00000	0.04195	0.00000	0.04195	0.04195	0.00000	100.00000
0.100	0.00000	0.05136	0.00000	0.05136	0.05136	0.00000	100.00000
0.110	0.00000	0.06199	0.00000	0.06199	0.06199	0.00000	100.00000
0.120	0.00000	0.07393	0.00000	0.07393	0.07393	0.00000	100.00000
0.130	0.00000	0.08726	0.00000	0.08726	0.08726	0.00000	100.00000
0.140	0.00000	0.10201	0.00000	0.10201	0.10201	0.00000	100.00000
0.150	0.00000	0.11827	0.00000	0.11827	0.11827	0.00000	100.00000
0.160	0.00000	0.13613	0.00000	0.13613	0.13613	0.00000	100.00000
0.170	0.00000	0.15571	0.00000	0.15571	0.15571	0.00000	100.00000
0.180	0.00000	0.17712	0.00000	0.17712	0.17712	0.00000	100.00000
0.190	0.00000	0.20045	0.00000	0.20045	0.20045	0.00000	100.00000
0.200	0.00000	0.22582	0.00000	0.22582	0.22582	0.00000	100.00000
0.210	0.00000	0.25331	0.00000	0.25331	0.25331	0.00000	100.00000
0.220	0.00000	0.28302	0.00000	0.28302	0.28302	0.00000	100.00000
0.230	0.00000	0.31507	0.00000	0.31507	0.31507	0.00000	100.00000

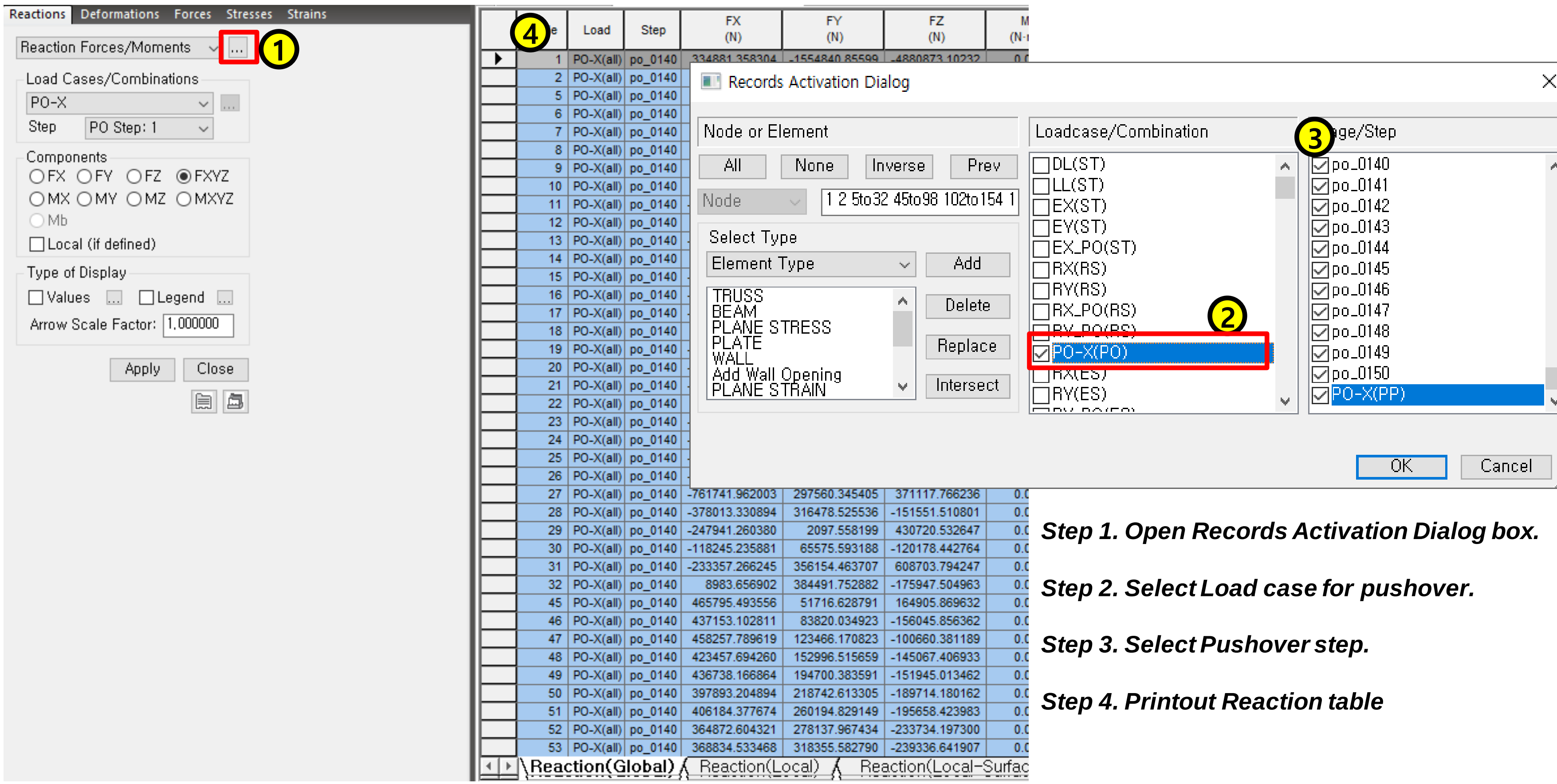


[New] Energy Percentage Result of all step

→ Click to display text window

12. Add reaction table for each step in Pushover

Add Reaction Table for each step in PUSHOVER



Step 1. Open Records Activation Dialog box.

Step 2. Select Load case for pushover.

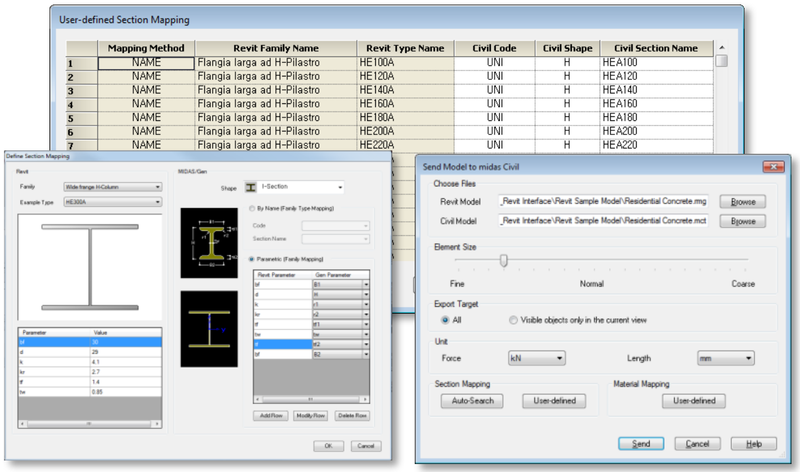
Step 3. Select Pushover step.

Step 4. Printout Reaction table

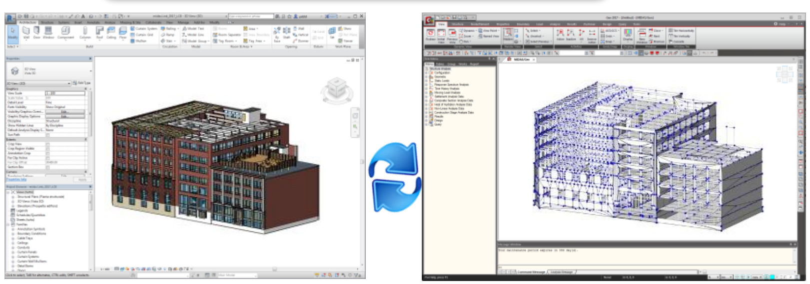
13. Revit 2020 Interface

Gen-Revit Link

- ***File > Import > midas Gen MGT File***
- ***File > Export > midas Gen MGT File***



Send Model to midas Gen



Revit 2020

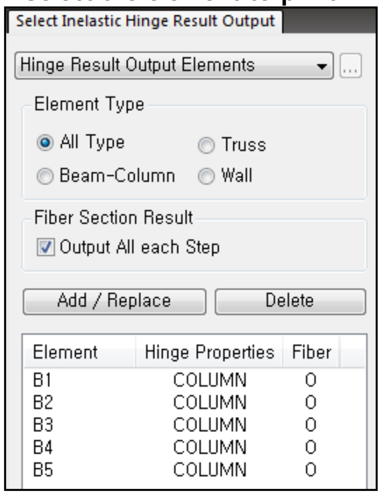
Gen2020

	Functions	Revit <> Gen
Linear Elements	Structural Column	<>
	Beam	<>
	Brace	<>
	Curved Beam	>
	Beam System	>
	Truss	>
Planar Elements	Foundation Slab	<>
	Structural Floor	<>
	Structural Wall	<>
	Wall Opening & Window	>
	Door	>
	Vertical or Shaft Opening	>
Boundary	Offset	>
	Rigid Link	>
	Cross-Section Rotation	>
	End Release	>
	Isolated Foundation Support	>
	Point Boundary Condition	>
	Line Boundary Condition	>
	Wall Foundation	>
	Area Boundary Condition	>
Load	Load Nature	>
	Load Case	>
	Load Combination	>
	Hosted Point Load	>
	Hosted Line Load	>
	Hosted Area Load	>
Other Parameters	Material	<>
	Level	>

14. Select Inelastic Hinge Result Output in Inelastic time history analysis

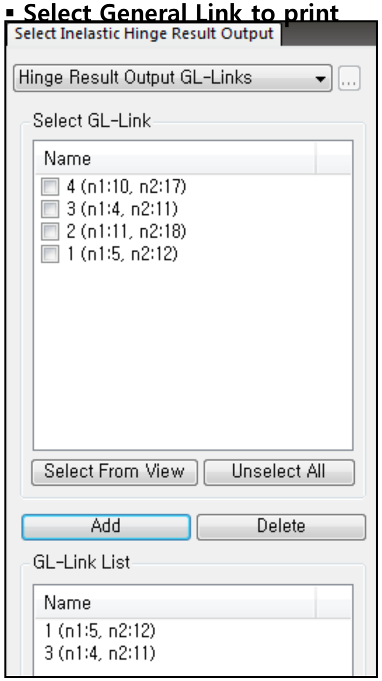
- ***Properties > Inelastic Properties > Inel. Control Data > Select Inelastic Hinge Result Output(Element/General Link)***
- ***Load > Dynamic Loads > Time History Analysis Data > Global Control***

▪ Select the element to print



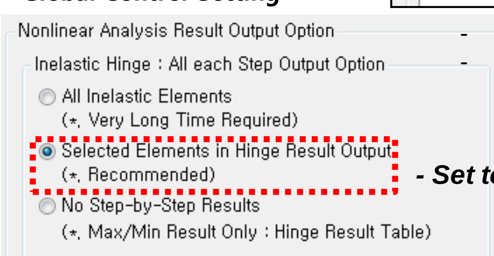
- Press 'Add/Replace' button after selecting element on model view

▪ Select General Link to print



- Press 'Add' button after Selecting GL-Link

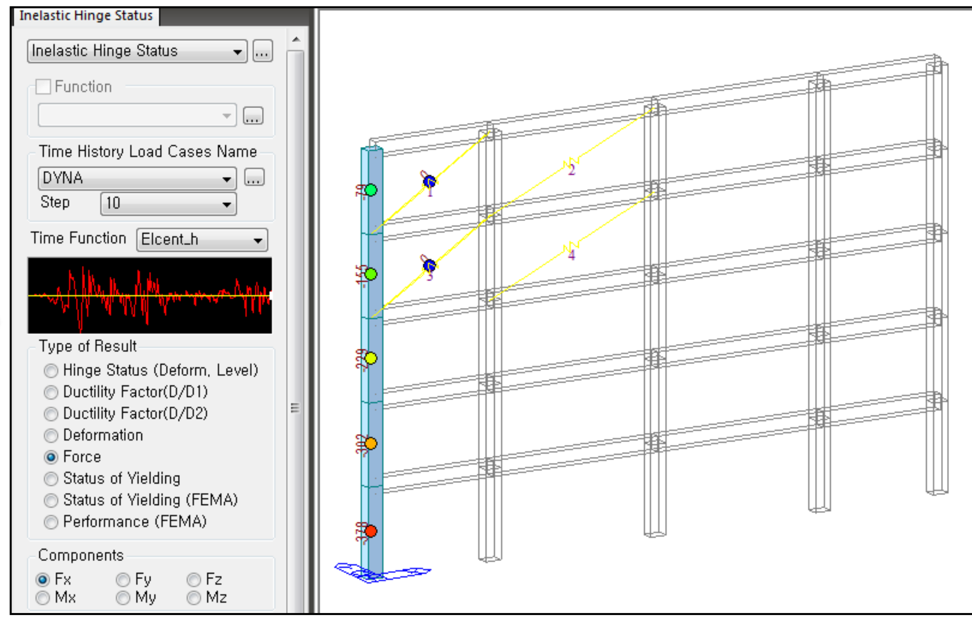
▪ Global Control Setting



- Set to output selected elements

- ***By setting to output only the results of the selected element,***
- ***It can be shorten the analysis time and check the required results.***

▪ Inelastic Hinge Status Result

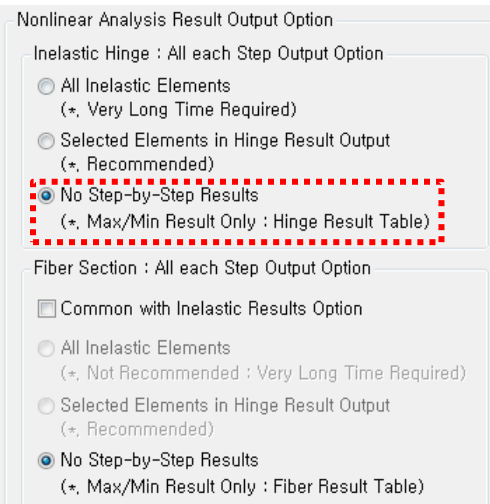


- Check result of selected elements

14. Select Inelastic Hinge Result Output in Inelastic time history analysis

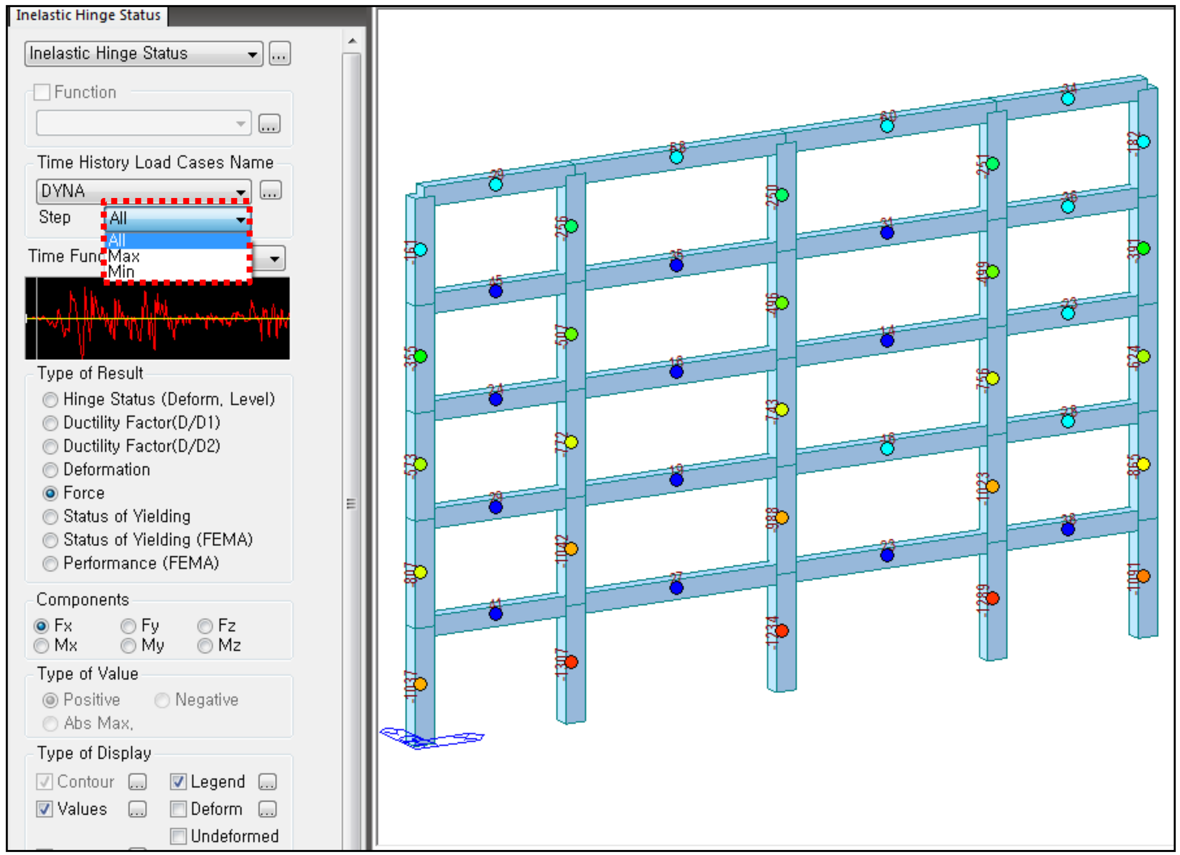
- ***Properties > Inelastic Properties > Inel. Control Data > Select Inelastic Hinge Result Output(Element/General Link)***
- ***Load > Dynamic Loads > Time History Analysis Data > Global Control***

▪ Global Control Setting



- Set to Max/Min Result Only

▪ Inelastic Hinge Status Result

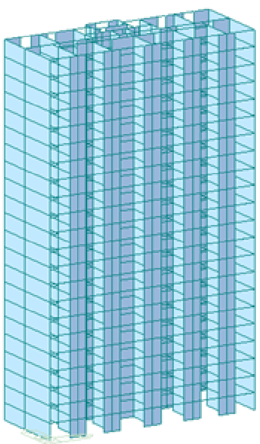


- Check Max/Min result output

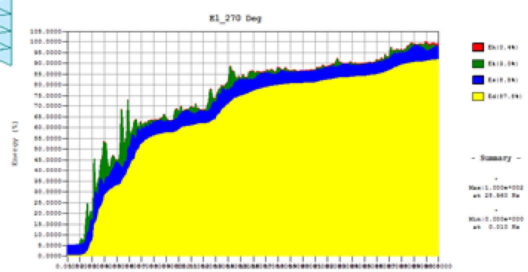
15. Improvement in analysis speed for inelastic time history analysis

- ***Reduction of analysis time by optimizing the inelastic time history analysis program and improving the output algorithm for inelastic analysis results***

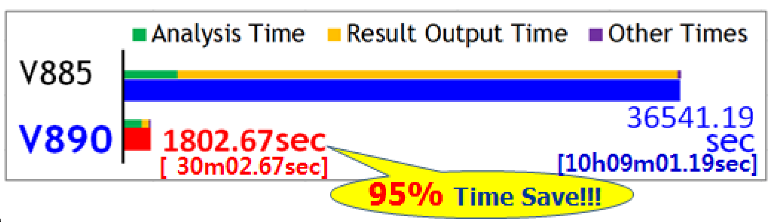
3D Fiber Wall Model (23F)



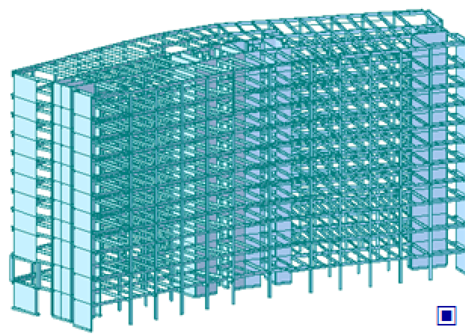
- Beam : 770 Element
- Wall : 1,320 Element
- Hinge Status : 11,880
- Fiber Cell : 950,040
- Analysis End Time : 30 sec (3000 step)



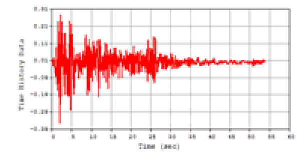
■ Total Analysis Time : V885 vs V890



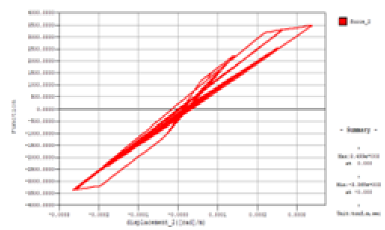
3D Structure Hinge Model (12F)



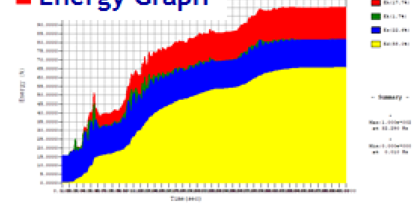
- Dynamic Loading



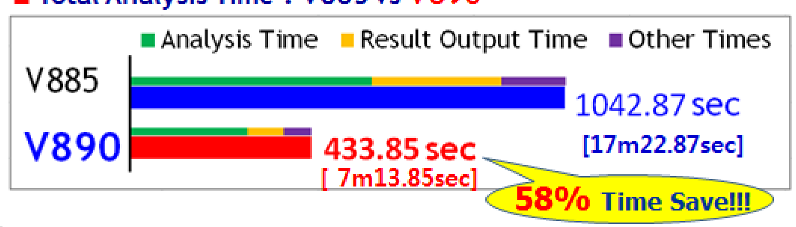
- Analysis End Time : 40 sec (4000 step)
- Beam : 5,117 Element
- Hinge Status : 4,050



■ Energy Graph



■ Total Analysis Time : V885 vs V890



16. Add result summary table of fiber beam, wall for inelastic hinge

- ***Results > Results Tables > Inelastic Hinge > Fiber Beam Summary, Fiber Wall Summary***

▪ Fiber Beam Summary

Element	Section Position	Material	Load	Cell	Minimum		Maximum	
					ε	Time/Step	ε	Time/Step

Maximum and Minimum Strains at Each Section														
Element	Section	Load	Concrete						Steel					
			Minimum			Maximum			Minimum			Maximum		
			Cell	ε	Time/Step	Cell	ε	Time/Step	Cell	ε	Time/Step	Cell	ε	Time/Step
1	1-pos	DYNA	212	-1.31090e-003	3.080	2	4.51657e-003	3.090	234	-1.13533e-003	3.080	226	4.34048e-003	3.090
1	2-pos	DYNA	212	-3.65713e-004	2.990	212	6.49857e-004	6.050	234	-3.42752e-004	2.990	234	6.24902e-004	6.050
1	3-pos	DYNA	2	-2.26298e-004	3.100	212	3.83368e-004	2.660	229	-2.16190e-004	3.100	234	3.66219e-004	2.660
2	1-pos	DYNA	212	-4.33781e-004	2.080	212	1.16795e-003	5.950	234	-3.94597e-004	2.080	234	1.12444e-003	5.950
2	2-pos	DYNA	212	-1.60712e-004	2.180	212	4.11072e-004	4.560	234	-1.52268e-004	2.180	234	3.95087e-004	4.560
2	3-pos	DYNA	2	-3.94532e-004	3.060	212	7.49057e-004	3.060	226	-3.59973e-004	3.060	234	7.14507e-004	3.070
3	1-pos	DYNA	224	-2.35641e-004	2.890	212	9.42264e-004	5.950	235	-2.18520e-004	2.890	234	9.07028e-004	5.950
3	2-pos	DYNA	2	-1.55364e-004	3.060	212	2.61186e-004	2.360	226	-1.46279e-004	3.060	234	2.51061e-004	2.360
3	3-pos	DYNA	2	-4.04808e-004	3.020	212	1.01659e-003	3.030	226	-3.62026e-004	3.020	234	9.73654e-004	3.030

\Fiber Beam Summary /

▪ Fiber Wall Summary

Story	Wall ID	Section Position	Material	Load	Cell	Minimum		Maximum	
						ε	Time/Step	ε	Time/Step

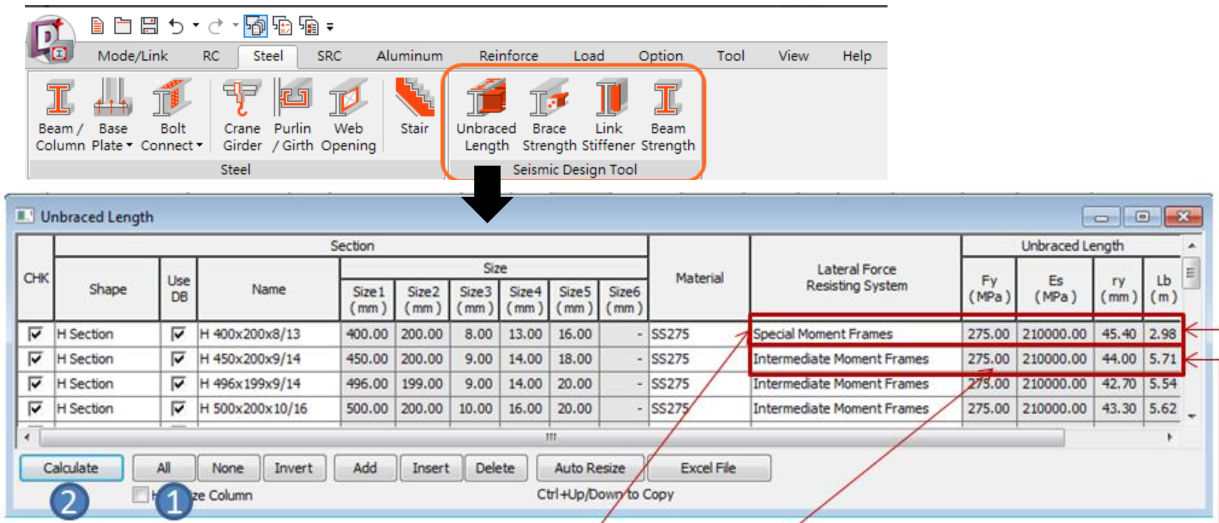
Maximum and Minimum Strains at Each Section															
Story	Wall ID	Section	Load	Concrete						Steel					
				Minimum			Maximum			Minimum			Maximum		
				Cell	ε	Time/Step	Cell	ε	Time/Step	Cell	ε	Time/Step	Cell	ε	Time/Step
1F	1	1-pos	DYNA	1	-9.39160e-004	2.680	15	2.81189e-001	2.680	17	-7.11083e-004	2.360	24	2.80383e-001	2.680
1F	1	2-pos	DYNA	1	-8.67644e-004	2.680	15	1.67658e-001	2.680	17	-7.19437e-004	2.450	24	1.67176e-001	2.680
1F	1	3-pos	DYNA	1	-6.64995e-004	2.680	15	6.16266e-003	2.680	17	-6.45485e-004	2.680	24	6.14315e-003	2.680
1F	1	4-pos	DYNA	1	-4.82424e-004	2.680	15	2.32626e-003	2.680	17	-4.74398e-004	2.680	24	2.31824e-003	2.680
1F	1	5-pos	DYNA	1	-4.11744e-004	2.680	15	1.77338e-003	2.680	17	-4.05500e-004	2.680	24	1.76714e-003	2.680
2F	1	1-pos	DYNA	1	-4.08757e-004	2.680	15	1.77946e-003	2.660	17	-4.02511e-004	2.680	24	1.77321e-003	2.660
2F	1	2-pos	DYNA	1	-3.63986e-004	2.680	15	1.50301e-003	2.660	17	-3.58657e-004	2.680	24	1.49767e-003	2.660
2F	1	3-pos	DYNA	1	-2.97825e-004	2.680	15	1.15894e-003	2.660	17	-2.93668e-004	2.680	24	1.15478e-003	2.660
2F	1	4-pos	DYNA	1	-2.47810e-004	2.680	15	9.54822e-004	2.660	17	-2.44377e-004	2.680	24	9.51387e-004	2.660
2F	1	5-pos	DYNA	1	-2.21425e-004	2.680	15	8.47144e-004	2.660	17	-2.18374e-004	2.680	24	8.44092e-004	2.660
3F	1	1-pos	DYNA	1	-2.19067e-004	2.680	15	8.53079e-004	2.670	17	-2.16011e-004	2.680	24	8.50018e-004	2.670
3F	1	2-pos	DYNA	1	-1.99154e-004	2.680	15	7.72331e-004	2.670	17	-1.96387e-004	2.680	24	7.69557e-004	2.670
3F	1	3-pos	DYNA	1	-1.62067e-004	2.690	15	6.20154e-004	2.690	17	-1.59832e-004	2.690	24	6.17919e-004	2.690

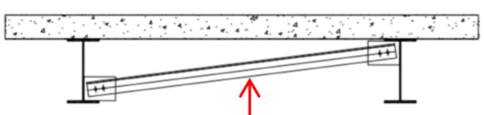
\Fiber Wall Summary /

midas ***Design+***

1. Steel design tool as per AISC

Unbraced Length of Beam bracing





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. When Ry=1.1, AISC is the same as Korean code

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.

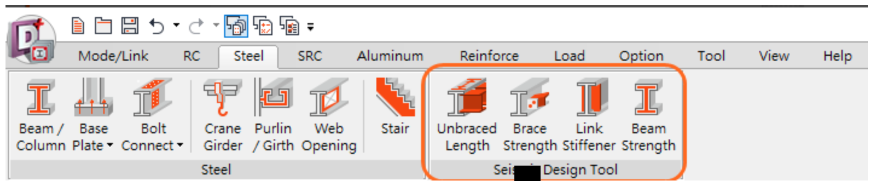
Korean code

Intermediated Moment
→ Lb = 0.17ry E/Fy

Special Moment Frames
→ Lb = 0.085ry E/Fy

1. Steel design tool as per AISC

Brace Strength (Beam)



** Korean code is the same as AISC*

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

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

and, the required stiffness of the brace is

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

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

$$\phi = 0.75 \text{ (LRFD)} \qquad \Omega = 2.00 \text{ (ASD)}$$

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 $\frac{P_r}{P_c} \geq 0.2$

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

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

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

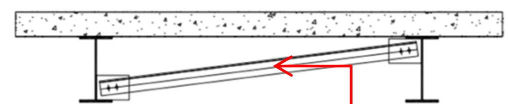
Koran code (LSD)

③ 횡지지가새 부재 검토 및 상세 – 0713.9.8

- 소요강도 $P_{br} = 0.02 M_r C_d / h_0$

- 소요강성 $\beta_{br} = \frac{1}{\emptyset}\left(\frac{10 M_r C_d}{L_b h_0}\right)$

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



Beam bracing

(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 $\frac{P_r}{P_c} < 0.2$

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

Brace Design Variables					Brace Strength	
øMn (kN.m)	ho (mm)	ø	Pbr (kN)	ßbr (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. Steel design tool as per AISC

Brace Strength (Beam)

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)	ßbr (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[illegible]	28.69	4782.0[illegible]	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	[illegible].37	25582.57	1[illegible]5.93	OK([illegible]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 → $P_{br} = 0.02\left(\dfrac{M_r C_d}{h_o}\right)$

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

0.008

[Combination stress check]

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

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

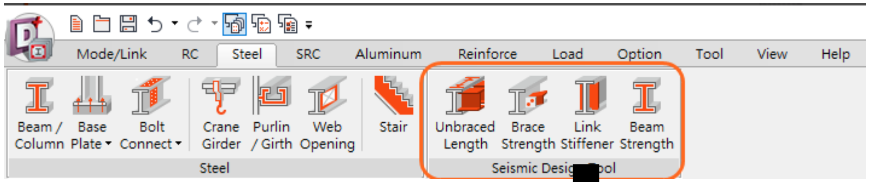
(b) When $\dfrac{P_r}{P_c} < 0.2$

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

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

1. Steel design tool as per AISC

Link Stiffener Design



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.

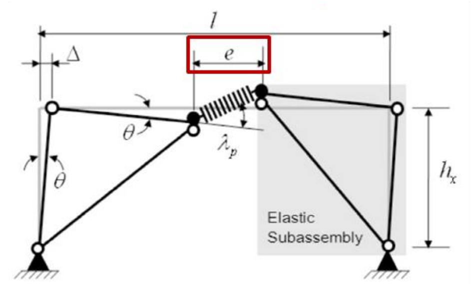
Intermediate web stiffeners shall not be required in links of length greater than $5M_p/V_p$.

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

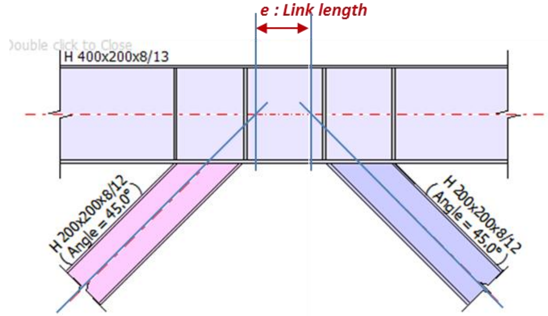
Sect. F3.] ECCENTRICALLY BRACED FRAMES (EBF) 9.1-75

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.

e : Link length



e : Link length



1. Steel design tool as per AISC

Link Stiffener Design

Link Length = 'e'

CHK	Section				Link		Link Stiffener									
	Shape	Use DB	Name	Material	Length (m)	Angle (Deg.)	Zx (mm^3)	Aweb (mm^2)	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 $5M_p/V_p$.

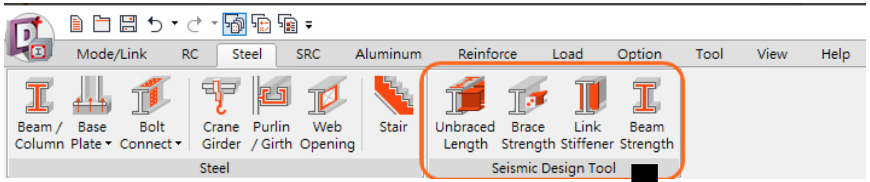
"No" : To provide on one side is possible
"Yes" : To provide on one side is not possible
****** it is just to inform whether one side is possible.*
And all results is for both side.

Link		Link Stiffener									
Length (m)	Angle (Deg.)	Zx (mm^3)	Aweb (mm^2)	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. Steel design tool as per AISC

Beam Strength (Beam design with K-brace)



L_b of beam

Unbraced length of brace

CHK	Beam: Section Shape	Use DB	Name	Material	Length (m)	Cb
☑	H Section	☑	H 400x200x8/13	SS275	2.00	1.00

Brace1: Section Shape	Use DB	Name	Material	Type	Ry: User	Ry	Length (m)	Cb	Angle (Deg.)
H Section	☑	H 200x200x8/12	SS275	Tension Brace	☐	1.100	1.00	1.00	45.00

Brace2: Section Shape	Use DB	Name	Material	Type	Ry: User	Ry	Length (m)	Cb	Angle (Deg.)
H Section	☑	H 200x200x8/12	SS275	Compression Brace	☐	1.100	1.00	1.00	45.00

Design Force							Check Result of Brace							
Dead Load			Live Load				Brace1				Brace2			
Factor	Mux (kN.m)	Vuy (kN)	Factor	Mux (kN.m)	Vuy (kN)	Seismic Load	Fy (MPa)	Pn (kN)	Qb (kN)	Qc (kN)	Fy (MPa)	Pn (kN)	Qb (kN)	Qc (kN)
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

Check Result of Beam										
	Design Forces			Design Strength			Strength Ratio			
Fy (MPa)	Pux (kN)	Mux (kN.m)	Vuy (kN)	øPn (kN)	øMn (kN.m)	øVn (kN)	Pux / øPn	Mux / øMn	Vuy / øVn	Comb.
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)*

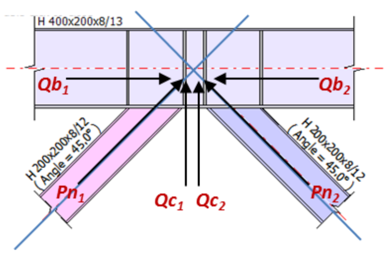
In case of compression,
Pn is the value considered the buckling

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]

0.0

(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 $\frac{P_r}{P_c} < 0.2$

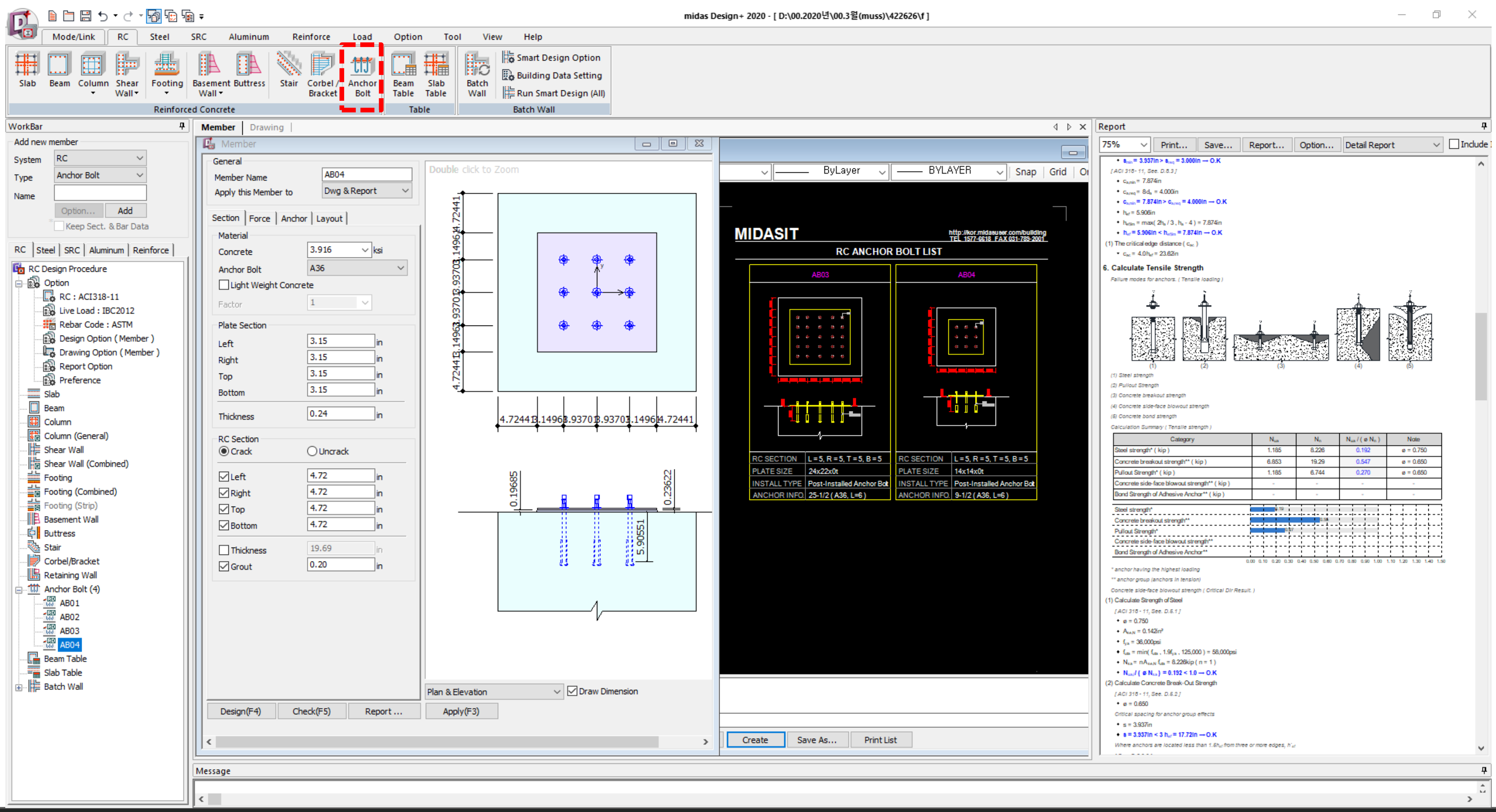
$$\frac{P_r}{2P_c} + \left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}}\right) \leq 1.0$$

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

2. Anchor bolt module as per ACI

RC > Anchor Bolt

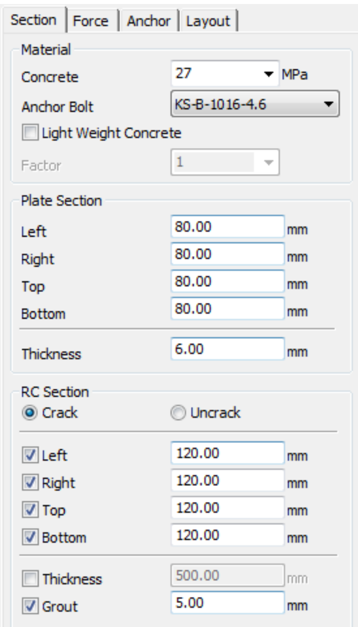
- **Applied Code : ACI318-14(M),11(M),08(M),NSR-10**
- **Spacing, Tensile,ShearStrength, Combined Ratio Check for Post-Installed / Cast-In-Place Anchor Bolt**



2. Anchor bolt module as per ACI

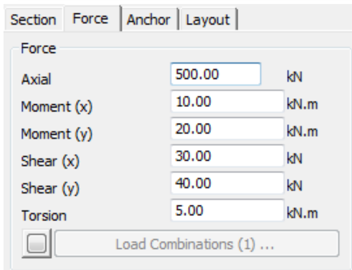
Procedure of Anchor Bolt Design

Section



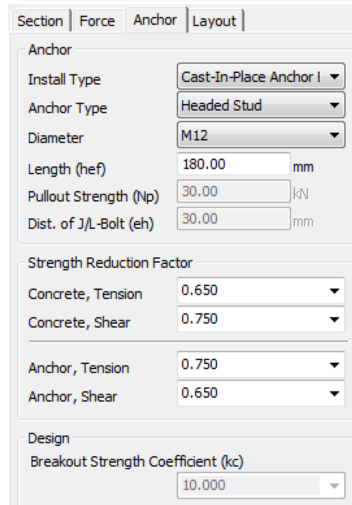
Step 1.
Define concrete, Anchor bolt material and element information.

Force



Step 2.
Define Force Data.
(Axial,Moment,Shear,Torsion)

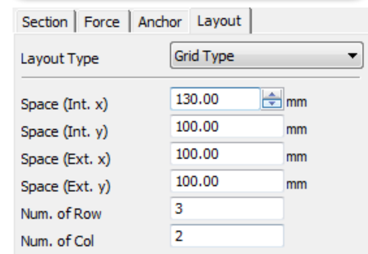
Anchor

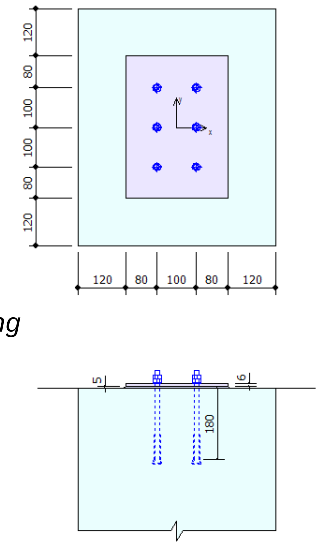


Step 3.
Define Anchor Bolt information.

Cast-In-Place Anchor : Headed Stud/Headed Bolt/Hooked Bolt(L/J)
Post-Installed Anchor:
Expansion(Torque,Displacement),Undercut,Adhesive anchors

Layout





Step 4.
Define the layout type & spacing Number of Anchor bolt.

2. Anchor bolt module as per ACI

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	

- ***Choose Summary/Detail Calculation Report***
- ***Easy to check by printing standard(code)chapter in detail calculation report.***

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
- **$V_{ua,i}$ / (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