Release Note

Release Date : July 2018

Product Ver. : Civil 2019 (v1.1)

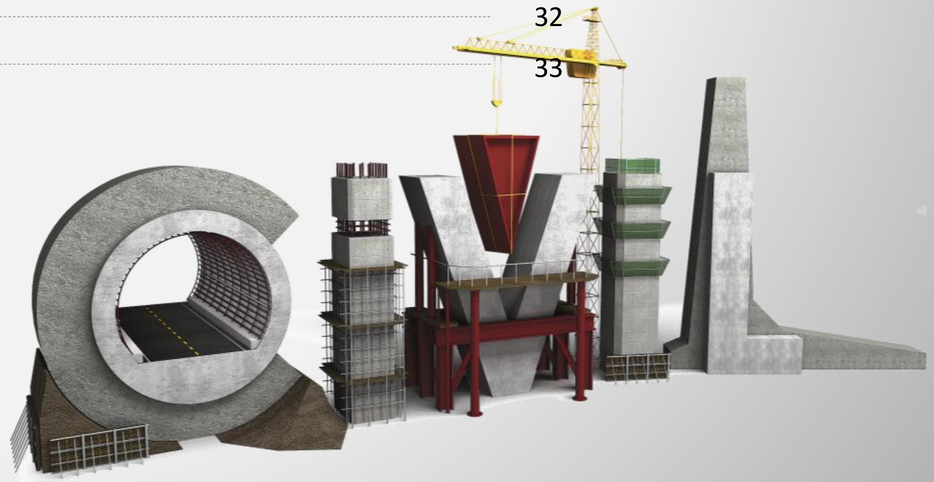
DESIGN OF CIVIL STRUCTURES

Integrated Solution System for Bridge and Civil Engineering

Enhancements

▪ Analysis & Design

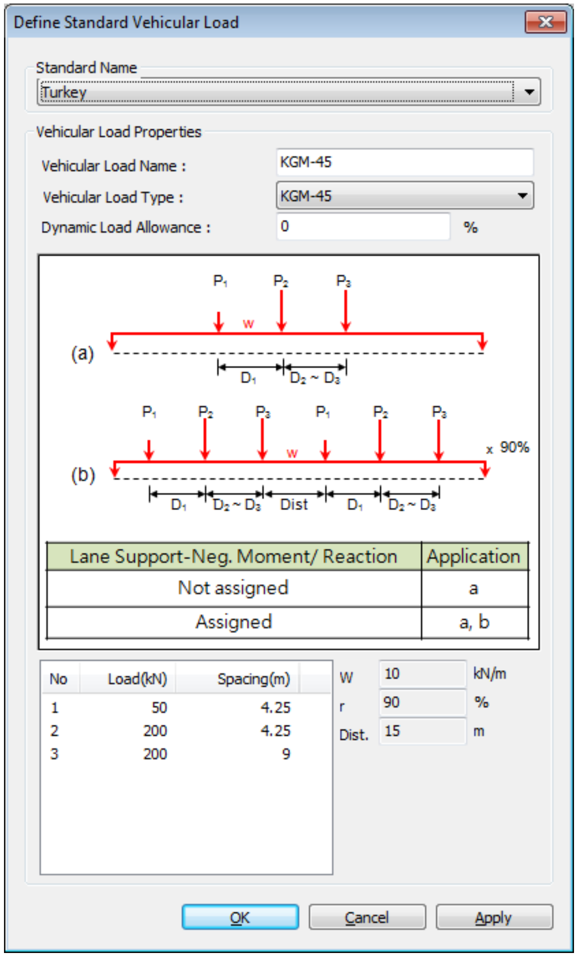
▪ Pre & Post-Processing



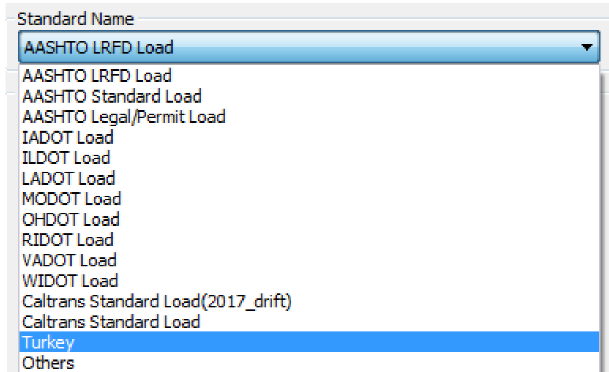
1. Traffic Load Models for Turkey

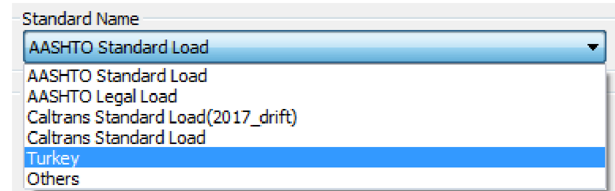
- Five Turkish live load models are implemented in midas Civil. KGM-45, H30-S24, H30-S24L, H20-S16, H20-S16L
- These vehicles can be found from the AASHTO LRFD / AASHTO Standard code.

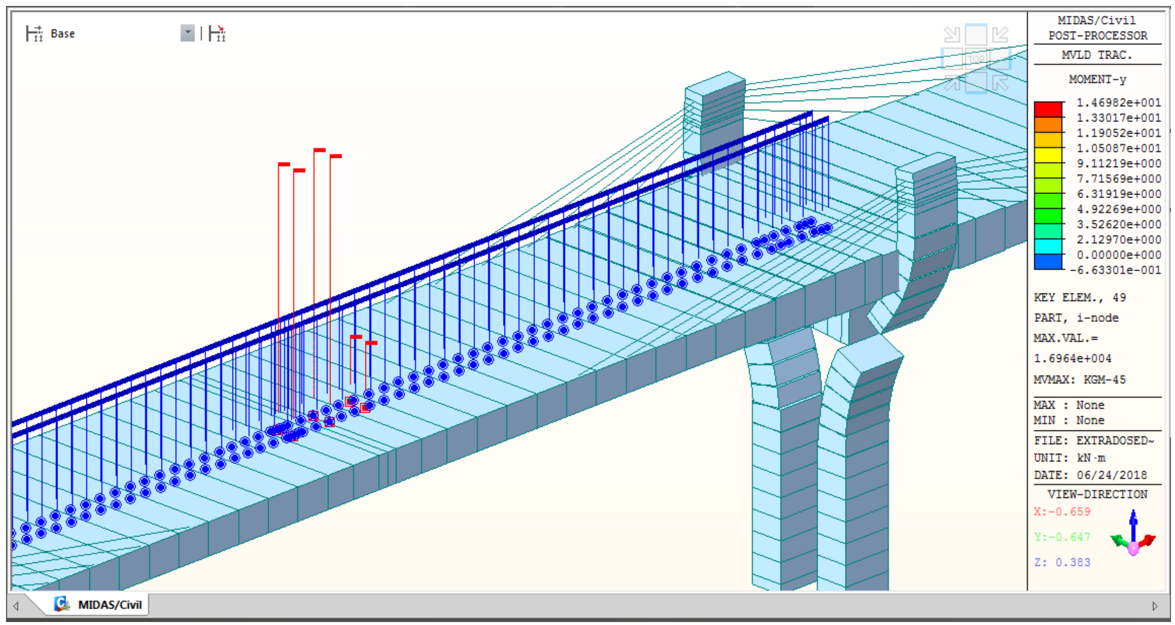
- ***Load/Moving Load Analysis Data > Vehicles***



Standard Vehicular Load, KGM-45



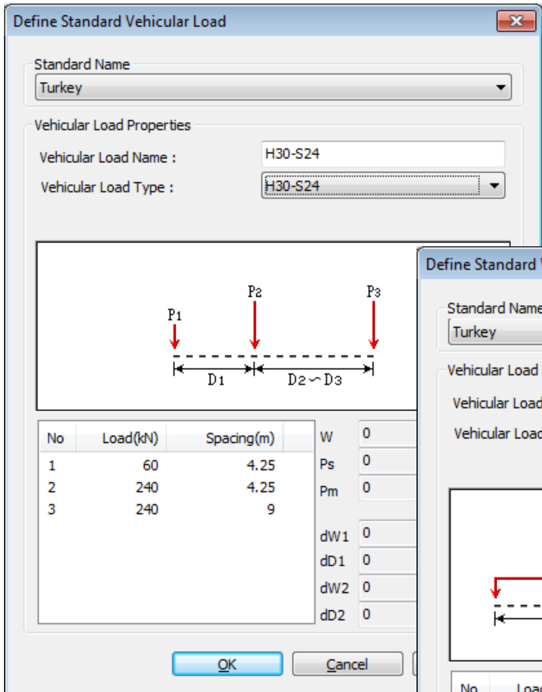




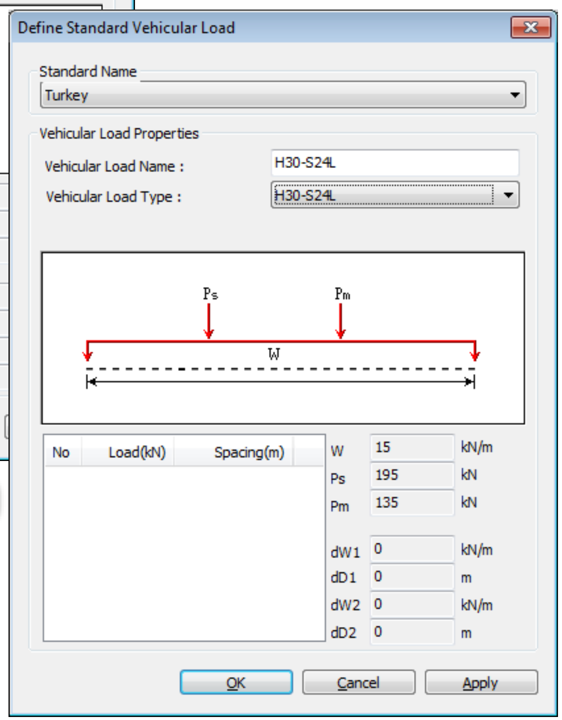
Moving Load Tracer, KGM-45

1. Traffic Load Models for Turkey

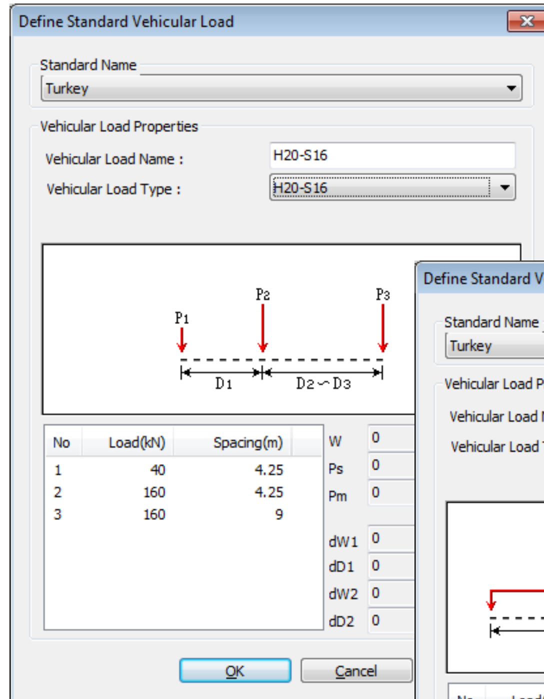
- ***Load/Moving Load Analysis Data > Vehicles***



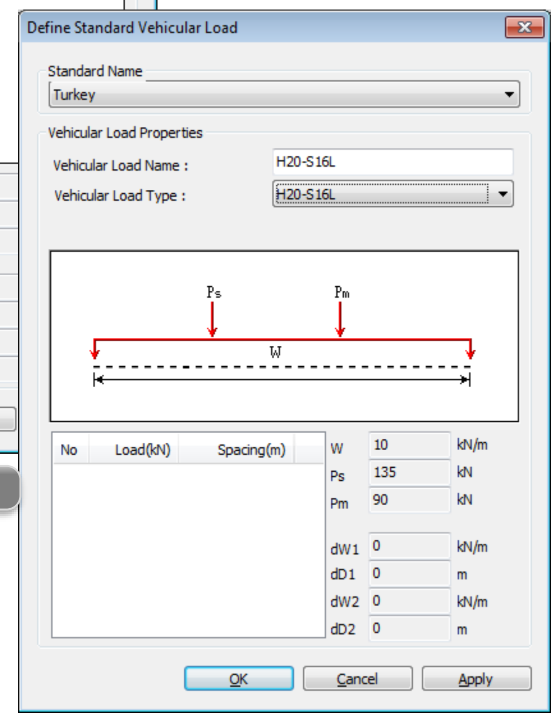
Standard Vehicular Load, H30-S24



Standard Vehicular Load, H30-S24L



Standard Vehicular Load, H20-S16

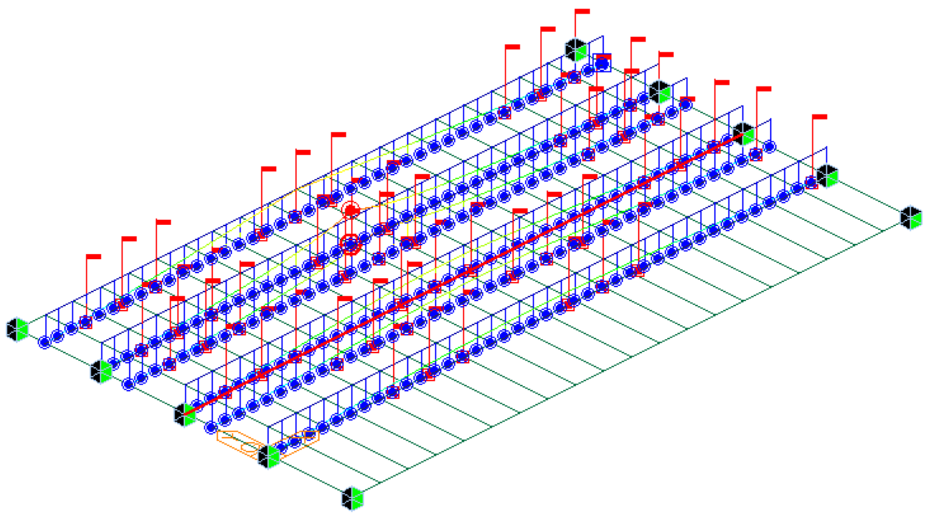


Standard Vehicular Load, H20-S16L

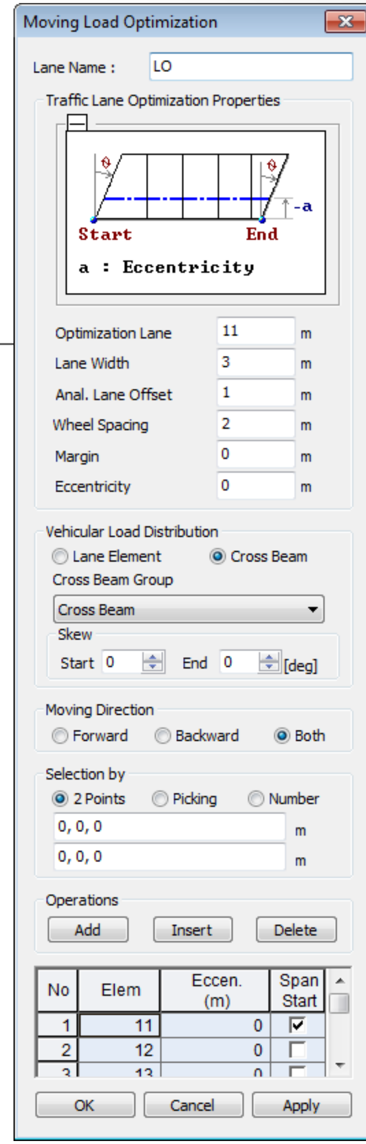
2. Moving Load Optimization for Australia

- Now, the moving load optimization function can be applied with the Australia code as well.
- Moving Load Optimization extends the capabilities of moving load analysis and helps to significantly simplify the evaluation of critical vehicle locations. The critical locations of vehicles can be identified in the transverse direction as well as longitudinal direction according to the code provision.

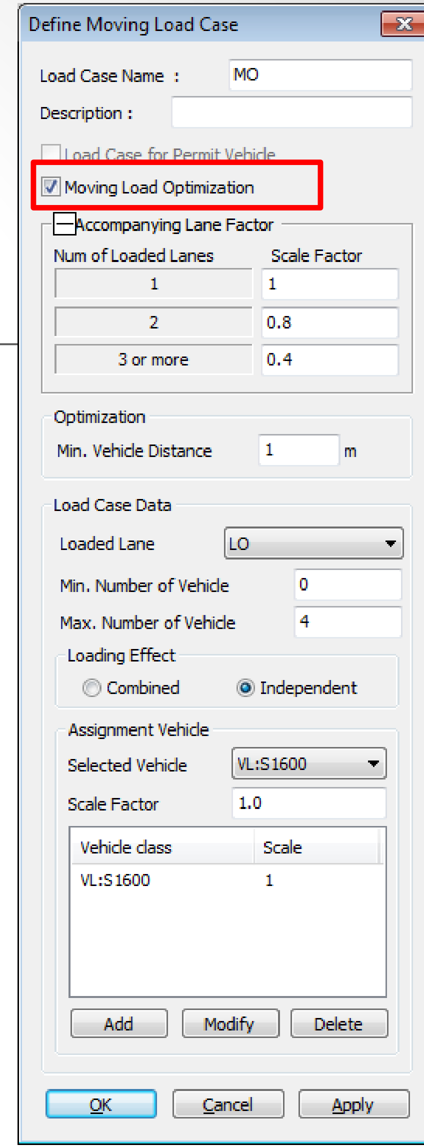
- ***Load > Moving Load > Traffic Line/Surface Lane > Moving Load Optimization***
- ***Load > Moving Load > Moving Load Cases***



Optimized Results for Exterior Girder by S1600



Traffic Line Lane Optimization

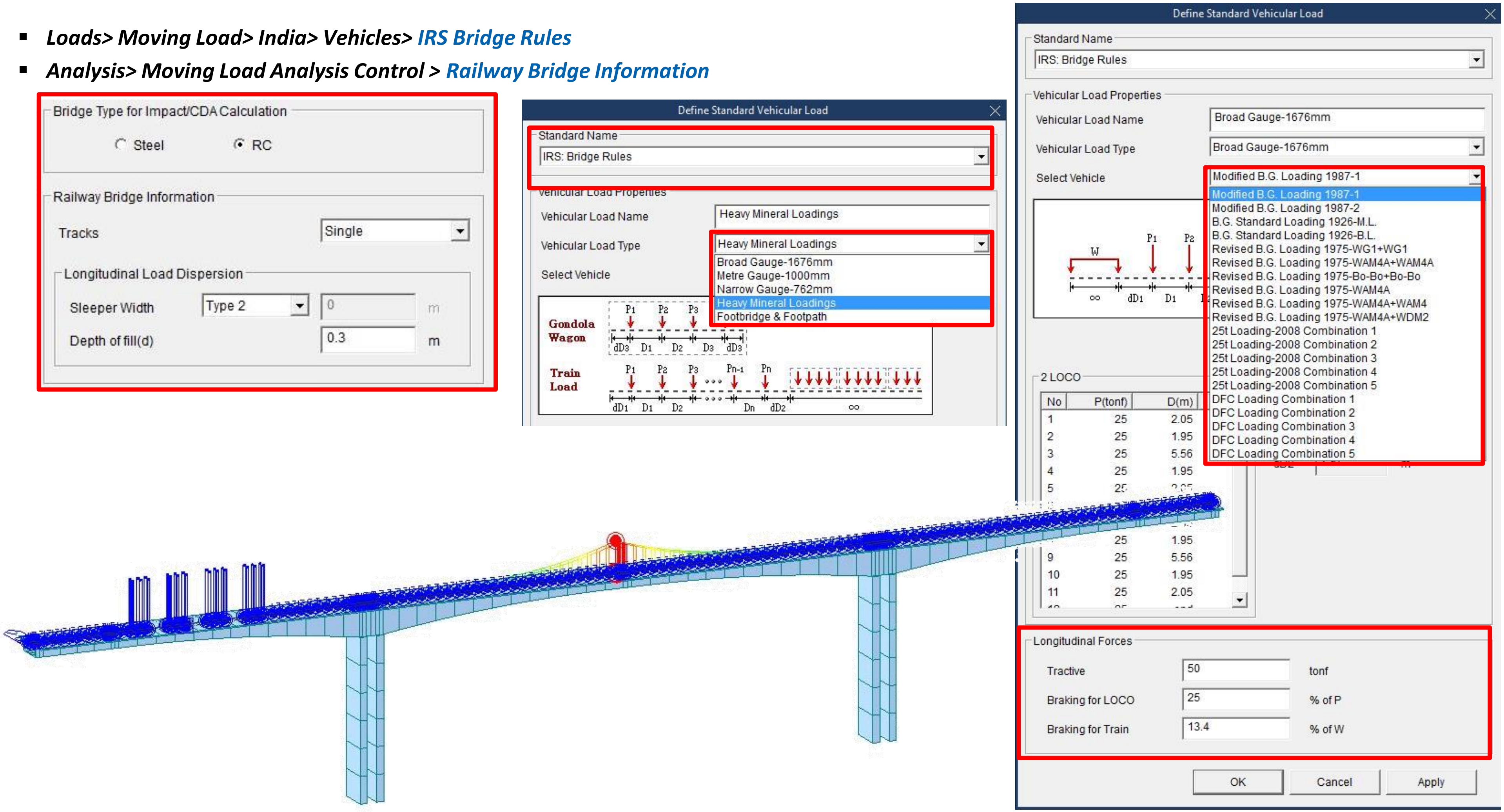


Moving Load Case

3. India IRS Bridge Rules: Railway Loads

- All the applicable railway loads could now directly be applied to any structure. The tractive and braking load of locomotive as well as wagon would be automatically considered.

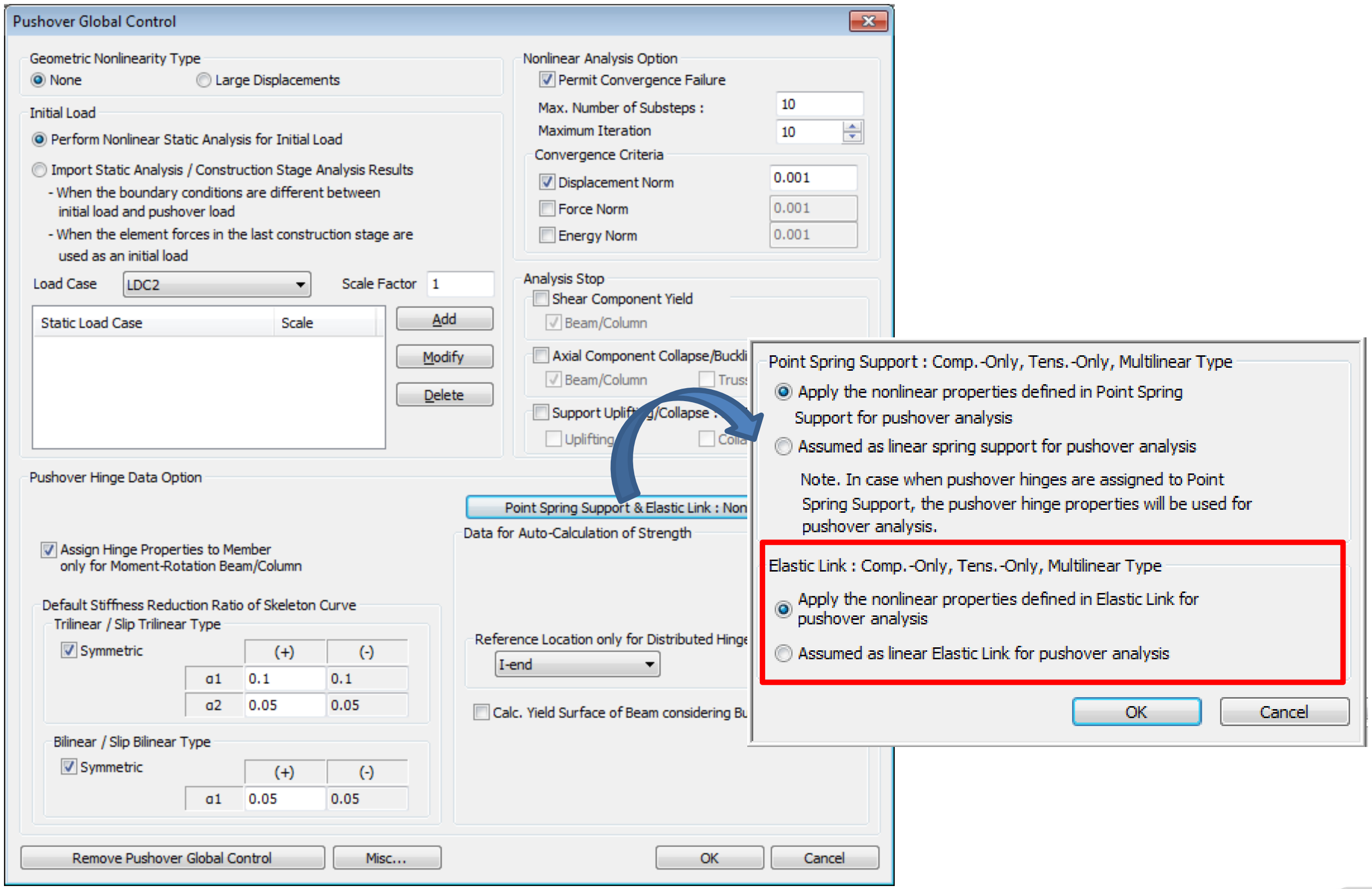
- ***Loads> Moving Load> India> Vehicles> IRS Bridge Rules***
- ***Analysis> Moving Load Analysis Control > Railway Bridge Information***



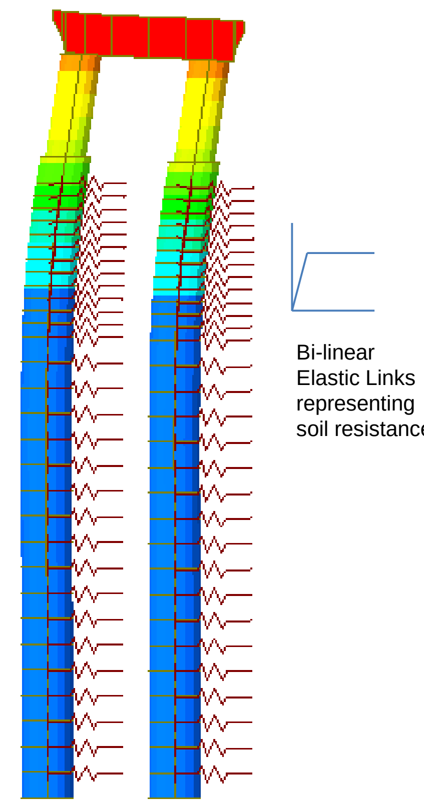
4. Nonlinear Elastic Links for Pushover Analysis

- Nonlinear behavior of the elastic links, i.e. comp.-only, tens.-only, multi-linear can be taken into account in the pushover analysis.
- Link forces imported from static analysis or construction stage analysis cannot be specified as initial loads for pushover analysis.

- ***Pushover > Control > Global Control***



Pushover Global Control

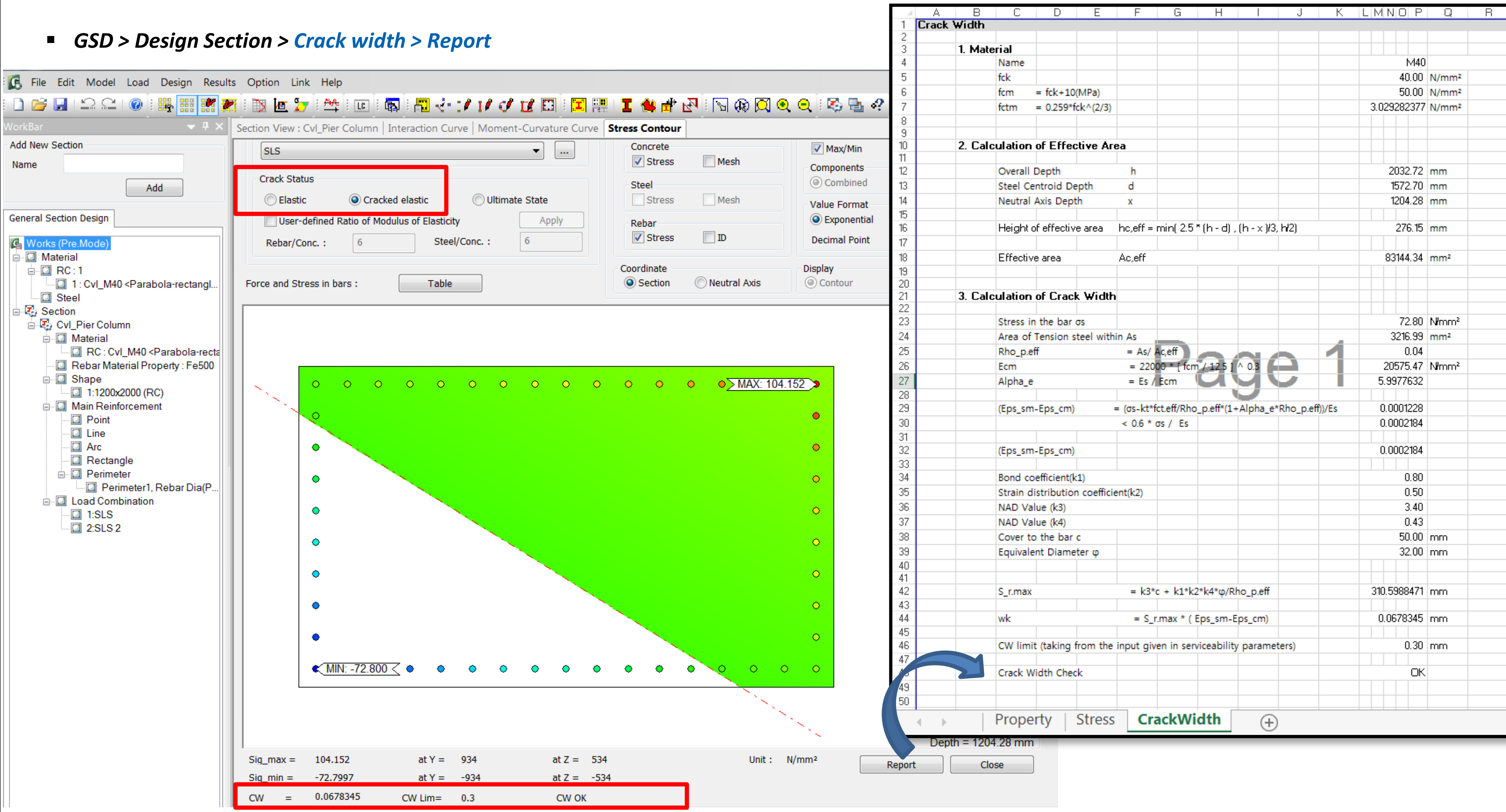


Pushover Analysis for the Pier and Shaft

5. GSD - Crack Width Calculation as per IRC 112: 2011

- For any irregular section, both elastic and cracked-elastic crack width can be computed as per IRC 112: 2011 code.
- Excel report of the stress and crack width calculation can be obtained.

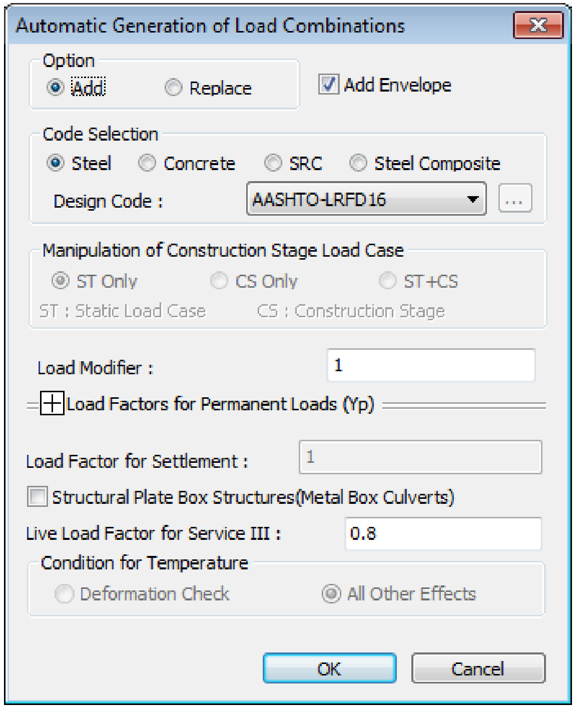
- ***GSD > Design Section > Crack width > Report***



6. AASHTO LRFD 2016 update

- ***Load Combination***

Load Combination Limit State	*DC DD DW EH EV ES EL PS CR SH*	*LL IM CE BR PL LS*	*WA*	*WS*	*WL*	*FR*	*TU*	*TG*	*SE*	Use One of These at a Time *EQ*	*BL*	*IC*	*CT*	*CV*
Strength I (unless noted)	γ_p	1.75	1.00	—	—	1.00	0.50/1.20	γ_{TG}	γ_{SE}	—	—	—	—	—
Strength II	γ_p	1.35	1.00	—	—	1.00	0.50/1.20	γ_{TG}	γ_{SE}	—	—	—	—	—
Strength III	γ_p	—	1.00	1.0 ~~1.40~~	—	1.00	0.50/1.20	γ_{TG}	γ_{SE}	—	—	—	—	—
Strength IV	γ_p	—	1.00	—	—	1.00	0.50/1.20	—	—	—	—	—	—	—
Strength V	γ_p	1.35	1.00	1.0 ~~0.40~~	1.00	1.00	0.50/1.20	γ_{TG}	γ_{SE}	—	—	—	—	—
Extreme Event I	1.0	γ_{EQ}	1.00	—	—	1.00	—	—	—	1.00	—	—	—	—
Extreme Event II	γ_p	0.50	1.00	—	—	1.00	—	—	—	—	1.00	1.00	1.00	1.00
Service I	1.00	1.00	1.00	1.0 ~~0.30~~	1.00	1.00	1.00/1.20	γ_{TG}	γ_{SE}	—	—	—	—	—
Service II	1.00	1.30	1.00	—	—	1.00	1.00/1.20	—	—	—	—	—	—	—
Service III	1.00	γ_{LL}	1.00	—	—	1.00	1.00/1.20	γ_{TG}	γ_{SE}	—	—	—	—	—
Service IV	1.00	—	1.00	1.0 ~~0.70~~	—	1.00	1.00/1.20	—	1.00	—	—	—	—	—
Fatigue I—*LL, IM & CE* only	—	1.50	—	—	—	—	—	—	—	—	—	—	—	—
Fatigue II—*LL, IM & CE* only	—	0.75	—	—	—	—	—	—	—	—	—	—	—	—

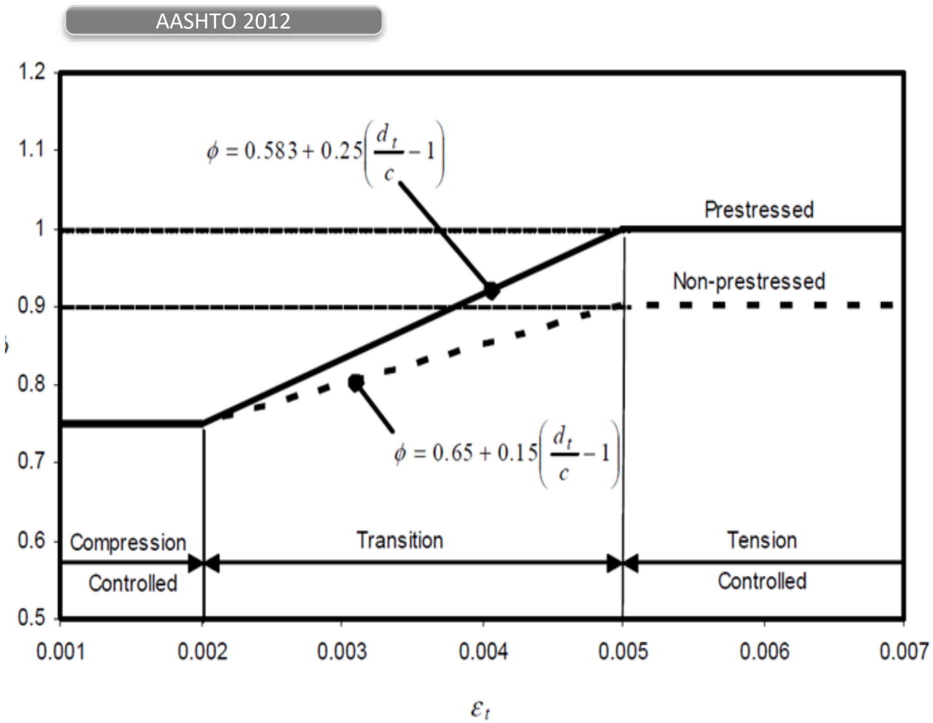


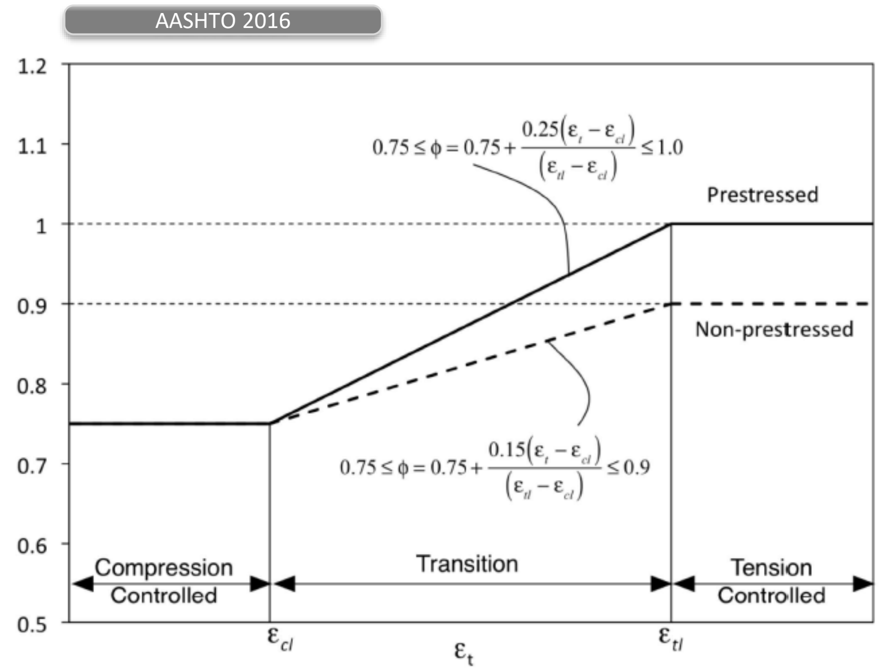
Load Combinations Dialog

- Load factors of WS for Strength III, Strength V, Service I, Service IV are changed from 1.4 to 1.0, 0.4 to 1.0, 0.3 to 1.0, 0.7 to 1.0, respectively.
- Load factor of permanent effects for Extreme Event I is changed from γ_p to 1.0. AASHTO-LRFD 2012 used a value for γ_p greater than 1.0.

6. AASHTO LRFD 2016 update

- ***Resistance Factor***

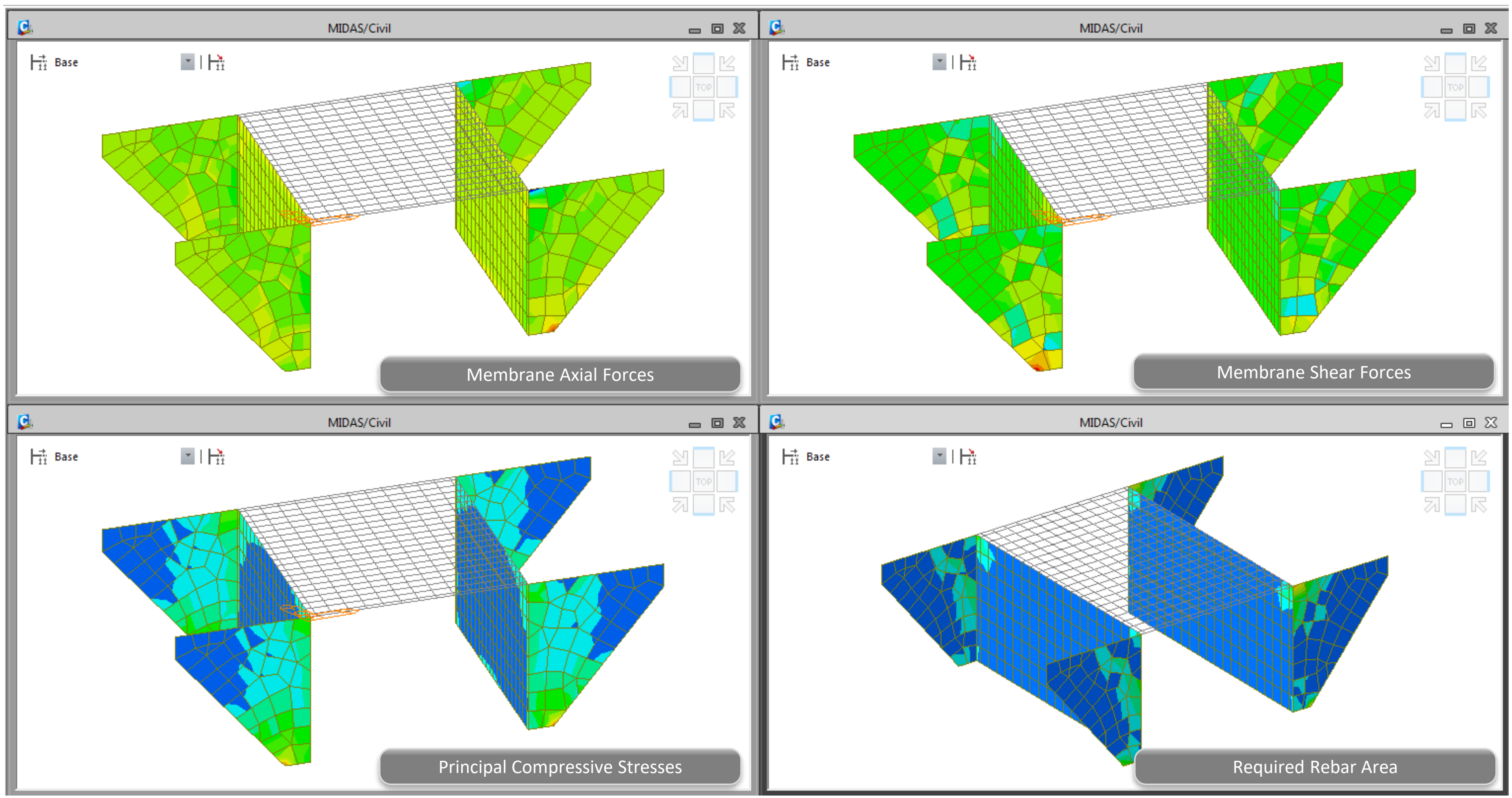




- ε_{cl} : compression-controlled strain limit in the extreme tension steel
- ε_{tl} : tension-controlled strain limit in the extreme tension steel

7. Shell Design

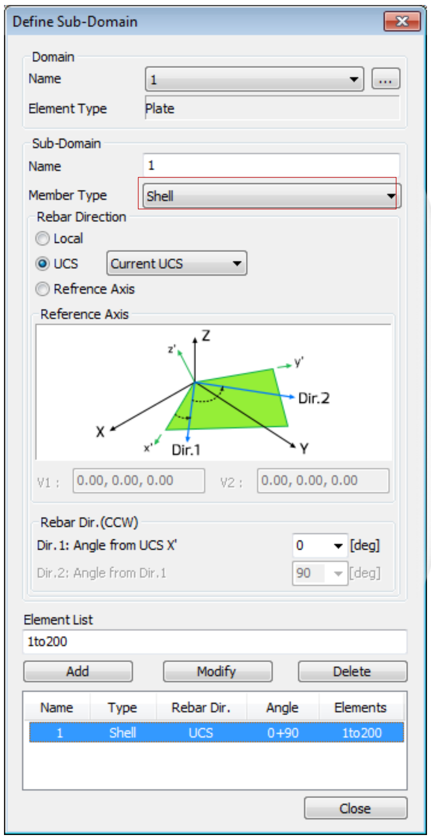
- The design of reinforcement concrete shells as per Annex LL of EN 1992-2 is implemented.
- Shell design considers three membrane forces, two flexural moments, twisting moment and two transverse shear forces.
- This design feature can be applied to concrete shell structure, abutment walls / wing walls, under ground structures.



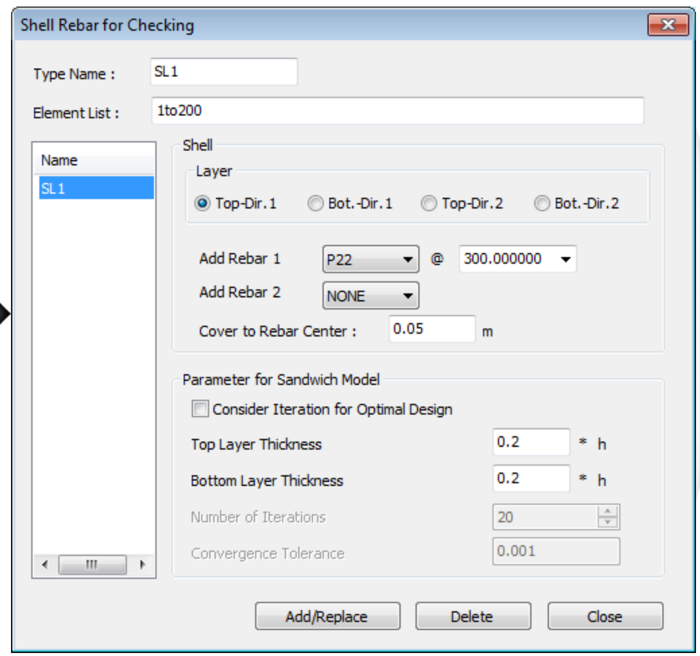
7. Shell Design

Shell Design

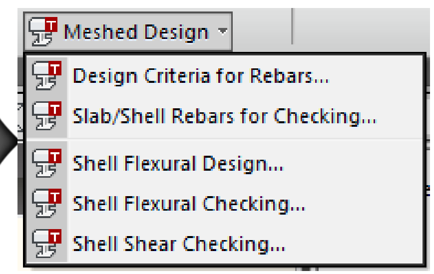
Step 1. Define as a shell member



Step 2. Define Rebar Data and Layer Thickness



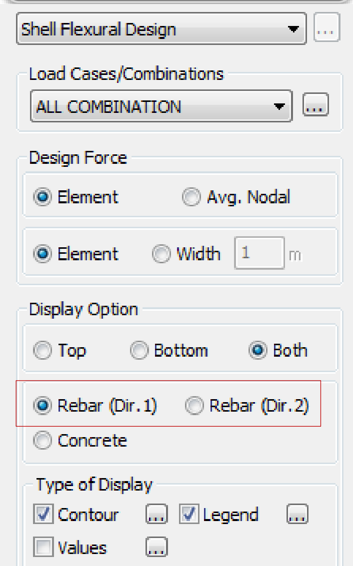
Step 3. Run Shell Design and Checking



7. Shell Design

Shell Flexural Design/Checking

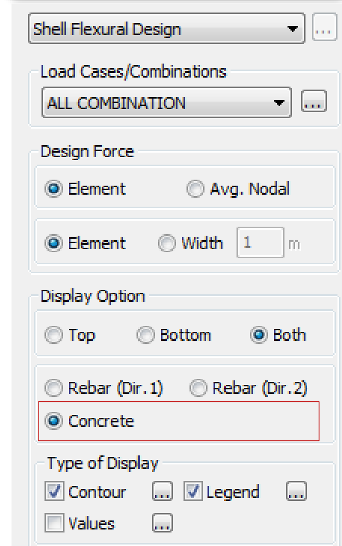
Result for Rebar



The followings can be displayed.

1. Membrane Axial Force
2. Membrane Shear Force
3. Rebar Stress
4. As_req
   (Required reinforcement area)
5. Rho_req
   (Required reinforcement ratio)
6. Rebar Arrangement

Result for Concrete



The followings can be displayed.

1. Membrane Axial Force
2. Membrane Shear Force
3. Principal Compressive Stress of Concrete

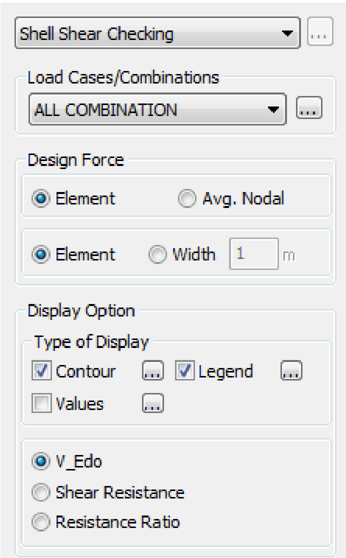
Results Table

	Elem	Node	POS	CHK	Dir-1				Dir-2				Conc			
					Lcom	f'td (kN/m²)	ftd (kN/m²)	Ratio	Lcom	f'td (kN/m²)	ftd (kN/m²)	Ratio	Lcom	Sig_cd (kN/m²)	sigcdlim (kN/m²)	Ratio
▶	2	2	TOP	NG	LC3-st	5720.27	808.63	7.07	LC3-st	1155.22	743.06	1.55	LC3-st	28.70	4000.00	0.01
	2	2	BOT	NG	LC3-st	139.52	771.16	0.18	LC3-st	28.18	721.21	0.04	LC3-st	5855.31	4000.00	1.46
	2	3	TOP	NG	LC3-st	5714.92	808.63	7.07	LC3-st	1148.37	743.06	1.55	LC3-st	13.97	4000.00	0.00
	2	3	BOT	NG	LC3-st	139.39	771.16	0.18	LC3-st	28.01	721.21	0.04	LC3-st	5856.79	4000.00	1.46
	2	7	TOP	NG	LC3-st	2992.12	808.63	3.70	LC3-st	524.62	743.06	0.71	LC3-st	69.89	4000.00	0.02
	2	7	BOT	OK	LC3-st	72.98	771.16	0.09	LC3-st	12.80	721.21	0.02	LC3-st	3040.47	4000.00	0.76
	2	8	TOP	NG	LC3-st	3092.07	808.63	3.82	LC3-st	630.71	743.06	0.85	LC3-st	27.22	4000.00	0.01
	2	8	BOT	OK	LC3-st	75.42	771.16	0.10	LC3-st	15.38	721.21	0.02	LC3-st	3163.41	4000.00	0.79

7. Shell Design

Shell Shear Checking

Result for Shear



The followings can be displayed.

1. V_Edo
2. Shear Resistance for Concrete
3. Resistance Ratio

Results Table

	Elem	Sub-Domain	Lcom	Node	CHK	Shear Force				Resistance		
						V_Edx (kN/m)	V_Edy (kN/m)	V_Edo (kN/m)	phi_o	V_Rdc (kN/m)	V_Rds (kN/m)	Asw/s (m^2/m)
▶	2	L-B	LC2-ser	7	OK	-44.70	1.76	44.73	-0.04	117.78	0.00	0.00
	2	L-B	LC2-ser	8	OK	-43.10	1.76	43.14	-0.04	117.78	0.00	0.00
	2	L-B	LC2-ser	3	OK	-43.10	0.00	43.10	-0.00	126.37	0.00	0.00
	2	L-B	LC2-ser	2	OK	-44.70	0.00	44.70	-0.00	126.37	0.00	0.00

7. Shell Design

Design Concept of Shell Design

- Shell or plate element subjected to membrane forces Nx,Ny,Nxy + flexural forces Mx,My,Mxy
- Resisted by resultant tensile forces of reinforcement + resultant compressive forces of concrete

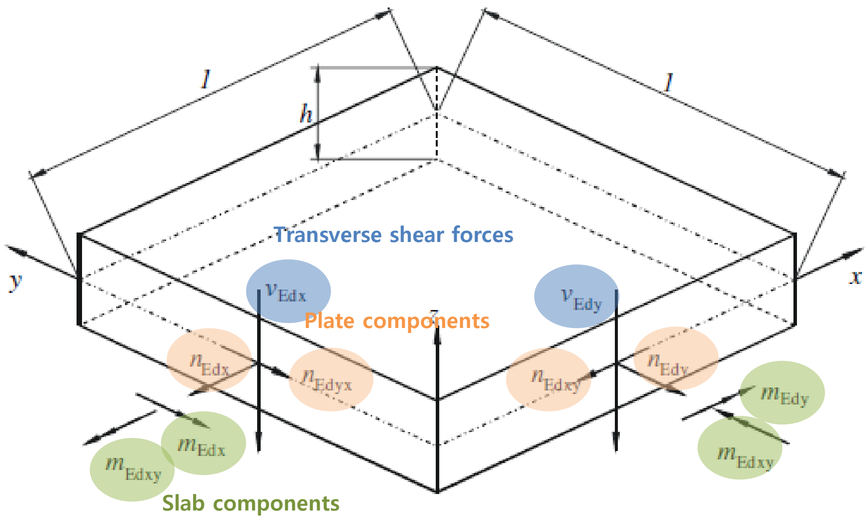


Figure LL.1 — Shell element

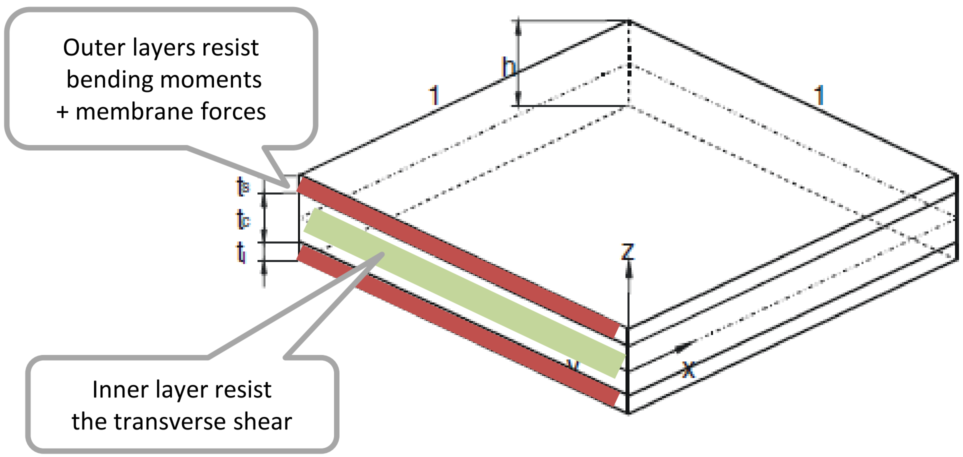
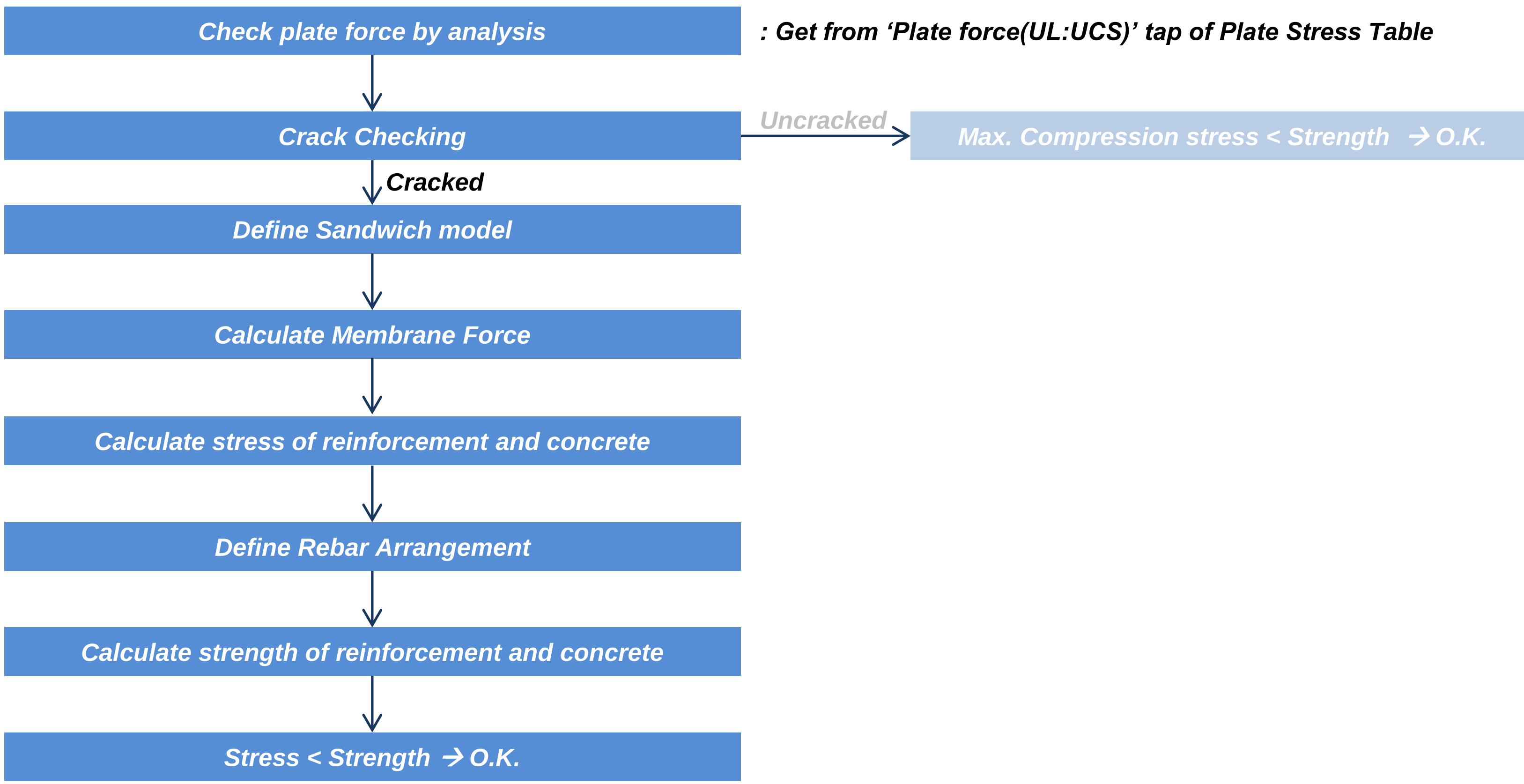


Figure LL.2 — The sandwich model

7. Shell Design

Procedure of Shell Design



7. Shell Design

Procedure of Shell Design

Crack Checking

$$\Phi = \alpha \frac{J_2}{f_{cm}^2} + \lambda \frac{\sqrt{J_2}}{f_{cm}} + \beta \frac{I_1}{f_{cm}} - 1 \le 0$$

→ *Uncracked,* ***If Φ > 0.0, Cracked***

where:

$$J_2 = \frac{1}{6}\left[(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2\right]$$

$$J_3 = (\sigma_1 - \sigma_m)(\sigma_2 - \sigma_m)(\sigma_3 - \sigma_m)$$

$$I_1 = \sigma_1 + \sigma_2 + \sigma_3$$

$$\sigma_m = (\sigma_1 + \sigma_2 + \sigma_3)/3$$

$$\alpha = \frac{1}{9k^{1,4}}$$

σ1 = Max. [σx, σy] = Max. [Fxx, Fyy]

σ2 = Min. [σx, σy] = Min. [Fxx, Fyy]

σ3 = 0

$$\lambda = c_1 \cos\left[\frac{1}{3}\mathrm{ar}\cos(C_2 \cos 3\theta)\right] \quad \text{for} \quad \cos 3\theta \ge 0$$

$$\lambda = c_1 \cos\left[\frac{\pi}{3} - \frac{1}{3}\mathrm{ar}\cos(-C_2 \cos 3\theta)\right] \quad \text{for} \quad \cos 3\theta < 0$$

$$\beta = \frac{1}{3{,}7k^{1,1}}$$

$$\cos 3\theta = \frac{3\sqrt{3}}{2}\frac{J_3}{J_2^{3/2}}$$

$$c_1 = \frac{1}{0{,}7k^{0,9}}$$

$$c_2 = 1 - 6{,}8\,(k - 0{,}07)^2$$

$$k = \frac{f_{ctm}}{f_{cm}}$$

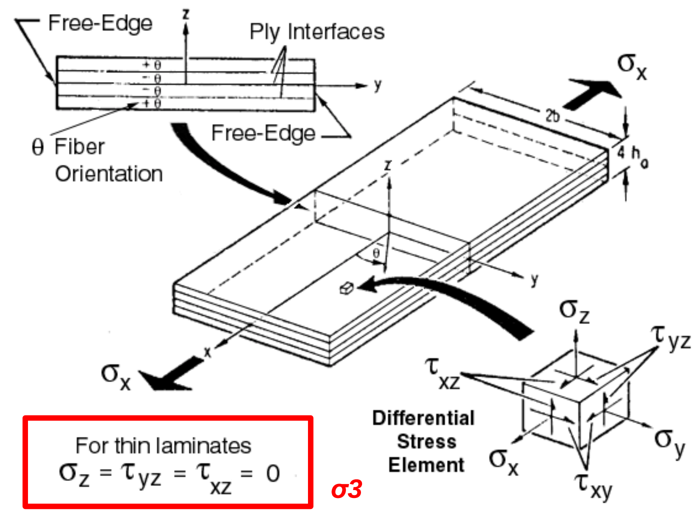


Plate Stress (UL : UCS) Table

	Elem	Load	Node	Fxx (kN/m)	Fyy (kN/m)	Fxy (kN/m)	Fmax (kN/m)	Fmin (kN/m)
▶	218	cLCB1	Cent	-17.633	-1.408	-0.083	-1.408	-17.634
	218	cLCB1	186	-18.198	-0.873	-0.319	-0.867	-18.203
	218	cLCB1	238	-17.152	-0.873	-0.275	-0.869	-17.157
	218	cLCB1	185	-17.152	-1.860	0.152	-1.859	-17.154
	218	cLCB1	150	-18.198	-1.860	0.108	-1.859	-18.198

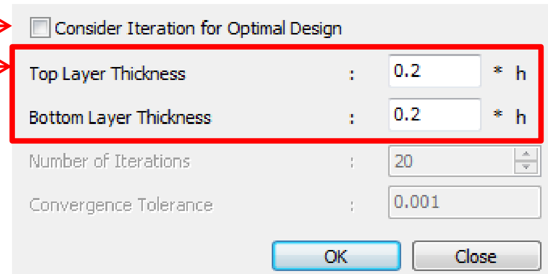
Plate Force(L) | Plate Force(G) | Plate Force(UL:Local) | **Plate Force(UL:UCS)** | F

7. Shell Design

Procedure of Shell Design

Define Sandwich model

- Use ‘ 0.2*h’ as default value.
- If check on “ Consider Iteration for optimal design”, layer thickness will be calculated automatically.



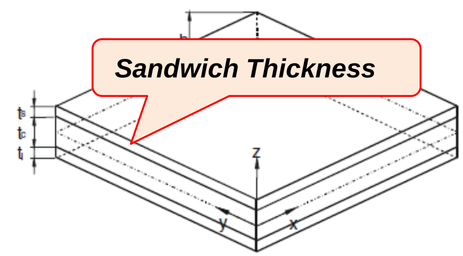


Figure LL.2 — The sandwich model

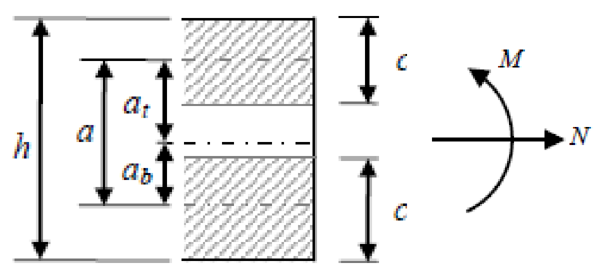
Calculate Membrane Force

- The geometry of sandwich element has to be known to compute the membrane forces (Nxk, Nyk, Nxyk).

$$N_{xt} = N_x \frac{a_b}{a} - \frac{M_x}{a} \qquad N_{xb} = N_x \frac{a_t}{a} + \frac{M_x}{a}$$

$$N_{yt} = N_y \frac{a_b}{a} - \frac{M_y}{a} \qquad N_{yb} = N_y \frac{a_t}{a} + \frac{M_y}{a}$$

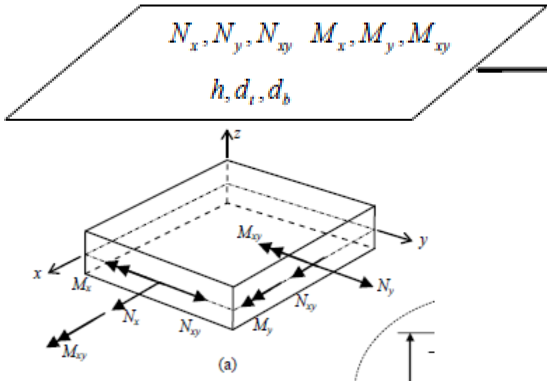
$$N_{xyt} = N_{xy} \frac{a_b}{a} - \frac{M_{xy}}{a} \qquad N_{xyb} = N_{xy} \frac{a_t}{a} + \frac{M_{xy}}{a}$$

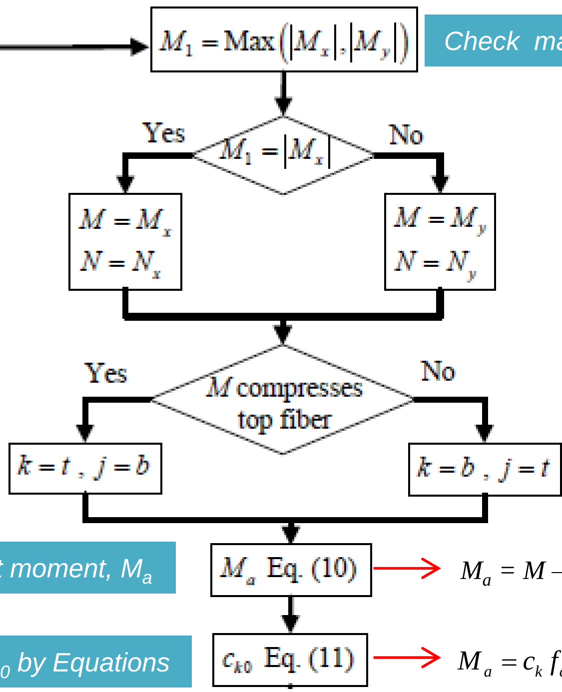


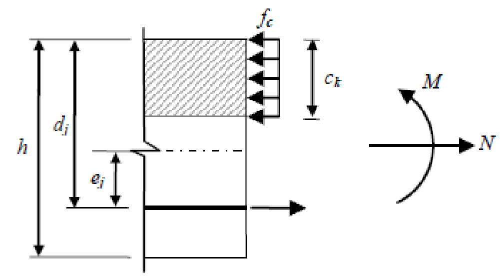
7. Shell Design

Procedure of Shell Design

Calculation of Sandwich Thickness for Optimal Design - 1







Check main moment

Define Comp. / Tens. by sign of moment

k=compression layer
j = tension layer

Cal. of Resultant moment, M_a

$M_a = M - Ne_j \qquad e_j = d_j - h/2$

Cal c_{k0} by Equations

$$M_a = c_k f_c \left(d_j - \frac{c_k}{2} \right), \quad put \ \mu = \frac{M_a}{d_j^2 f_c}$$

$$c_k = d_j \left(1 - \sqrt{\max[1.0 - 2\mu,\ 0]}\right)$$

ck0 : 1st estimation of ck
ck : the depth of the compression block

7. Shell Design

Procedure of Shell Design

Calculation of Sandwich Thickness for Optimal Design - 2

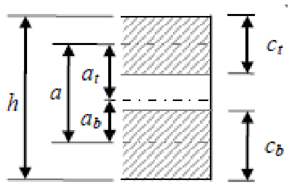
Membrane force in compression layer.

$$a = d_j - \frac{c_k}{2},\quad a_k = \frac{h - c_k}{2},\quad a_j = a - a_k$$

$$N_{xk} = N_x \frac{a_j}{a} - \frac{M_x}{a}$$

$$N_{yk} = N_y \frac{a_j}{a} - \frac{M_y}{a}$$

$$N_{xyk} = N_{xy} \frac{a_j}{a} - \frac{M_{xy}}{a}$$



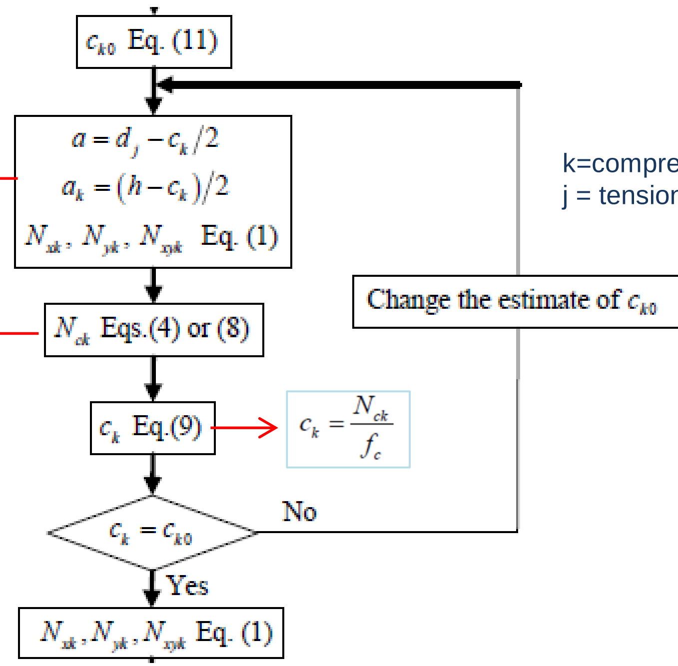
Compression Force of Concrete .

When $N_{xk} < -|N_{xyk}|,\ N_{yk} < -|N_{xyk}|$

$$N_{ck} = \frac{1}{2}(N_{xk} + N_{yk}) - \frac{1}{2}\sqrt{(N_{xk} - N_{yk})^2 + 4N_{xyk}}$$

When excluding $N_{xk} < -|N_{xyk}|,\ N_{yk} < -|N_{xyk}|$

$$N_{ck} = |N_{xyk}|(\tan\alpha_k + \cot\alpha_k)$$



k=compression layer
j = tension layer

7. Shell Design

Procedure of Shell Design

Calculation of Membrane Force in tension layer and Required Rebar Area

N_{xk}, N_{yk}, N_{xyk} Eq. (1)

↓

N_{xak}, N_{yak} Eqs.(2) & (3)

$$N_{xak} = N_{xk} + |N_{xyk}| \cot \alpha_k$$

$$N_{yak} = N_{yk} + |N_{xyk}| \tan \alpha_k$$

Calculate Comp. forces in reinforcement in compressed layer.
In Gen, Ignore Comp. forces in reinforcement (Required rebar Area by comp. is 0)

↓

$$N_{xj} = N_x - N_{xk}$$
$$N_{yj} = N_y - N_{yk}$$
$$N_{xyj} = N_{xy} - N_{xyk}$$

Calculate membrane force in tensioned layer.

↓

N_{xaj}, N_{yaj} Eqs.(2) & (3)

N_{cj} Eqs.(4) or (8)

Calculate tension forces in reinforcement in tension layer.

↓

Areq,x = Nxaj / fyd

Areq,y = Nyaj / fyd

Calculate required Rebar Area in tension layer.

7. Shell Design

Procedure of Shell Design

Calculate Force of reinforcement(Tension Layer) and concrete(Compression Layer)

Axis labels: $-|N_{xyk}|$, N_{yk}, N_{xk}, $-|N_{xyk}|$

$$N_{xk} < -|N_{xyk}|,\ N_{yk} \ge -|N_{xky}|$$

$$N_{xak} = 0$$

$$\alpha_k = \arctan\left(\frac{|N_{xyk}|}{-N_{xk}}\right)$$

$$N_{yak} = N_{yk} + |N_{xyk}| \tan\alpha_k$$

$$N_{ck} = |N_{xyk}|(\tan\alpha_k + \cot\alpha_k)$$

$$N_{yk} \ge -|N_{xyk}|,\ N_{xk} \ge -|N_{xky}|$$

$$\alpha_k = 45°$$

$$N_{xak} = N_{xk} + |N_{xyk}|\cot\alpha_k = N_{xk} + |N_{xyk}|$$

$$N_{yak} = N_{yk} + |N_{xyk}|\tan\alpha_k = N_{yk} + |N_{xyk}|$$

$$N_{ck} = |N_{xyk}|(\tan\alpha_k + \cot\alpha_k) = 2|N_{xyk}|$$

$$N_{xk} < -|N_{xyk}|,\ N_{yk} < -|N_{xyk}|$$

$$N_{xak} = N_{yak} = 0$$

$$N_{ck} = \frac{1}{2}(N_{xk} + N_{yk}) - \frac{1}{2}\sqrt{(N_{xk} - N_{yk})^2 + 4N_{xyk}^2}$$

$$N_{yk} < -|N_{xyk}|,\ N_{xk} \ge -|N_{xky}|$$

$$N_{yak} = 0$$

$$\alpha_k = \arctan\left(\frac{-N_{yk}}{|N_{xyk}|}\right)$$

$$N_{xak} = N_{xk} + |N_{xyk}|\cot\alpha_k$$

$$N_{ck} = |N_{xyk}|(\tan\alpha_k + \cot\alpha_k)$$

N_{xak}, N_{yak} : tension forces in reinforcement placed in x and y direction in layer k

N_{ck} : Concrete compression force in layer k

7. Shell Design

Procedure of Shell Design

Modification of Tension force by considering the location of rebar

Distance from center section to center of outerRebar

Distance from center section to center of sandwich thickness

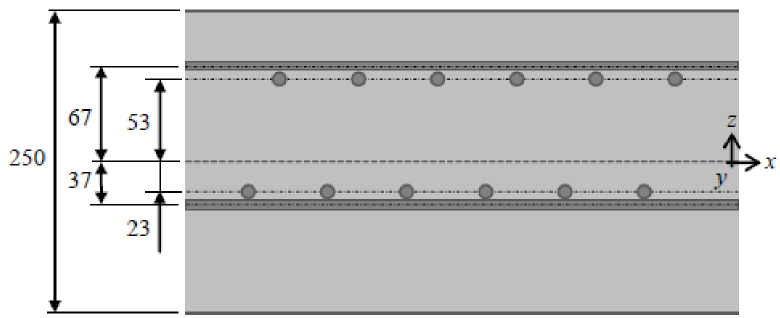
$$z_{ya} = \frac{N_{yat} z_{yat} + N_{yab} z_{yab}}{\sum N_{ya}} = \frac{168.71 \cdot 67 + 229.47(-80)}{398.18} = -17.72\ mm$$

The actual positions of y reinforcement in top and bottom layer are $z^*_{yat} = 53$ mm and $z^*_{yab} = -23$ mm, the corresponding tension forces at those levels, N^*_{yat} and N^*_{yab}, can be obtained from:

$$N^*_{yat} = \sum N_{ya} \frac{z_{ya} - z^*_{yab}}{z^*_{yat} - z^*_{yab}} = 398.18 \frac{-17.72 + 23}{53 + 23} = 27.68\ N/mm$$

$$N^*_{yab} = \sum N_{ya} \frac{z^*_{yat} - z_{ya}}{z^*_{yat} - z^*_{yab}} = 398.18 \frac{53 + 17.72}{53 + 23} = 370.50\ N/mm$$

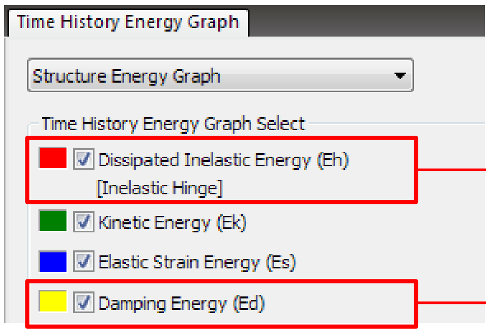
All the measurements in mm

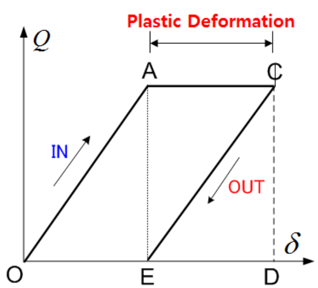


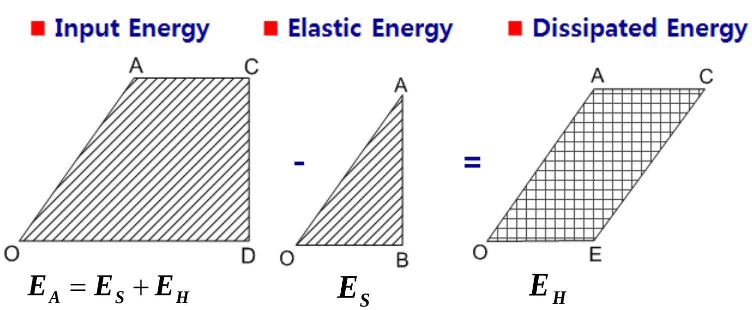
1. Energy Result Graph for Time History Analysis

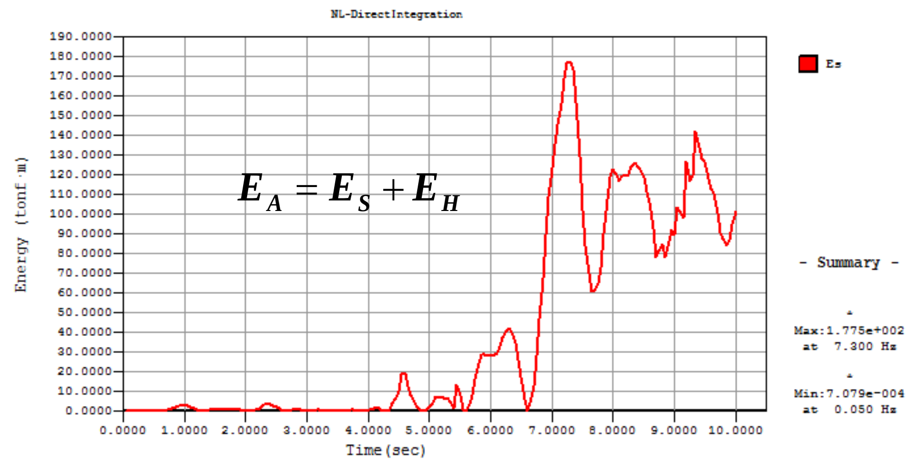
- Print out energy results graph for isolator and vibration control devices in the nonlinear time history analysis.

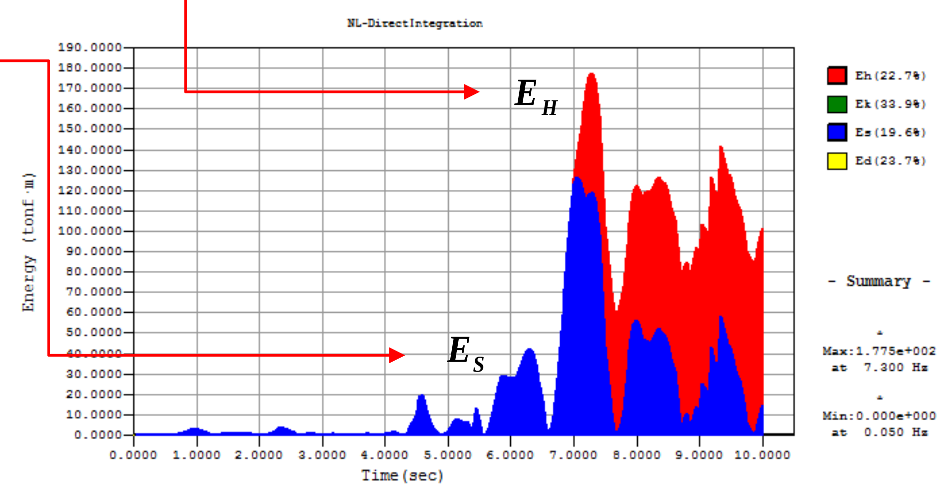
- ***Result > T.H. Graph/Text > Time History Energy Graph***





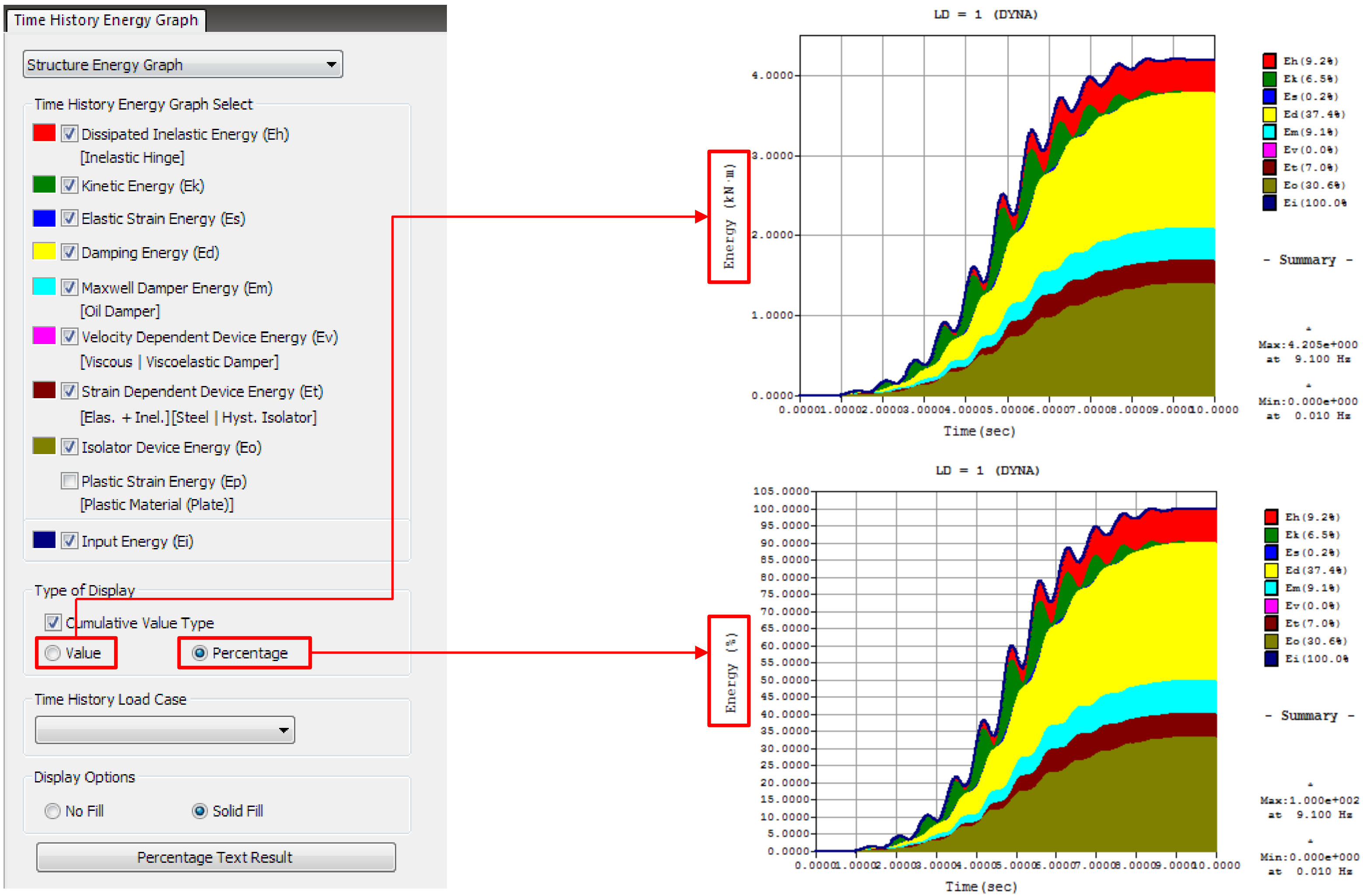






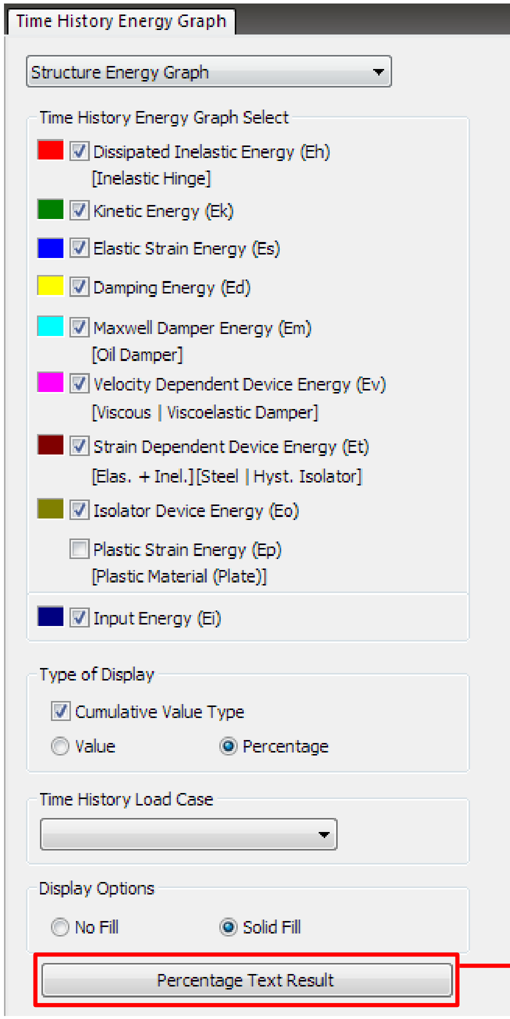
1. Energy Result Graph for Time History Analysis

- ***Result > T.H. Graph/Text > Time History Energy Graph***

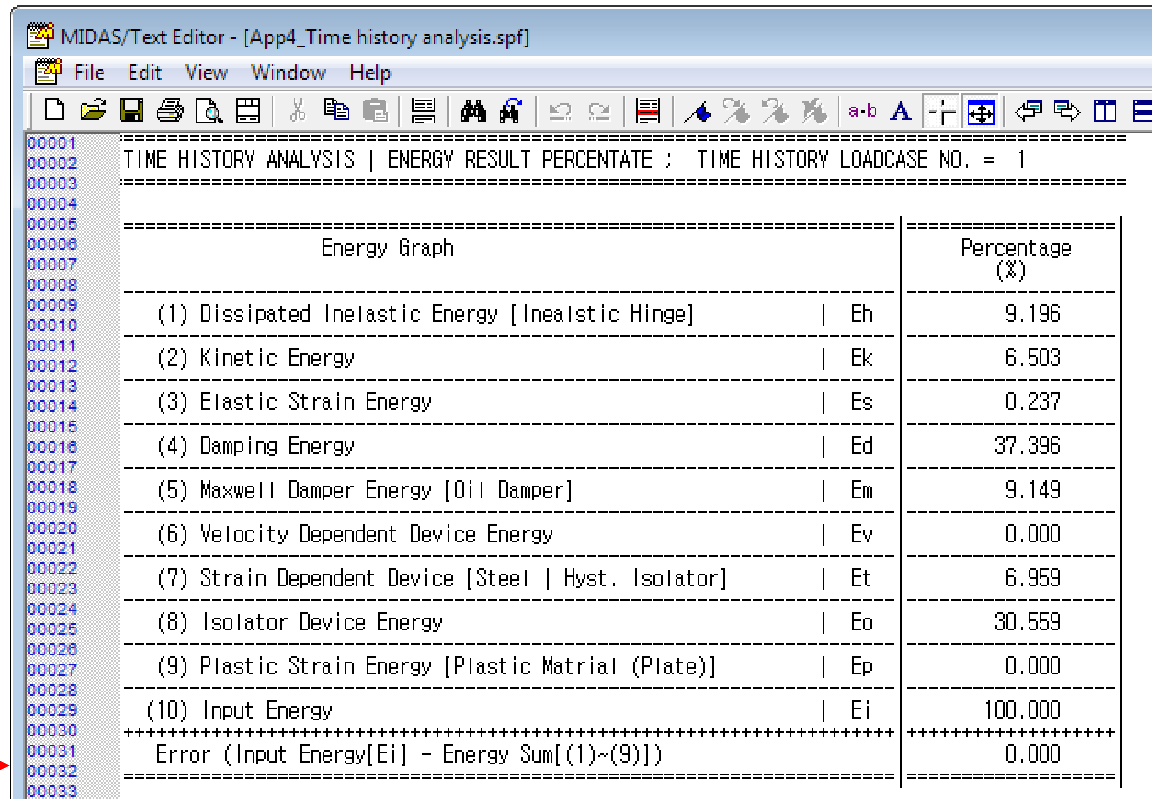


1. Energy Result Graph for Time History Analysis

- ***Result > T.H. Graph/Text > Time History Energy Graph***



< Text result of the each energy ratio >

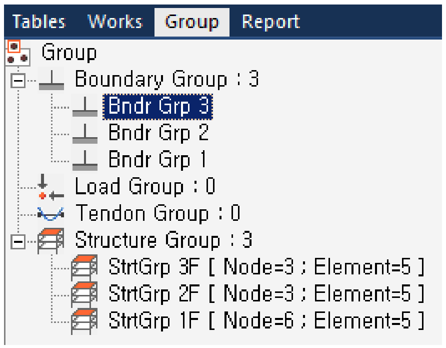


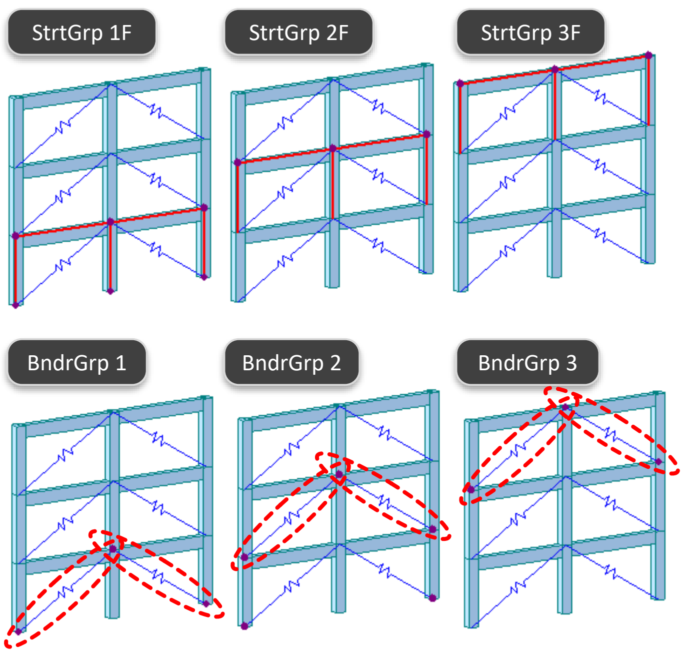
TIME HISTORY ANALYSIS | ENERGY RESULT PERCENTATE ; TIME HISTORY LOADCASE NO. = 1

Energy Graph		Percentage (%)
(1) Dissipated Inelastic Energy [Inealstic Hinge]	Eh	9.196
(2) Kinetic Energy	Ek	6.503
(3) Elastic Strain Energy	Es	0.237
(4) Damping Energy	Ed	37.396
(5) Maxwell Damper Energy [Oil Damper]	Em	9.149
(6) Velocity Dependent Device Energy	Ev	0.000
(7) Strain Dependent Device [Steel | Hyst. Isolator]	Et	6.959
(8) Isolator Device Energy	Eo	30.559
(9) Plastic Strain Energy [Plastic Matrial (Plate)]	Ep	0.000
(10) Input Energy	Ei	100.000
Error (Input Energy[Ei] - Energy Sum[(1)~(9)])		0.000

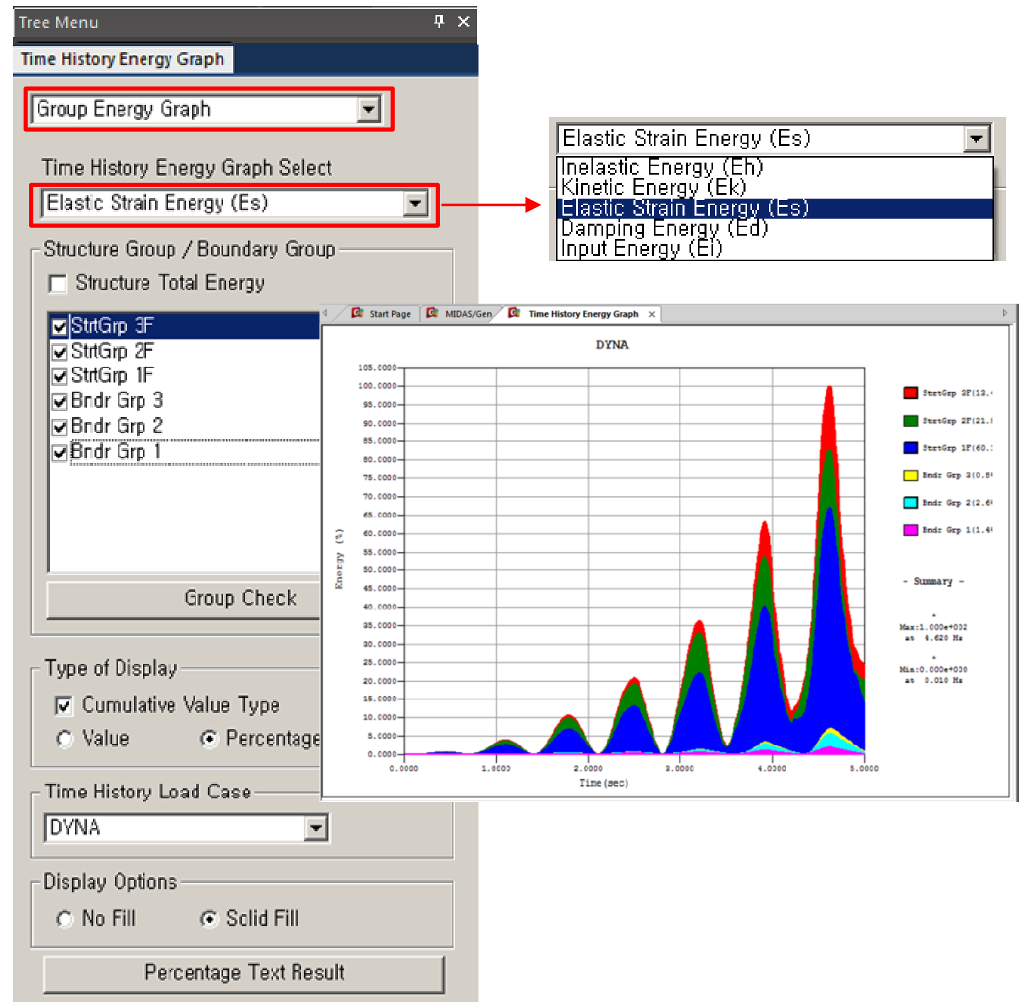
1. Energy Result Graph for Time History Analysis

- ***Result > T.H. Graph/Text > Time History Energy Graph***





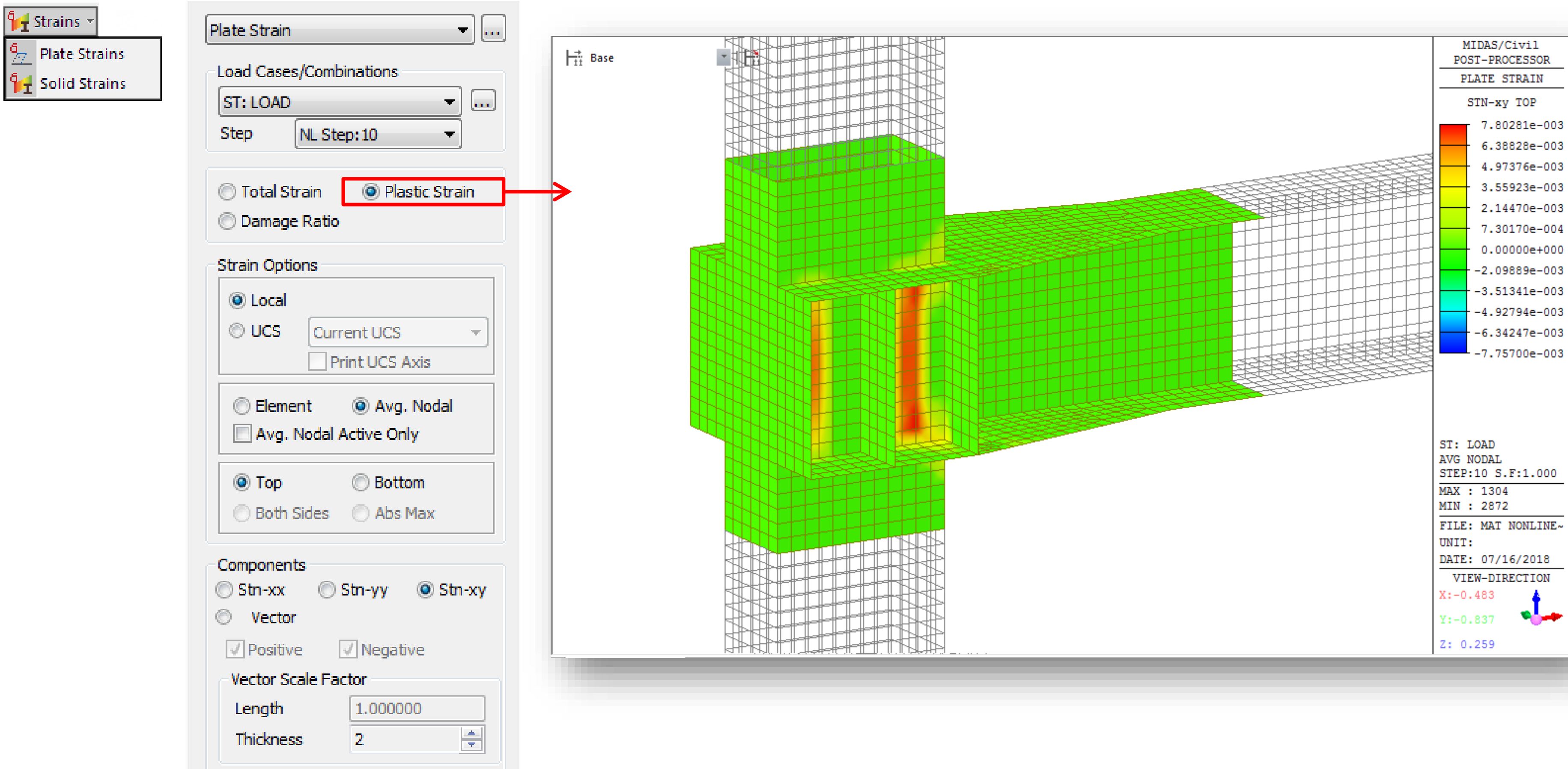
< Result output of group distribution for each energy item >



2. Strain Output for Material Nonlinear Analysis

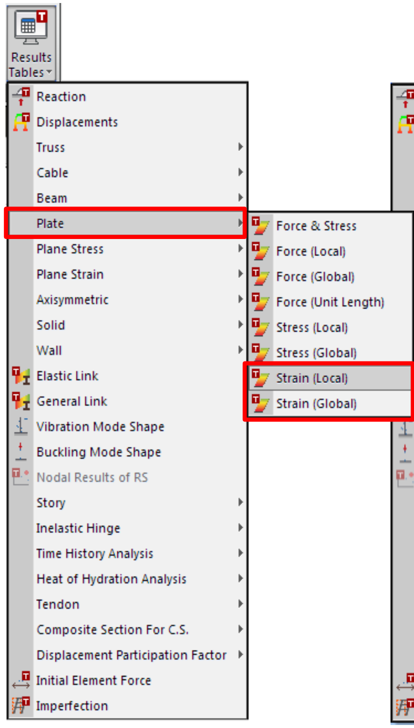
- Strain results are provided for plastic materials, i.e. Tresca, Von Mises, Mohr-Coulomb, Drucker-Prager, and Concrete Damage.
- Damage ratios for compression and tension are provided for the 'Concrete Damage' model.

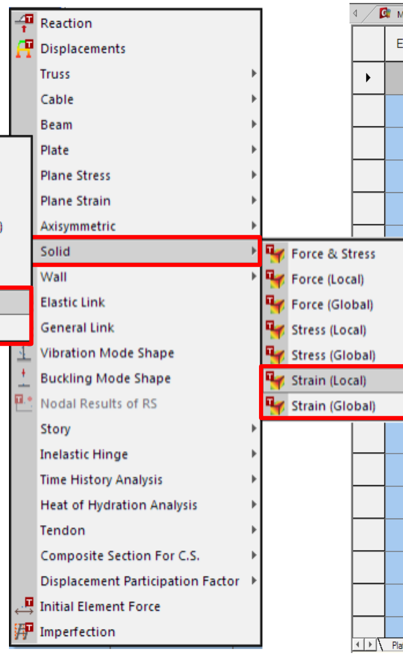
- ***Results > Results > Strains > Plate Strains/ Solid Strains***

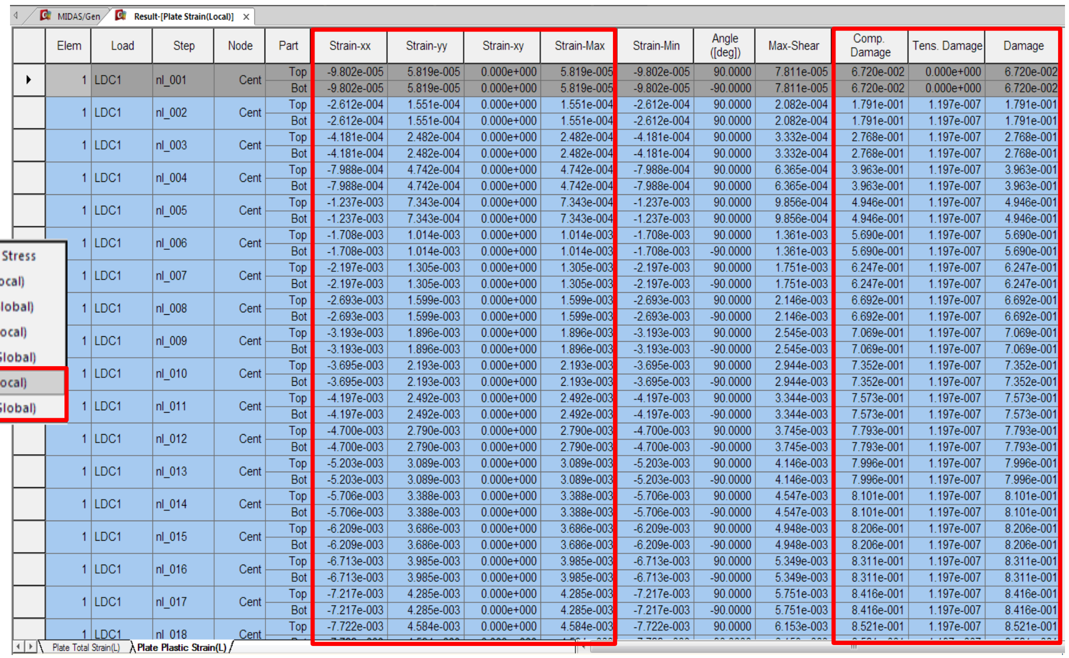


2. Strain Output for Material Nonlinear Analysis

- ***Results > Tables > Results Tables > Plate/ Solid > Strain(local)/ Strain(Global)***







Elem	Load	Step	Node	Part	Strain-xx	Strain-yy	Strain-xy	Strain-Max	Strain-Min	Angle ([deg])	Max-Shear	Comp. Damage	Tens. Damage	Damage
1	LDC1	nl_001	Cent	Top	-9.802e-005	5.819e-005	0.000e+000	5.819e-005	-9.802e-005	90.0000	7.811e-005	6.720e-002	0.000e+000	6.720e-002
				Bot	-9.802e-005	5.819e-005	0.000e+000	5.819e-005	-9.802e-005	-90.0000	7.811e-005	6.720e-002	0.000e+000	6.720e-002
1	LDC1	nl_002	Cent	Top	-2.612e-004	1.551e-004	0.000e+000	1.551e-004	-2.612e-004	90.0000	2.082e-004	1.791e-001	1.197e-007	1.791e-001
				Bot	-2.612e-004	1.551e-004	0.000e+000	1.551e-004	-2.612e-004	90.0000	2.082e-004	1.791e-001	1.197e-007	1.791e-001
1	LDC1	nl_003	Cent	Top	-4.181e-004	2.482e-004	0.000e+000	2.482e-004	-4.181e-004	90.0000	3.332e-004	2.768e-001	1.197e-007	2.768e-001
				Bot	-4.181e-004	2.482e-004	0.000e+000	2.482e-004	-4.181e-004	90.0000	3.332e-004	2.768e-001	1.197e-007	2.768e-001
1	LDC1	nl_004	Cent	Top	-7.988e-004	4.742e-004	0.000e+000	4.742e-004	-7.988e-004	90.0000	6.365e-004	3.963e-001	1.197e-007	3.963e-001
				Bot	-7.988e-004	4.742e-004	0.000e+000	4.742e-004	-7.988e-004	90.0000	6.365e-004	3.963e-001	1.197e-007	3.963e-001
1	LDC1	nl_005	Cent	Top	-1.237e-003	7.343e-004	0.000e+000	7.343e-004	-1.237e-003	90.0000	9.856e-004	4.946e-001	1.197e-007	4.946e-001
				Bot	-1.237e-003	7.343e-004	0.000e+000	7.343e-004	-1.237e-003	90.0000	9.856e-004	4.946e-001	1.197e-007	4.946e-001
1	LDC1	nl_006	Cent	Top	-1.708e-003	1.014e-003	0.000e+000	1.014e-003	-1.708e-003	90.0000	1.361e-003	5.690e-001	1.197e-007	5.690e-001
				Bot	-1.708e-003	1.014e-003	0.000e+000	1.014e-003	-1.708e-003	-90.0000	1.361e-003	5.690e-001	1.197e-007	5.690e-001
1	LDC1	nl_007	Cent	Top	-2.197e-003	1.305e-003	0.000e+000	1.305e-003	-2.197e-003	90.0000	1.751e-003	6.247e-001	1.197e-007	6.247e-001
				Bot	-2.197e-003	1.305e-003	0.000e+000	1.305e-003	-2.197e-003	-90.0000	1.751e-003	6.247e-001	1.197e-007	6.247e-001
1	LDC1	nl_008	Cent	Top	-2.693e-003	1.599e-003	0.000e+000	1.599e-003	-2.693e-003	90.0000	2.146e-003	6.692e-001	1.197e-007	6.692e-001
				Bot	-2.693e-003	1.599e-003	0.000e+000	1.599e-003	-2.693e-003	-90.0000	2.146e-003	6.692e-001	1.197e-007	6.692e-001
1	LDC1	nl_009	Cent	Top	-3.193e-003	1.896e-003	0.000e+000	1.896e-003	-3.193e-003	90.0000	2.545e-003	7.069e-001	1.197e-007	7.069e-001
				Bot	-3.193e-003	1.896e-003	0.000e+000	1.896e-003	-3.193e-003	-90.0000	2.545e-003	7.069e-001	1.197e-007	7.069e-001
1	LDC1	nl_010	Cent	Top	-3.695e-003	2.193e-003	0.000e+000	2.193e-003	-3.695e-003	90.0000	2.944e-003	7.352e-001	1.197e-007	7.352e-001
				Bot	-3.695e-003	2.193e-003	0.000e+000	2.193e-003	-3.695e-003	-90.0000	2.944e-003	7.352e-001	1.197e-007	7.352e-001
1	LDC1	nl_011	Cent	Top	-4.197e-003	2.492e-003	0.000e+000	2.492e-003	-4.197e-003	90.0000	3.344e-003	7.573e-001	1.197e-007	7.573e-001
				Bot	-4.197e-003	2.492e-003	0.000e+000	2.492e-003	-4.197e-003	-90.0000	3.344e-003	7.573e-001	1.197e-007	7.573e-001
1	LDC1	nl_012	Cent	Top	-4.700e-003	2.790e-003	0.000e+000	2.790e-003	-4.700e-003	90.0000	3.745e-003	7.793e-001	1.197e-007	7.793e-001
				Bot	-4.700e-003	2.790e-003	0.000e+000	2.790e-003	-4.700e-003	-90.0000	3.745e-003	7.793e-001	1.197e-007	7.793e-001
1	LDC1	nl_013	Cent	Top	-5.203e-003	3.089e-003	0.000e+000	3.089e-003	-5.203e-003	90.0000	4.146e-003	7.996e-001	1.197e-007	7.996e-001
				Bot	-5.203e-003	3.089e-003	0.000e+000	3.089e-003	-5.203e-003	-90.0000	4.146e-003	7.996e-001	1.197e-007	7.996e-001
1	LDC1	nl_014	Cent	Top	-5.706e-003	3.388e-003	0.000e+000	3.388e-003	-5.706e-003	90.0000	4.547e-003	8.101e-001	1.197e-007	8.101e-001
				Bot	-5.706e-003	3.388e-003	0.000e+000	3.388e-003	-5.706e-003	-90.0000	4.547e-003	8.101e-001	1.197e-007	8.101e-001
1	LDC1	nl_015	Cent	Top	-6.209e-003	3.686e-003	0.000e+000	3.686e-003	-6.209e-003	90.0000	4.948e-003	8.206e-001	1.197e-007	8.206e-001
				Bot	-6.209e-003	3.686e-003	0.000e+000	3.686e-003	-6.209e-003	-90.0000	4.948e-003	8.206e-001	1.197e-007	8.206e-001
1	LDC1	nl_016	Cent	Top	-6.713e-003	3.985e-003	0.000e+000	3.985e-003	-6.713e-003	90.0000	5.349e-003	8.311e-001	1.197e-007	8.311e-001
				Bot	-6.713e-003	3.985e-003	0.000e+000	3.985e-003	-6.713e-003	-90.0000	5.349e-003	8.311e-001	1.197e-007	8.311e-001
1	LDC1	nl_017	Cent	Top	-7.217e-003	4.285e-003	0.000e+000	4.285e-003	-7.217e-003	90.0000	5.751e-003	8.416e-001	1.197e-007	8.416e-001
				Bot	-7.217e-003	4.285e-003	0.000e+000	4.285e-003	-7.217e-003	-90.0000	5.751e-003	8.416e-001	1.197e-007	8.416e-001
1	LDC1	nl_018	Cent	Top	-7.722e-003	4.584e-003	0.000e+000	4.584e-003	-7.722e-003	90.0000	6.153e-003	8.521e-001	1.197e-007	8.521e-001

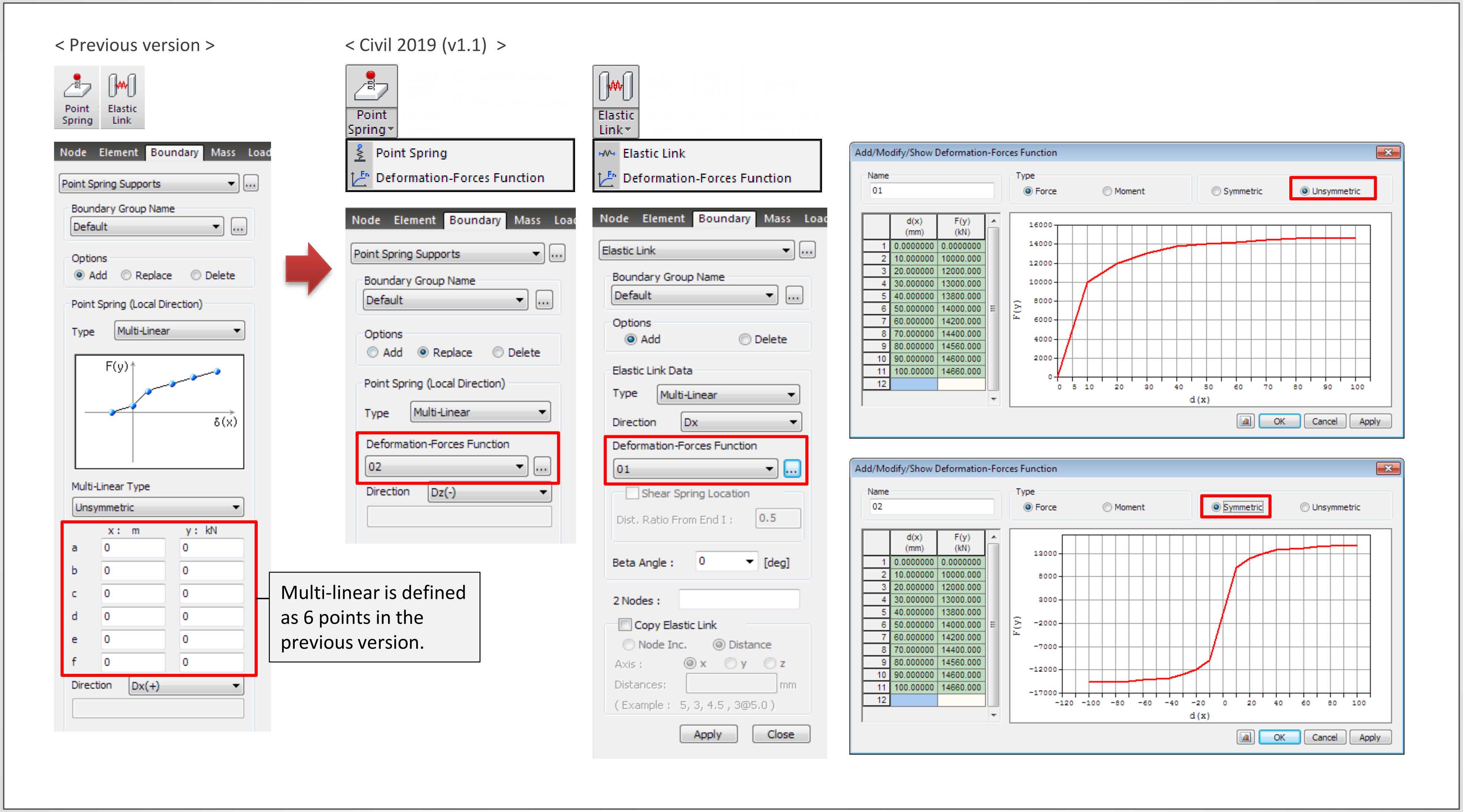
<Plate Strain (local) menu>

<Solid Strain (local) menu>

Plate Strain Table

3. Multi-linear force-deformation function for Point Spring Support and Elastic Link

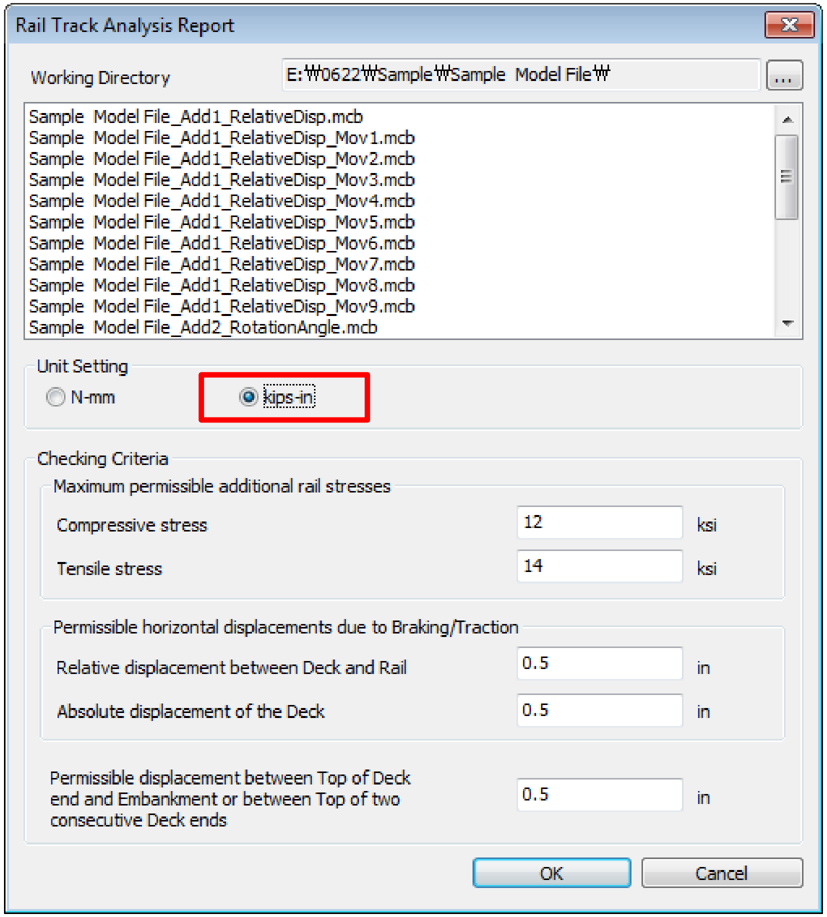
- Multi-linear curve for Point Spring Support and Elastic Link can be defined as a function without limitation in terms of number of data.



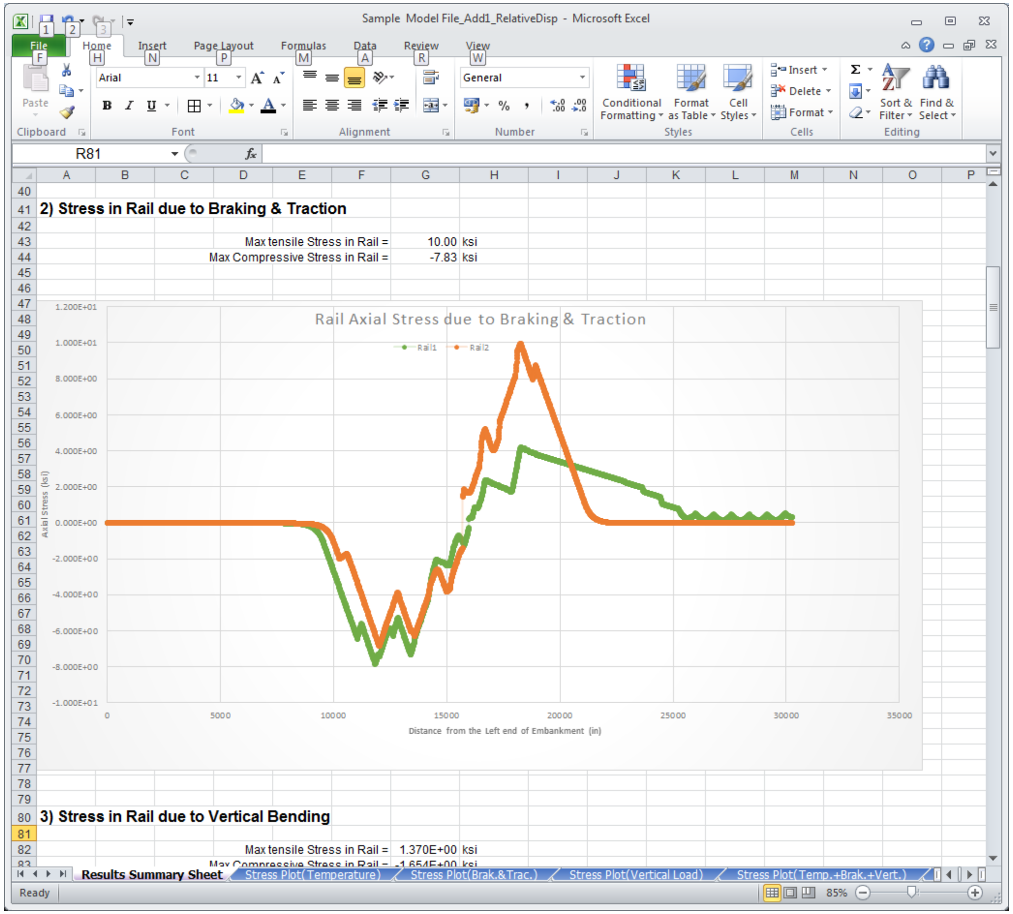
4. Rail Track Analysis Report with the US Unit Setting

- Rail Track Analysis report supports the US unit system as well as SI unit system.

- ***Structure > Wizard > Rail Track Analysis Model > Rail Track Analysis Report***



Report Setting to the US unit

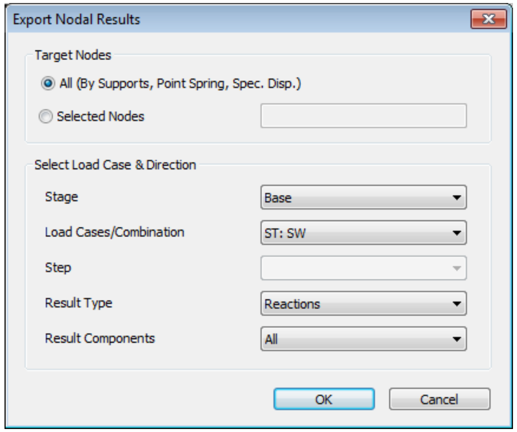


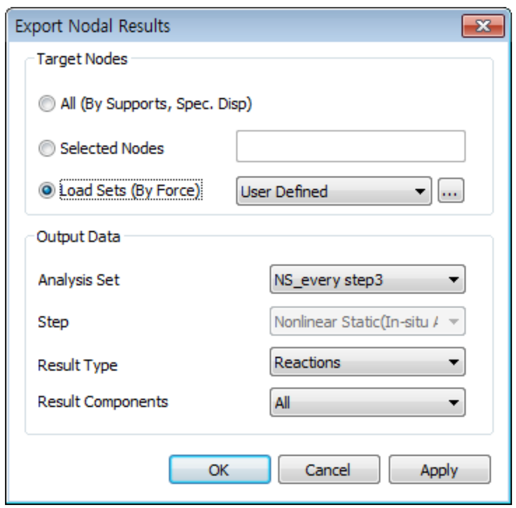
Rail Track Analysis Report

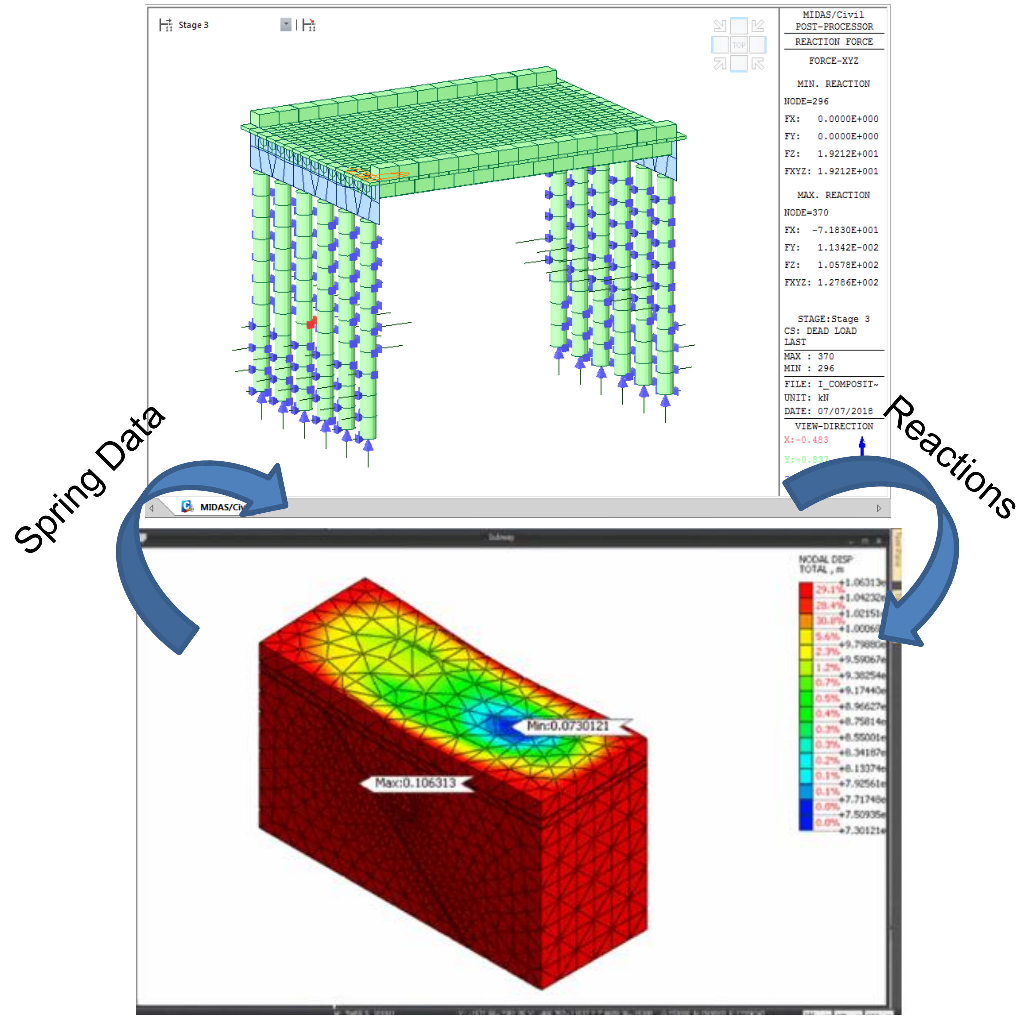
5. Data Interface with GTS NX

- Reactions from Point Spring Support can be exported to GTS NX.
- Force-displacement results of soil can be imported from GTS NX into midas Civil, and the input data of the multi-linear Point Spring Supports are updated.

- ***File > Export > Nodal Results for GTS***
- ***File > Import > Nodal Results for GTS***



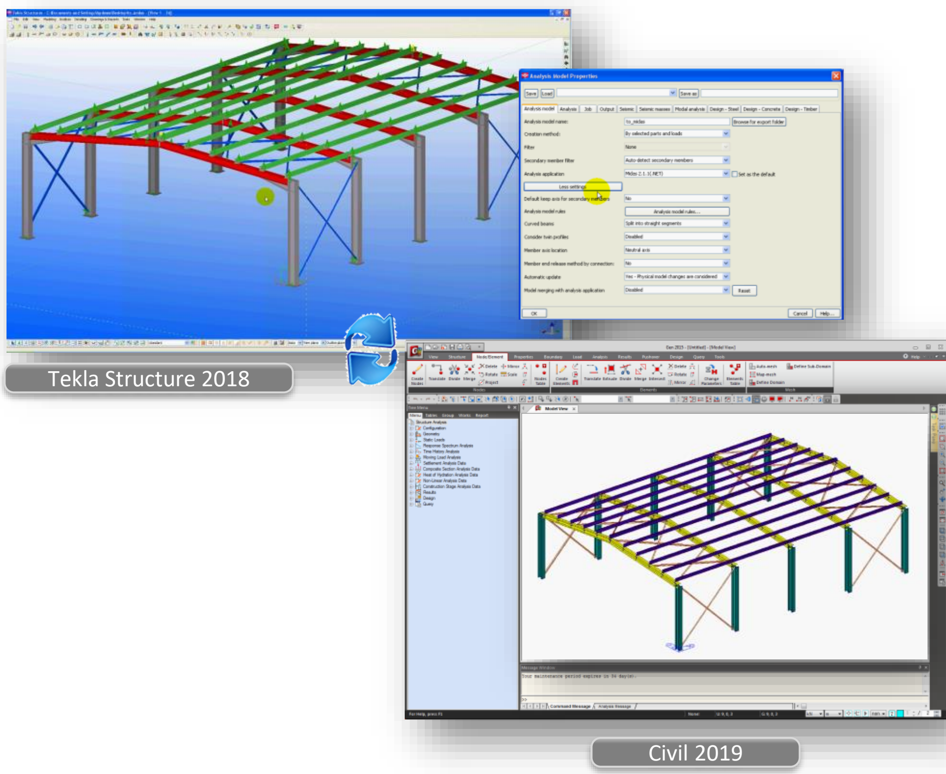




6. Tekla Structure 2018 Interface

- Tekla Structures interface is a tool provided to speed up the entire modeling, analysis, and design procedure of a structure by direct data transfer with midas Civil.
- Data transfer is limited to structural elements.
- Tekla Structure interface enables us to directly transfer a Tekla model data to midas Civil, and delivery back to the Tekla model file. midas Civil text file (*.mct) is used for the roundtrip.

- ***File > Import > midas Civil MCT File***
- ***File > Export > midas Civil MCT File***



Category	Features	Tekla <> Gen
MATERIAL	concrete	<>
	steel	<>
	pre cast - wood and other types	<>
	Material user defined	<>
ELEMENT TYPE/ ROTATIONS	vertical column	<>
	inclined column	<>
	straight beam	<>
	curved beam	>
	Slab	<>
	vertical panel	>
2D ELEMENTS	Concrete panels and slab	<>
BOUNDARY CONDITIONS	support	>
	beam end release	<>
	section offset	>
STATIC LOAD	self weigth	>
	linear load (uniform or trapezoidal)	<>
MERGE OPTION	new element	<>
	new element that divide other elements	<>
	topology changes	<>