MIDAS

Release Note

Release Date : January 2021

Product Ver. : FEA NX 2021 (v1.1)

ADVANCED NONLINEAR AND DETAIL

New Paradigm in Advanced Structural Analysis

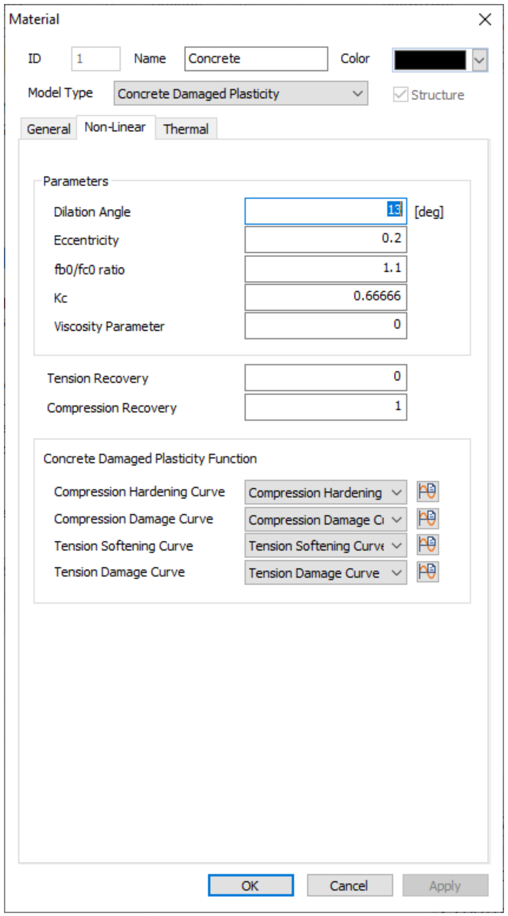
Enhancements

1. Concrete Damage Plasticity Model
2. Fatigue Analysis
3. Virtual Beam for Calculation of Resultant Forces of 2D/3D Mesh
4. Displacement-Control Method for Nonlinear Analysis
5. Modal Participation Factor
6. Improvement of Multi-Layered Grid (Composite Shell)
7. Improvement of Bond Slip Interface
8. Modified Menegotto-Pinto Material Model for Steel
9. General Hyperbolic Equation GHE-S Model
10. 3D Hill Plastic Model
11. Creep & Shrinkage Function and Expansive Additive for Concrete (JCI 2016/JSCE 2017)

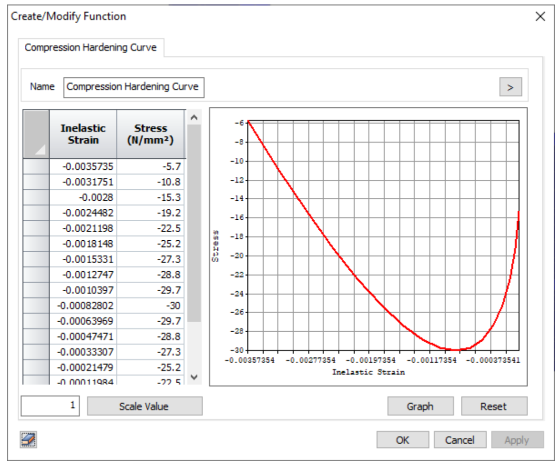
1. Concrete Damaged Plasticity Model

- Concrete Damaged Plasticity Model is now available in midas FEA NX. It provides a general capability for modeling concrete and other quasi-brittle materials including masonry and is designed for applications in which concrete is subjected to dynamic loading due to earthquake under low confining pressures.

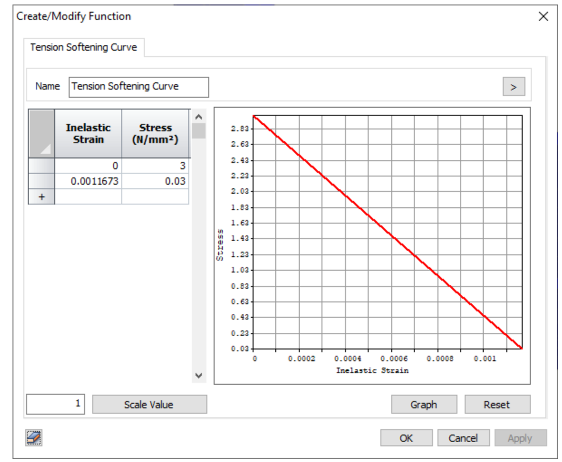
- ***Mesh > Material > Concrete Damaged Plasticity***



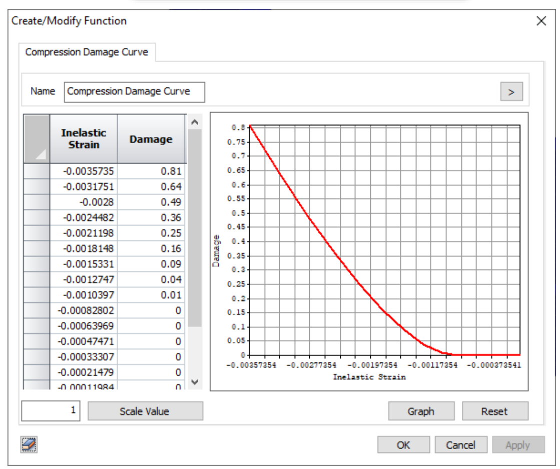
Concrete Damaged Plasticity Model



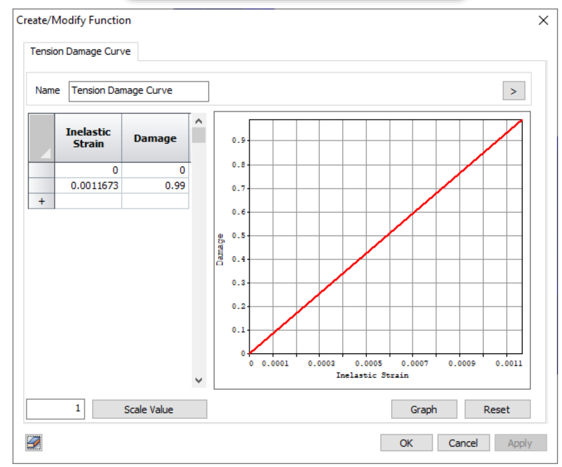
Compression Hardening Curve



Tension Softening Curve



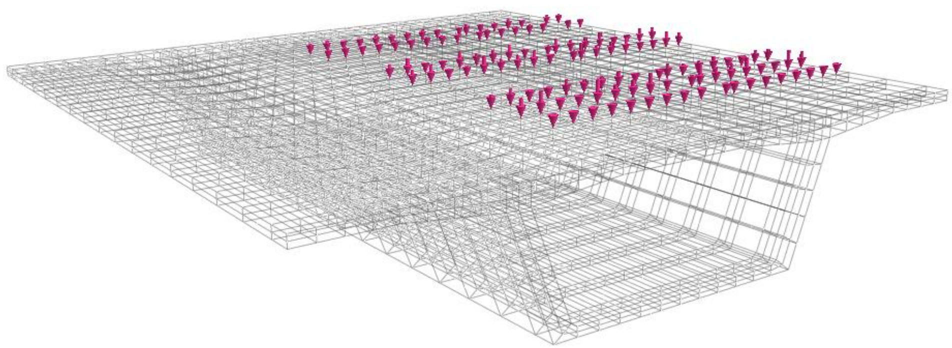
Compression Damage Curve

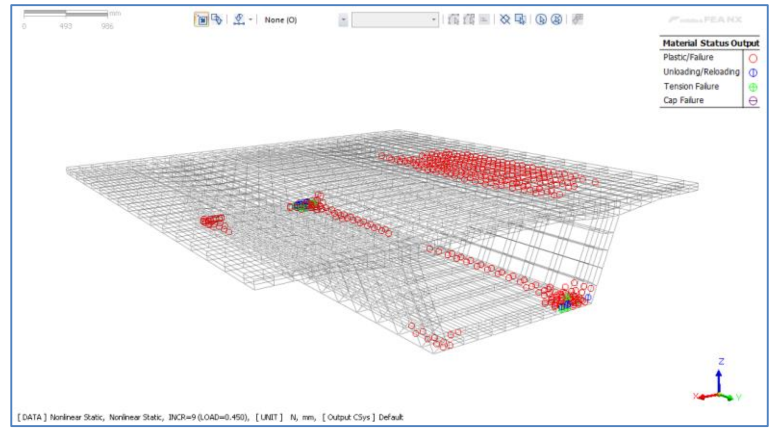


Tension Damage Curve

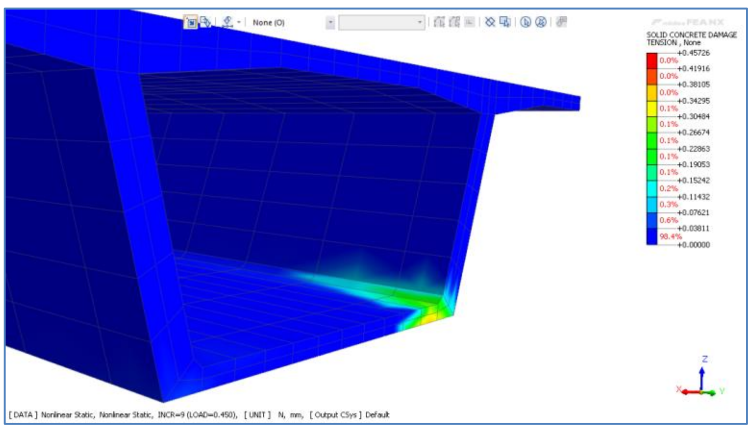
1. Concrete Damaged Plasticity Model

- Using this model, the following behaviors of concrete can be described. Different behaviors for tension and compression. Different reductions of the elastic stiffness when unloading for tension and compression. Stiffness recovery effects during cyclic load reversals.

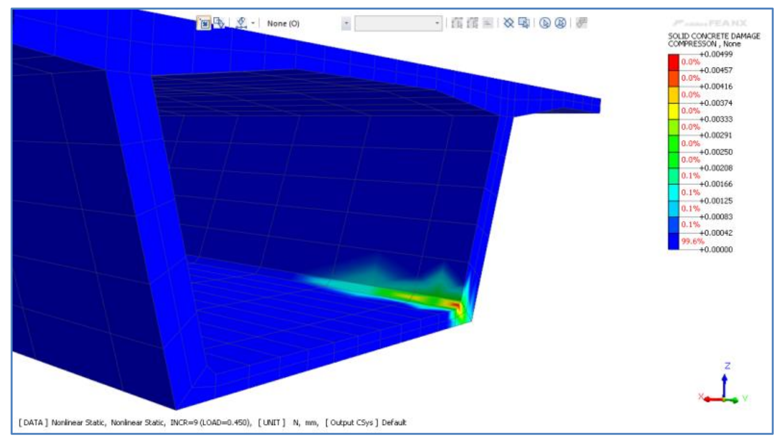




Plastic Status



Tension Damage

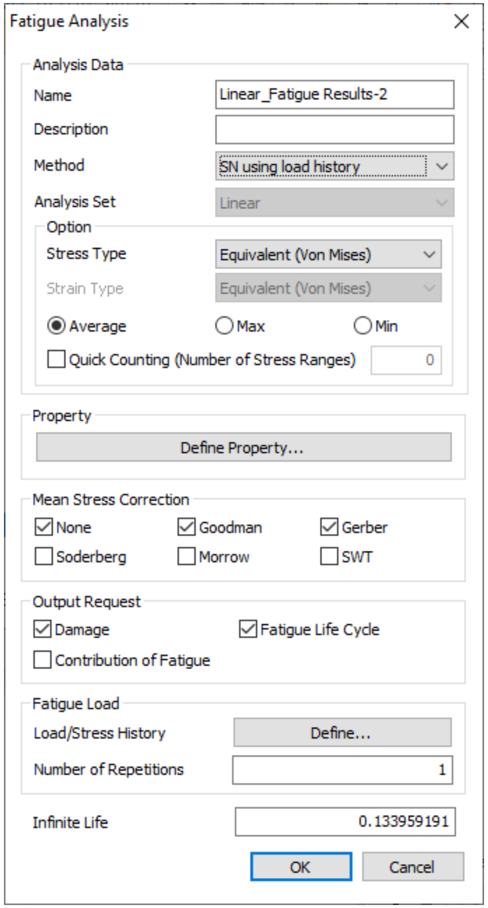


Compression Damage

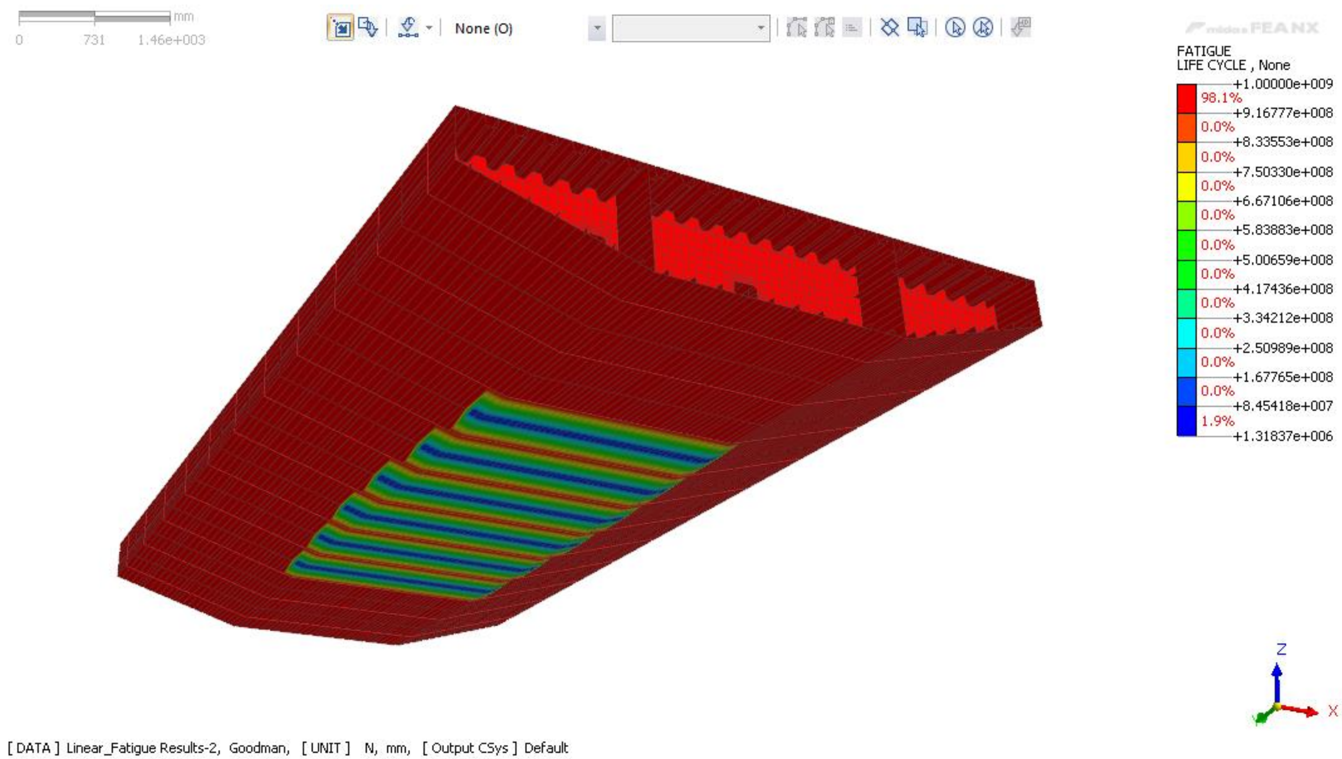
2. Fatigue Analysis

- Fatigue analysis can be performed on the basis of stress (stress-life method) and strain (strain-life method).
- Fatigue lifecycle and fatigue damage can be viewed for the various mean stress correction methods, i.e. Goodman, Gerber, etc.

▪ ***Results > Fatigue Analysis***



Fatigue Analysis



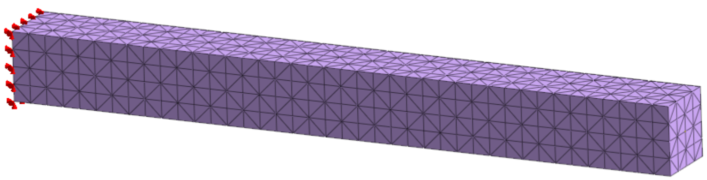
Fatigue Lifecycle Contour

3. Virtual Beam for Calculation of Resultant Forces of 2D/3D Mesh

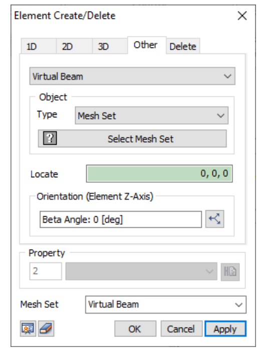
- Resultant forces of 2D/3D mesh can be calculated and viewed as force diagram.
- This is useful to check moment/shear force diagram for the pile modelled with solid elements.

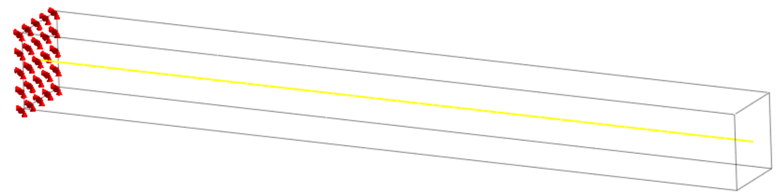
▪ ***Mesh > Element > Create > Other > Virtual Beam***

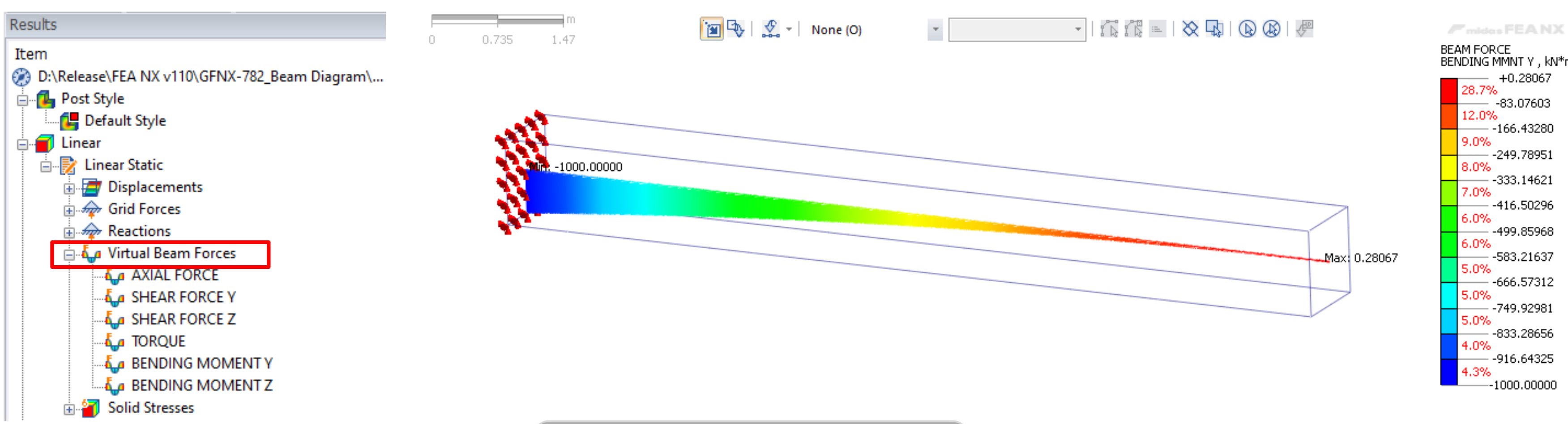
Step 1. Generate a 3D mesh.



Step 2. Generate a 1D mesh for virtual beam by clicking start point and end point of the virtual beam. 1D geometry is not necessary to generate virtual beam.





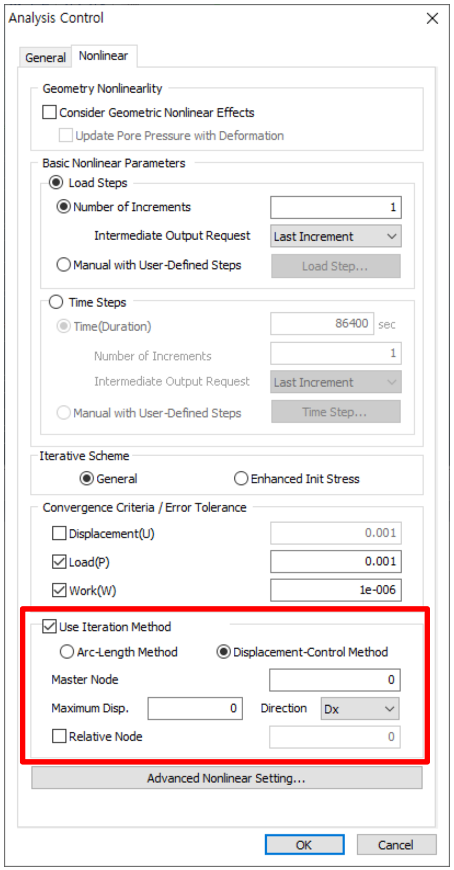


Bending Moment Diagram for Virtual Beam

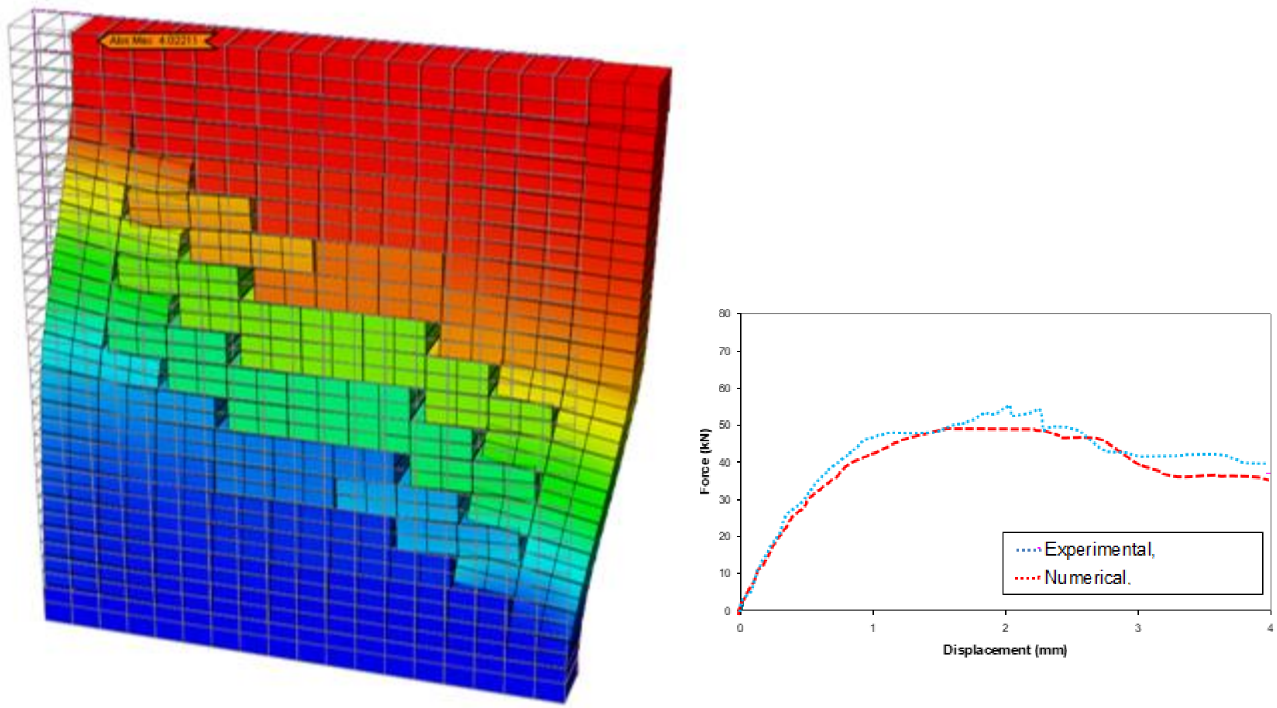
4. Displacement-Control Method for Nonlinear Analysis

- For performing nonlinear analysis, the Displacement-Control method is added for the iteration method.
- Global displacement of a master node can be controlled, or relative displacement between two nodes can be controlled using the 'Relative Node' option.

▪ ***Analysis > Analysis Case > General > Nonlinear Static > Analysis Control > Nonlinear***



Analysis Control Dialog Box

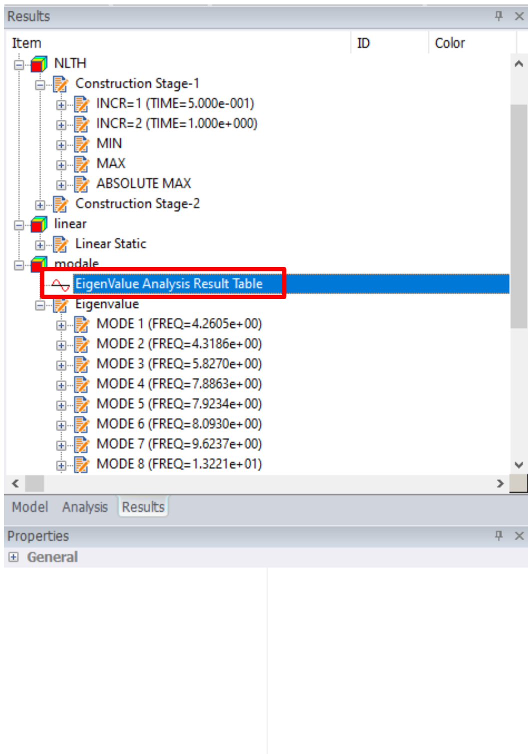


Nonlinear Static Analysis of Masonry Wall

5. Modal Participation Factor

- Modal participation factors are added on the Eigenvalue Analysis Result table.
- Modal participation factors measure the interaction between the modes and the directional excitation in a given reference frame. Larger values indicate a stronger contribution to the dynamic response.

- ***Analysis > Analysis Case > General > Eigenvalue***



7	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
8	2.88%	0.00%	0.00%	0.00%	97.12%	0.00%
9	0.00%	6.51%	0.00%	93.49%	0.00%	0.00%
10	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%
11	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%
12	0.00%	5.42%	0.00%	94.58%	0.00%	0.00%
13	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
14	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%
15	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
16	0.96%	0.00%	0.00%	0.00%	99.04%	0.00%
17	0.00%	2.69%	0.00%	97.31%	0.00%	0.00%
18	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%
19	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%
20	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%

MODAL PARTCIPATION FACTOR

MODE NUMBER	T1	T2	T3	R1	R2	R3
1	4.232951e-006	7.641526e+002	5.451806e-008	-2.386590e+003	4.623657e-006	9.782767e-008
2	8.686666e+002	-3.747556e-006	7.488364e-008	1.157561e-005	1.006357e+003	8.140729e-007
3	1.107821e-007	1.626399e-008	-2.120429e-008	9.181787e-009	4.448245e-007	-8.761479e+003
4	1.387459e+002	8.202906e-007	-4.643607e-007	-4.704561e-007	3.041575e+003	2.200145e-006
5	-2.036989e-007	4.512231e+002	-8.933741e-008	-2.571785e+002	-4.618771e-006	-2.009264e-007
6	1.348111e-007	8.343449e-008	2.577996e+002	-2.202076e-008	3.331761e-006	-2.618774e-007
7	4.325373e-009	-2.835867e-008	2.562032e-008	-6.652683e-008	5.210050e-007	-6.510971e+003
8	3.831609e+002	-9.225923e-007	1.584359e-006	-3.324123e-006	2.225873e+003	-3.502667e-009
9	1.062908e-006	3.129798e+002	-3.696034e-007	1.186511e+003	5.968742e-006	-2.192136e-007
10	-7.987340e-007	1.027265e-007	6.186671e+002	5.282248e-007	-4.215904e-006	1.058335e-007
11	-4.844969e-007	-5.861658e-008	3.207541e+002	1.309371e-007	-2.370148e-006	2.205706e-007
12	-1.348760e-007	-1.202912e+002	-1.739610e-007	-5.023965e+002	-7.097414e-006	9.110742e-006
13	3.620752e-008	-5.334179e-007	4.331499e-008	-2.224516e-006	2.551605e-006	-2.109102e+003
14	-8.219135e+000	-1.186601e-007	5.200613e-008	-5.166729e-007	7.196868e+003	8.417567e-007
15	-5.622794e-009	-3.898411e-009	1.774115e-009	-1.558507e-008	5.496881e-008	-1.281529e+003
16	-6.462378e+001	9.906624e-008	-4.053837e-008	6.069568e-007	6.547120e+002	6.040514e-007
17	-8.126314e-008	-4.295578e+001	-5.191696e-009	-2.583368e+002	8.038117e-007	3.793298e-007
18	-4.616023e-010	8.184668e-008	-1.502346e+002	2.518421e-007	3.570228e-007	2.924640e-007
19	1.506664e-008	6.466436e-008	4.677027e+002	1.919368e-007	2.245547e-008	3.888571e-007
20	8.483682e-008	9.408489e-009	-4.358896e-008	3.477454e-008	-9.055330e-007	2.591640e+003

EigenValue

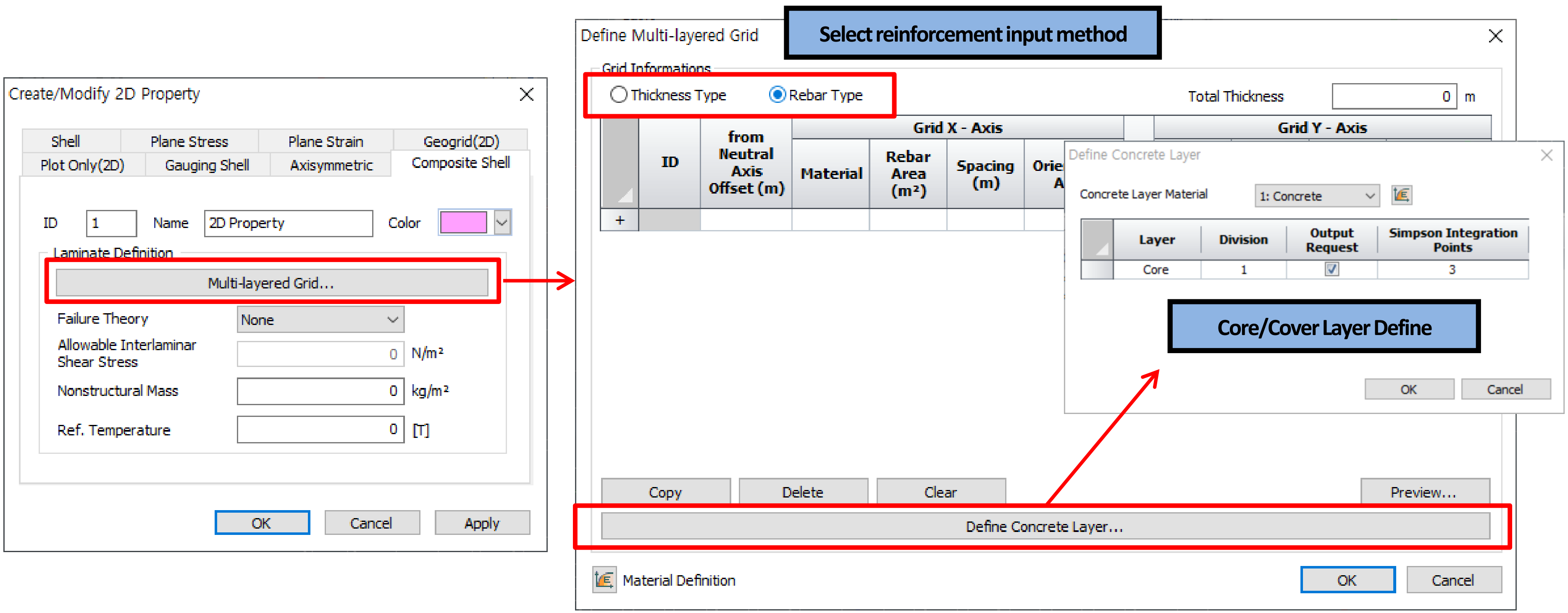
NXGT1 | Ponte Muratura 3D semplify NLTH 01:1 | EigenValue

Modal Participation Factor Table

6. Improvement of Multi-Layered Grid (Composite Shell)

- Composite Shell Property for Multi-Layered Grid is added.
- In the existing Multi-Layered Gird, only the results for the reinforcing bar layer could be checked, but the improved Multi-Layered Grid defines the Core Layer and the Cover Layer, so that the results for this layer can be additionally checked.
- Reinforcement input method (Thickness Type, Rebar Type) is added.

▪ ***Mesh > Prop./CSys./Func. > Property > Composite Shell***

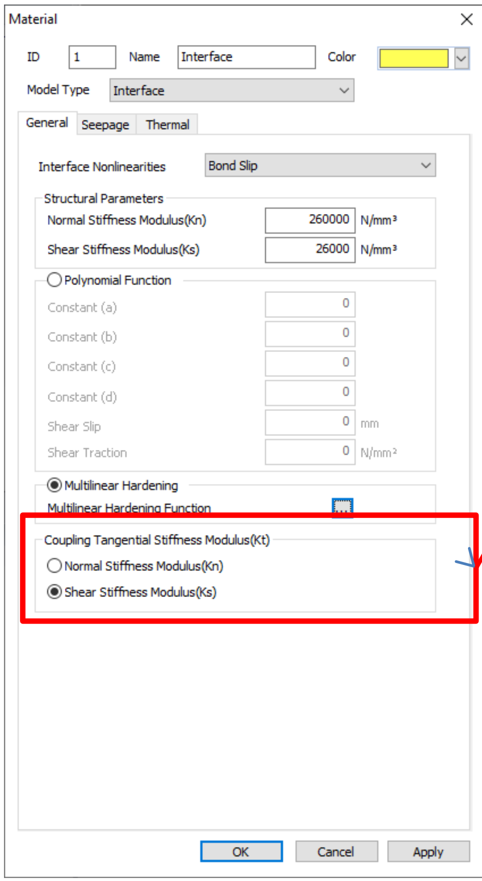


Define Multi-Layered Grid

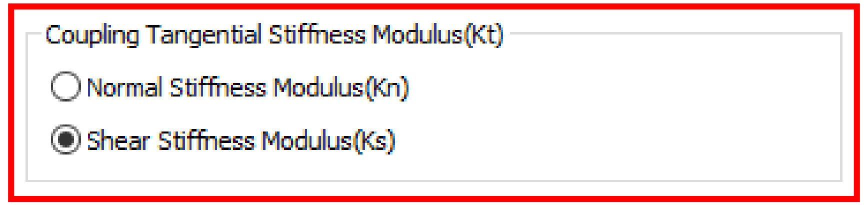
7. Improvement of Bond Slip Interface

- For the bond slip interface, we define stiffness for normal and shear direction. The normal and shear direction represents the linear and nonlinear behavior of bond slip, respectively. Now, the behavior of the tangential direction of the interface can be defined by the user between linear and nonlinear behavior.

▪ ***Mesh > Material > Interface and Pile > Interface***



Bond Slip Model

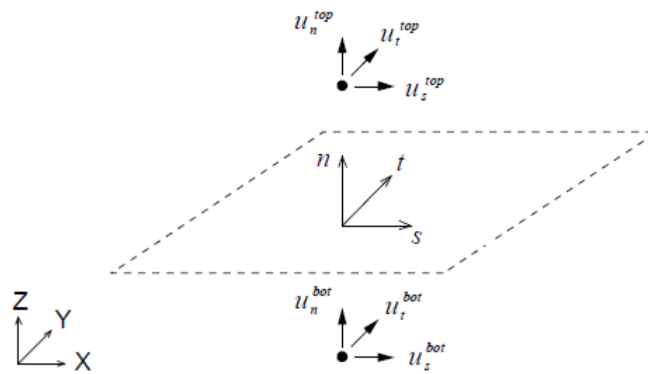


- **Normal Stiffness Modulus(Kn)**

: Linear behavior in tangential direction

- **Shear Stiffness Modulus(Ks)**

: Nonlinear behavior in tangential direction

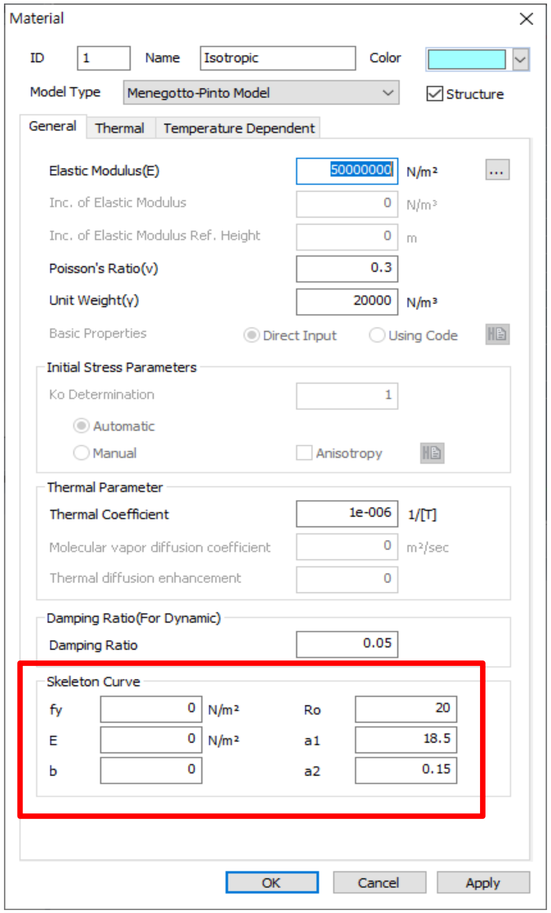


Local Axis of Interface Element

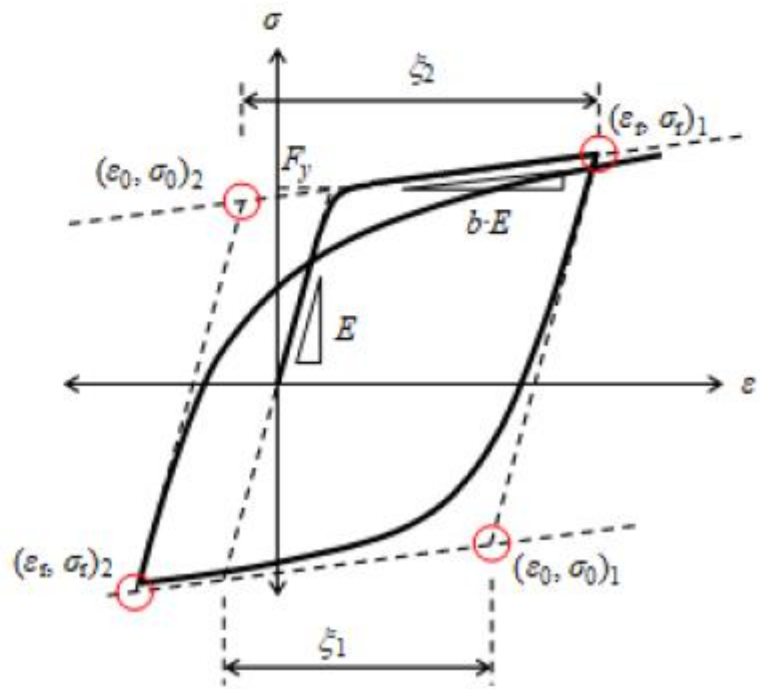
8. Modified Menegotto-Pinto Material Model for Steel

- This is a model proposed by Menegotto & Pinto and modified by Filipoor et al.
- The model is widely used to simulate the dynamic response of steel structures and steel bars of reinforced concrete structures.

- ***Mesh > Material > Isotropic > Menegotto-Pinto***



Menegotto – Pinto Model

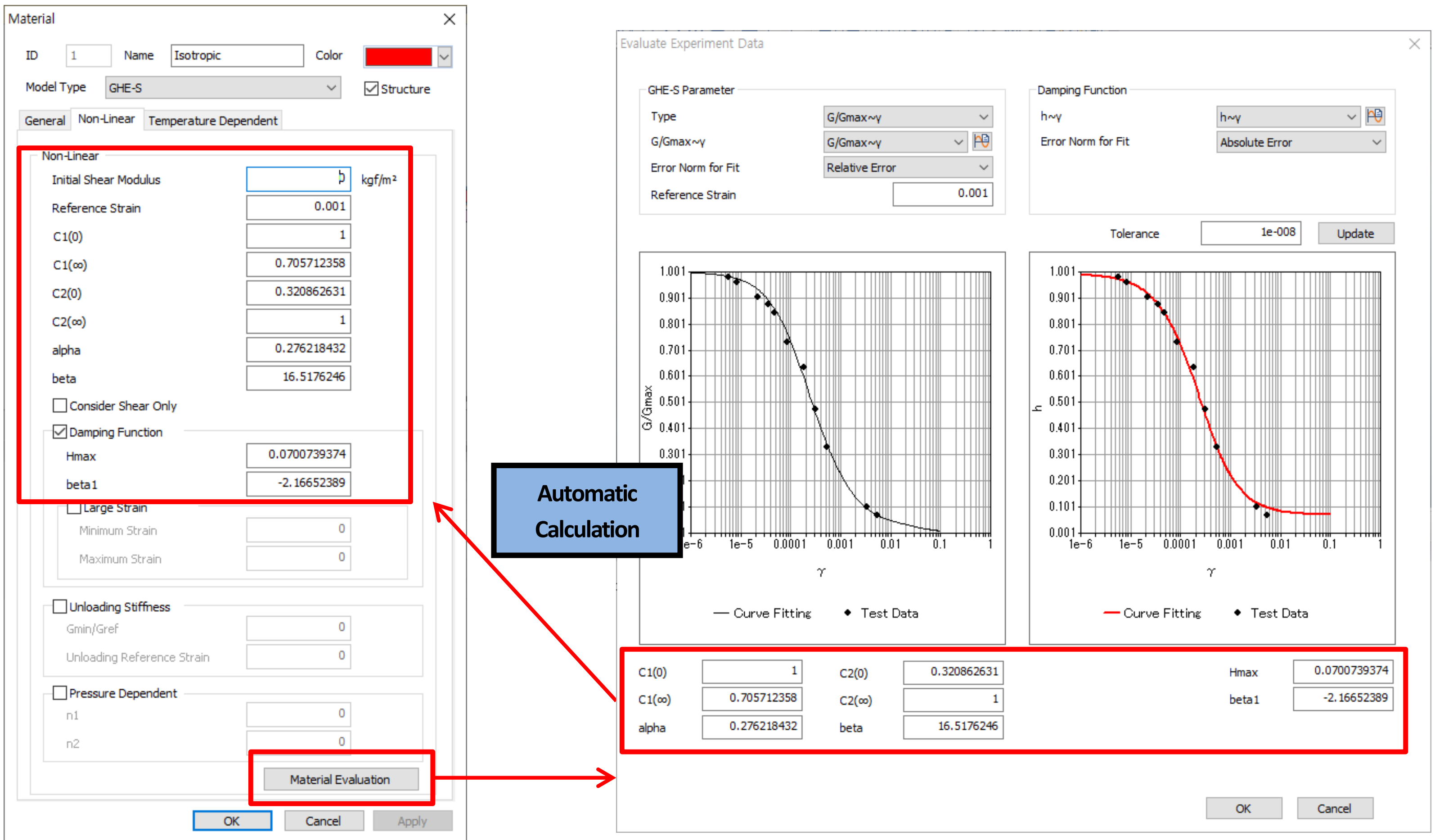


Hysteresis Rule

9. General Hyperbolic Equation GHE-S Model

- Experimental data can be converted into general hyperbolic equation to define nonlinear material properties.

- ***Mesh > Material > Isotropic > GHE-S***



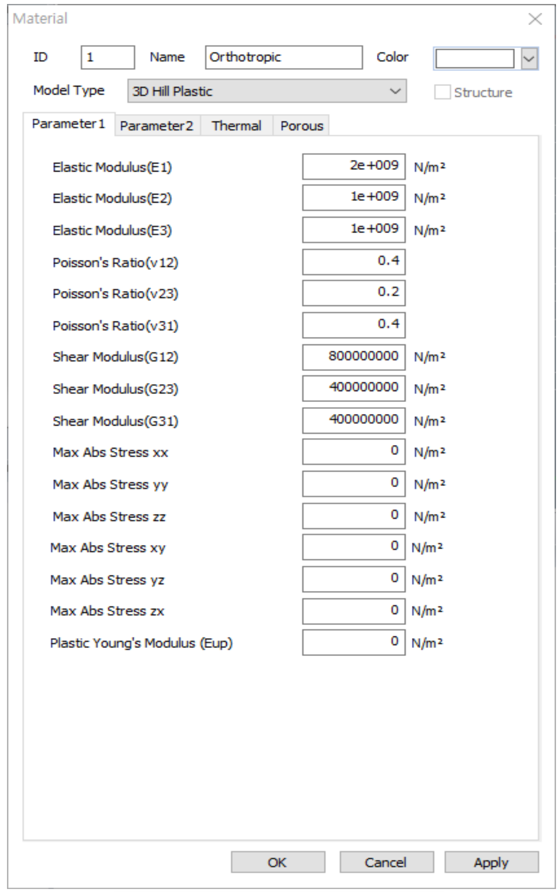
GHE-S Model

Generate GHE-S Material.

10. 3D Hill Plastic Model

- Orthotropic 3D Hill Plastic Model is added.
- It is possible to define nonlinear material properties of orthotropic, and it is easy to define materials for wood.

▪ ***Mesh > Material > Orthotropic > 3D Hill Plastic***

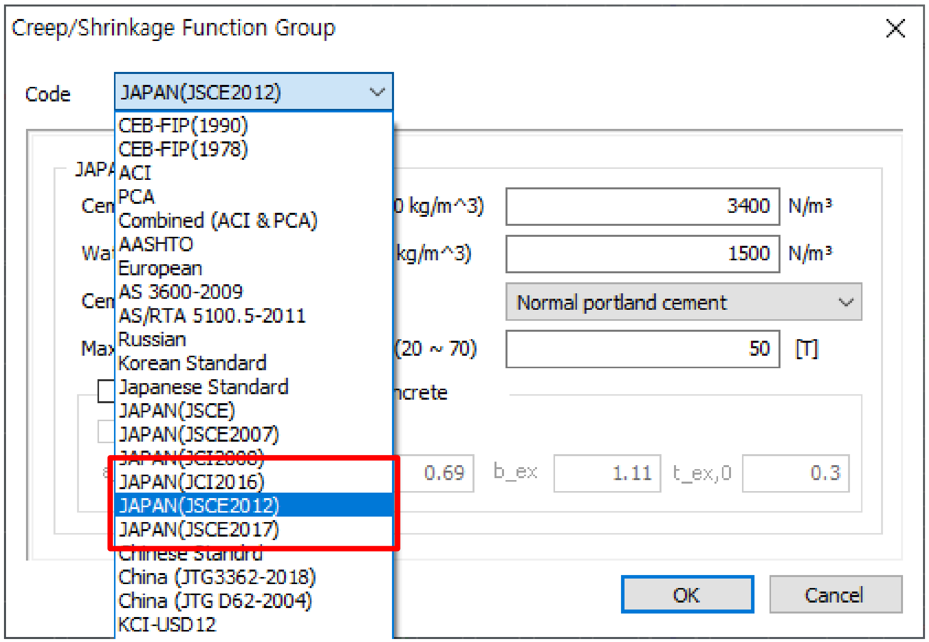


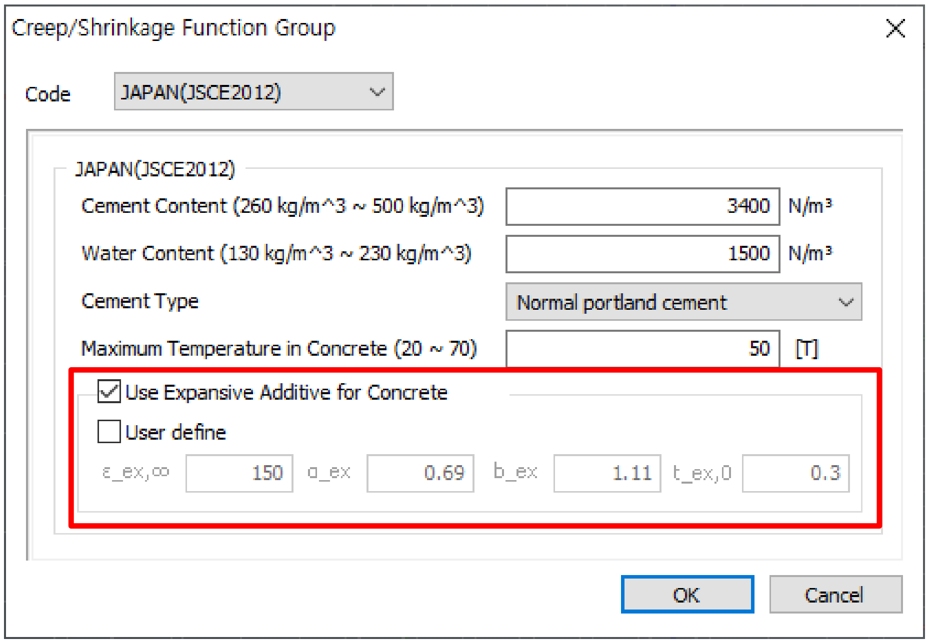
3D Hill Plastic Model

11. Creep & Shrinkage Function and Expansive Additive for Concrete (JCI 2016/JSCE 2017)

- JCI 2016/ JSCE 2017 Japanese shrinkage standards have been added.
- An option to consider Expansive Additive for Concrete, and the user can also define the coefficient value for the Expansive Additive for Concrete.

- ***Mesh > Prop./CSys./Func. > Creep/Shrinkage***





Expansive Additive for Concrete Option