

Release Notes

Release Date: September, 2019

Product Ver.: GTSNX 2019(v2.1)

GTS W Geo-Technical analysis System New eXperience





Integrated Solver Optimized for the next generation 64-bit platform Finite Element Solutions for Geotechnical Engineering



Enhancements

1. Analysis

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Integrated Solver Optimized for the next generation 64-bit platform Finite Element Solutions for Geotechnical Engineering

MIDAS

1. Analysis

1.1 New Heat Transfer, Thermal Stress, Seepage-Thermal Stress analysis types (Construction Stage) *Available upon request

This analysis type can be used to model the thermal changes in the ground due to environmental changes, or due to the construction of facilities, such as buildings or pipelines. In GTS NX thermal energy can be exchanged based on following phenomenological ways: Conduction and Convection. Thermal analyses (Heat Transfer, Thermal Stress, Seepage-Thermal Stress) are available as the steady state analysis and transient analysis (time dependent).

After the heat transfer analysis, results such as temperature distribution, temperature gradient, heat flow direction / size are printed.

Thermal stress and thermal deformation due to generated/exchanged heat can be obtained from Thermal Stress analysis (thermo-mechanical study).

Seepage -Thermal Stress analysis allows for hydro thermo mechanical simulation. Both structural analysis results and seepage / heat transfer analysis results are output.

Analyses are available from Construction Stage define window.



[Construction Stage Set window]







[Model with applied thermal loads]

*Available upon request

+4.94690e-001

+4.53466e-001

+4.12242e-001

+3.71018e-001

+3.29794e-001

-+2.88569e-001

+2.47345e-001

-+2.06121e-001

+1.64897e-001

-+1.23673e-001

+8.24484e-002

+4.12242e-002

+0.00000e+000

1. Analysis

Results

Item

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1.1 New Heat Transfer, Thermal Stress, Seepage-Thermal Stress analysis types (Construction Stage)

म – ID Color NODAL THERMAL TEMPERATURE, [T] +5.57745e+002 incr=1 (LOAD=1.000) 0.1% 📩 🛵 Nodal Thermal Results +5.34016e+002 0.4% A TEMPERATURE +5.10288e+002 APPLIED HEAT FLOW 1.3% A REACTION HEAT FLOW +4.86559e+002 2.1% in the sults +4.62830e+002 3.6% 🕼 1D THERMAL GRADIENT X +4.39101e+002 🎍 1D THERMAL GRADIENT RESULTANT 4.7% +4.15373e+002 🎍 1D HEAT FLUX X 6.5% 4 1D HEAT FLUX RESULTANT +3.91644e+002 10.7% +3.67915e+002 2D THERMAL GRADIENT X (V) 16.7% 2D THERMAL GRADIENT Y (V) +3.44186e+002 24.0% 2D THERMAL GRADIENT RESULTANT (V) +3.20458e+002 26.2% 2D HEAT FLUX X (V) +2.96729e+002 3 2D HEAT FLUX Y (V) 3.6% 2D HEAT FLUX RESULTANT (V) +2.73000e+002 Element Thermal Results THERMAL GRADIENT X (V) DISPLACEMENT. THERMAL GRADIENT Y (V) TOTAL T , m THERMAL GRADIENT Z (V) THERMAL GRADIENT RESULTANT (V) 📲 HEAT FLUX X (V) 0.3% I HEAT FLUX Y (V) 1.6% I HEAT FLUX Z (V) HEAT FLUX RESULTANT (V) 3.9% S27-1[Nonlinear Static] 3.2% INCR=1 (LOAD=1.000) 4.8% 🔄 📑 Displacements 4.3% Grid Forces Reactions 3.5% 🗄 🦾 Truss Element Forces 4.2% - Shell Element Forces 🗄 🍰 Truss Element Stresses 9.4% 🗄 🚰 Shell Element Stresses 17.5% 📲 Solid Stresses 47.2% 🗄 🚰 Solid Strains Model Analysis Results

[Every CS output combines Heat Transfer and Structural results]

[Thermal Stress analysis results for lining thermal expansion analysis]

1. Analysis

1.2 Improving Hyperbolic (Duncan-Chang) Model

Previously Hyperbolic(Duncan-Chang) material has updated as two types such as Duncan-Chang E-B and Duncan-Chang E-v with additional parameters.

Mesh > Prop./Csys./Func. > Material > Isotropic > Hyperbolic(Duncan-Chang E-B) or Hyperbolic(Duncan-Chang E-v) Х Material Material \times Isotropic Color ID ID Name Isotropic Colo 1 Hyperbolic(Duncan-Chang E-B) Model Type Structure Hyperbolic(Duncan-Chang E-v) Model Structure Non-Linear Thermal General Porous General Porous Non-Linear Thermal Cohesion(C) 30 kN/m² 30 kN/m² Cohesion(C) ···· <u>. . . .</u> Frictional Angle(Φ) 36 [deg] Frictional Angle(Φ) 36 [deg] Frictional Angle Increment 0 [deg] Frictional Angle Increment 0 [deg] 47 Initial Loading Modulus(K) 47 Initial Loading Modulus(K) Exponent(n) 0 0 Exponent(n) 0.8 0.8 Failure Ratio(Rf) Failure Ratio(Rf) Poisson Ratio Parameters _____ Kur User Defined 0 Interception 0 Kb User Defined 0 Variation rate 1 0 Exponent(m) 0 Variation rate 2 0 Min. Tangential Modulus 100 kN/m² 10 kN/m² Min. Confining Stress(omin) Kur User Defined 101.312501 kN/m3 Atmospheric Pressure(Pa) Exponent(m) 0 Min. Tangential Modulus 100 kN/m² Min. Confining Stress(amin) 10 kN/m² Atmospheric Pressure(Pa) 101.312501 kN/m² OK OK Cancel Apply Cancel Apply

[Hyperbolic(Duncan Chang E-B)]

[Hyperbolic(Duncan Chang E-v)]

[Friction Angle Increment for E-B & E-v]

· In case of "Coarse grained soil", frictional angle will be decreased with increased compression (σ 3) so that it will consider this situation.

Friction angle(Φ) will be defined by following equation,

$$\emptyset = \emptyset_0 - \Delta \emptyset \times \log \left(\frac{\sigma_3}{p_a} \right)$$

[Additional parameters for E-v(G, F, D)]

• Parameters have added for calculating Vt(Poisson's ratio).

G: Distance to axis from initial poisson's ratio

F: Rate of change for compression from initial poisson's ratio

D: Rate of change for stress from initial poission's ratio

· Parameters and limiation are defined by following equation,

$$E_t = K p_a \left(\frac{\sigma_3}{p_a}\right)^m \left[1 - \frac{R_f}{(\sigma_1 - \sigma_3)_f} (\sigma_1 - \sigma_3)\right]^2$$

$$v_t = \frac{G - F \times \log\left(\frac{\sigma_3}{p_a}\right)}{\left\{1 - \frac{D(\sigma_1 - \sigma_3)}{Kp_a\left(\frac{\sigma_3}{p_a}\right)^m \left[1 - \frac{R_f}{(\sigma_1 - \sigma_3)_f} (\sigma_1 - \sigma_3)\right]}\right\}^2}$$

D > 0.0 < G < 0.5, F < G

1. Analysis

1.3 Improving Slope Stability Analysis(SRM)

- Previously it could be got the result of last iteration only. It can find the results from each step which are selected by user from now on.
- SRF1 and SRF2 can use for reduced function such as friction angle and cohesion respectively. And, User can consider dilatancy angle(SRF3) for reduced function additionally. (*Safety factor function can apply only to Mohr-Coulomb model)

alysis Control	×		Analysis Control X
General Dynamic Nonlinear Slope Stability(SRM)			General Dynamic Nonlinear Slope Stability(SRM)
Define Time		INTH with SKM_noSafetyFactorFunction	Define Time
No Time A	0 sec	Nonlinear Static(in-situ Analysis)	
1 0.3		·····································	
2 0.4 Add		Nonlinear Time History(In-situ Analysis)	2 0.4
3 0.5 V Modify			3 0.5 V Modify
< > Delete			< > Delete
NI		INCR=15 (TIME=1.500e-001)	N-B
Nonlinear parameters	50	i INCR=20 (TIME=2.000e-001)	Ivorinnear parameters
Maximum Number of Trials	50		
Maximum Number of Iterations	50	ia	Maximum Number of Iterations 50
Stiffness Lindate Scheme Full Newton-Danh	son V	🖮 🛃 MIN	Stiffness Lindate Scheme Full New Setty Factor Function
	son		Name Enfort Entre Bantine
Intermediate Output Request Every Iteration	~	B-Z ABSOLUTE MAX	Intermediate Output Request
Convergence Criteria / Error Tolerance			Convergence Criteria / Error Tolerance
Displacement(U)	0.01		Displacement(U)
V Load(P)	0.01		Load(P)
Work(W)	0.0001		Work(W) 4 1 0.35
Cafety Easter		□ INCR=5 (FOS=0.9000)	Safety Factor
Salety Factor			
Initial Safety Factor	0.5	□ INCR-7 (FOS-1 0250)	
Increment of Safety Factor	0.1	Nonlinear Time History After CDM[1]	Increment of Safety Factor
Development of Confector Constant	0.05		Resolution of Safety Factor
Resolution of Safety Factor	0.05		
Safety Factor Function	~ 🍋		Safety Factor Function Safety Factor Function V
			Advanced Nonlinear Darameters
Advanced Nonlinear Parameters			Auvanceu normitear Faranceers
OK	Cancel		OK Cancel

1. Analysis

1.4 Adding Prescribed Strain Function

Prescribed strain function is using to apply volumetric strain by compulsion, can be assumed volume loss from Jet Grouting method or compensation grouting.
(*Prescribed strain will not be supported to linear analysis and dynamic analysis)



MIDAS

2. Pre/Post Processing

2.1 Load Table import/export for thermal analyses

Cards for thermal loads has been added to manage large amount of data.

Users can import the amounts of load sets from excel file and export defined load sets (node/element number, magnitude, and direction) as well.

The sample of table for load sets (Load Table Sample.xlsx) can be found in the installation folder. (ex. C:\Program Files\MIDAS\GTS NX\Sample)



[Imported Temperatures and Heat Fluxes]

2. Pre/Post Processing

2.2 Database for Unsaturated Soil

Previously, It was inputted (θ_r, θ_s. α, n) by user manually. It will be used for reference from database of those parameters which are provided by GTS NX from now on. (* Permeability has inputted as default value. Porosity will be applied to analysis which is provided by Add/Modify function. This database will be using for reference of permeability from soil type)





base Van Genuchten data(Carsel and Parrish, 1988) 🗸 🗸							
No	o Soil	Ks (m/sec)	0s(m³/m³)	Or(m³/m³)	a (1/m)	n	Selec
	1 Sand	8.25e-005	0.43	0.045	14.5	2.68	
	2 Loamy Sand	4.05324e-005	0.41	0.057	12.4	2.28	
	3 Sandy Loam	1.22801e-005	0.41	0.065	7.5	1.89	
	4 Loam	2.88889e-006	0.43	0.078	3.6	1.56	
	5 Silt	6.94444e-007	0.46	0.034	1.6	1.37	
	6 Silt Loam	1.25e-006	0.45	0.067	2	1.41	
	7 Sandy Clay Loam	3.63889e-006	0.39	0.1	5.9	1.48	
	8 Clay Loam	7.22222e-007	0.41	0.095	1.9	1.31	
	9 Silt Clay Loam	1.94444e-007	0.43	0.089	1	1.23	
	10 Sandy Clay	3.33333e-007	0.38	0.1	2.7	1.23	
	11 Silty Clay	5.55556e-008	0.36	0.07	0.5	1.09	
	12 Clay	5.55556e-007	0.38	0.068	0.8	1.09	

Reference - Developing Joint Probability Distributions of Soil Water Retention Characteristics - ROBERT F. CARSEL and RUDOLPH S. PARRISH, 1988

[Database from Soil Type]

2. Pre/Post Processing

2.3 Improving the Interaction between Function Table and Excel

- It has updated to display real input values with upgrading the base of function table library.
- xls file will be created with Export to Excel function.



[Previously Function Table]

[Currently Function Table & Export function]

2. Pre/Post Processing

2.4 Extract from Result of Water Level(Line & Surface)

- From advanced view control(_____), coordinate with 3D can be export with text file from result of water level.
- Decreased depth of water level can be defined easily and accurately with this function instead of measure function(F3).

Advanced View Control > Iso value surface > Export Iso Surface X 2D - Notepad X Iso Value File Edit Format View Help 0,150.0 0,150,0 4,149.604,0 -3.902 0 150 4.4401,149.56,0 8.149.207.0 Lock Value While Result Changing 8.88022,149.12,0 12,148,811,0 13.3204,148.68,0 Export 16,148.414,0 17.7605,148.239,0 20,148.017,0 22.2007,147.799,0 Capped Style 24,147.621,0 26.6409,147.359,0 Upper Part O Lower Part 28,147.224,0 31.0809,146.919.0 [Tunnel : Water level line] [Decreased pore pressure] O Surface Style 32.146.828.0 100% Windows (CRLF) UTF-8 Add Delete Delete All × 3D - Notepad File Edit Format View Help 0.1525,41.08,37.9715 0.734618,41.08,37.975 Close -1.50188,41.08,37.9691 3.61944,41.08,37.9715 4.65125,41.08,37.9559 -2.85125,41.08,37.9797 [Export Function] -2.08109,41.08,37.9732 -5.39805,41.08,37.9547 -6.45125,41.08,37.956 -7.1939,41.08,37.9535 -8.2505,41.08,37.9574 -8.98661,41.08,37.9495 -10.0505,41.08,37.9402 10.7635,41.08,37.9308 11.8505,41.08,37.9155 -12.5307,41.08,37.9035 -13 6497 41 08 37 886 [Excavation : Water level surface] Windows (CRLF) UTF-8 [Decreased pore pressure]

2. Pre/Post Processing

2.5 Extract with Word Formation from Input Parameter

- Information of parameters(General, Porous, Non-Linear) can be exported with image or word file.
- Information will be exported which is using from analysis case only. Analysis steps can be selected for extracting in case of construction stage analysis.

xport Material Image Files X	Material X	Material X	Material X
port Material Image Files	ID 8 Name Isotropic Color Model Type Mohr-Coulomb □ Structure General Porous Non-Linear Time Dependent Elastic Modulus(E) 50000 kN/m² Inc. of Elastic Modulus Ref. Height 0 m Poisson's Ratio(V) 0.3 Unit Weight(Y) 20 kN/m³ Initial Stress Parameters Ko Determination 0.412214748 @ Automatic Manual Anisotropy Thermal Parameter 1/[1] Molecular vapor diffusion coefficient 0 Thermal diffusion enhancement 0 Damping Ratio 0.05	ID 8 Name Isotropic Color ID 8 Name Isotropic Color Model Type Mohr-Coulomb Istructure General Porous Non-Linear Thermal Time Dependent Unit Weight(Saturated) 21 Md/m³ Initial Void Ratio(eo) 0.5 Initial Void Ratio(eo) 0.5 Initial Void Ratio(eo) 0.5 Drainage Parameters Frainad 0.495 Imitial Void Ratio Dependent Void rained Poisson's Ratio 0.97626087 Seepage & Consolidation Parameters Permeability Coefficients 0.97626087 Ie-005 Ie-005 Void Ratio Dependency of Permeability(dx) 0.5 Specific Storativity(Se) 5.230213 Void Ratio Dependency of Permeability(dx) 0.5 Specific Storativity(Se) 5.230213 J/m	ID 8 Name Isotropic Color Model Type Mohr-Coulomb Structure General Porous Non-Linear Thermal Time Dependent Cohesion Parameter 0 dsl/m² inc. of Cohesion Ref. Height 0 m Hardening Curve None 10 kl/m² inc. of Cohesion Ref. Height 0 m Hardening Curve None 10 Inc. of Cohesion Ref. Height 0 m Hardening Curve None 10 Inc. of Cohesion Ref. Height 0 m Dilatancy Angle Parameter 10 Inc. of Cohesion Ref. 10 Inc. of Cohesion Ref. Dilatancy Angle Parameter 36 [deg] Hardening Curve 10 Inc. of Cohesion Rule Dilatancy Angle 36 [deg] 10 Int. of Cohesion Ref. 10 Hardening Curve None 10 Int. of Linear 10 Int. of Linear Cut-off Yield Surface 0 Rankine 10 Int. of Linear 10
[Export Material Image]	Cohesion(C) 30 kN/m ² Frictional Angle(Φ) 36 [deg] Tensile Strength 0 kN/m ²	OK Cancel Apply	OK Cancel Apply
	[General]	[Porous]	[Non-Linear]

2. Pre/Post Processing

2.6 Adding the Extract Function to MIDAS Gen/Civil

- GTS NX 2019(v2.1) can export *.mgt and *.mct to MIDS Gen and Civil. (*Over than Gen v875, Civil v875 can be importing this exported file)
- Static linear analysis can be carried out with those files(*.mgt / *.mct) from MIDAS Gen and Civil.





2. Pre/Post Processing

2.7 Dividing Mesh Set with Arbitrary Surface

- After to create mesh from 3D model, 3D mesh set can be divided by arbitrary surface. Dividing location will be determined by large volume under the divided surface. (* Dividing Surface will be considered only for plane surface. Curved surface is not supported)
- This function is useful to divide mesh set which is created as one mesh. For example, mesh set can be divided two layers of soil from one layer with this divide function as below.





2. Pre/Post Processing

2.8 Apply Nonlinear Time History to Type More Than One Stage from Construction Stage Analysis with Stress-Nonlinear Time History

- Previously, Stress-Nonlinear Time History analysis could been applied only 1 stage at last stage. Time history analysis can apply more than one stage.
- Now, only nonlinear time history type can be applied after nonlinear time history analysis stage(Stress analysis type can not be applied after nonlinear time history analysis stage).
 - Ex) Stress \rightarrow Stress \rightarrow Nonlinear Time History \rightarrow Nonlinear Time History : OK,
 - $\mathsf{Stress} \to \mathsf{Nonlinear} \; \mathsf{Time} \; \mathsf{History} \to \mathsf{Stress} \to \mathsf{Nonlinear} \; \mathsf{Time} \; \mathsf{History} : \mathsf{NG}$

2.9 Improving Searching Method to Mother Element from Embedded Element

- Algorism has improved to search whether element is deactivated which is designated as mother element form embedded element during construction stage analysis.
- Computation of every step which is activated embedded element -> Searching the activated element from computed step -> Designating & investigating the mother element from searched elements
- Display the error message for user from difficult to recognize with tiny error which is satisfied with tolerance.
- Ex) [error] node[216707] and node[216596] are located almost same but, they are not connected. Please make them same coordinate.

2.10 Changing the Default Method from Auto Connection

Default method has changed from imprint to Boolean from auto connection function to consider frequency of usage.

2.11 Improving Initialize Function

- Previously, Advanced view control() was remained when initialize function applied. Advanced view will not be remained with applying initialize function from now on.
 - (Result > etc. > Initialize)