Why GTS NX

GTS NX is a next generation geotechnical analysis software that features the newest development in cutting-edge computer graphics and analysis technology. GTS NX fully supports the latest 64-bit OS Graphic user interface. The intuitive interface will enable new users to easily integrate the software in their work process. The fast analysis speed, outstanding graphics, and output capabilities will provide users with a new and advanced level of geotechnical design.
Geotechnical Analysis “New Experience”

GTS NX can simulate in-situ conditions by considering material nonlinearity as well as initial ground stresses. GTS NX supports all analysis types including static, dynamic, seepage, stress-seepage coupled, consolidation, construction stage and slope stability analysis.

In dynamic analysis, nonlinear time history analysis considering water level and self weight is supported. Any ground behavior that is related to ground water flow (seepage / stress / consolidation) can be simulated through fully coupled stress-seepage analysis. Through the fully integrated FE Solver, GTS NX provides highly reliable results for complex geotechnical analysis and design.
User-friendly Interface

GTS NX provides a user-friendly GUI (graphic user interface) through the use of a state-of-the-art graphics engine.

1. Multi - Windows

Multi-Window GUI enables you to develop multiple model files simultaneously. You can view and modify the same model while the analysis is being run. Multiple analysis result items can be also viewed and compared simultaneously.

2. Ribbon menu for convenient tool organization

The menu has been designed to accommodate the modeling workflow. Similar functions and commands are intuitively grouped together for easier recognition. Command description, tips and diagrams explicitly guide you through the work process in the corresponding input windows.
Geometry Modeling

CAD based modeling
Users can quickly become proficient with modeling in GTS NX – a tribute to CAD based 2D and 3D modeling commands.

- **Point, Line**
  - Line, arc, circle (oval), polyline, rectangle, extend curve, trim curve

- **Face, Solid**
  - Cylinder, cone, box, wedge, sphere, torus, plate, chamfer, offset

- **Boolean Operation**
  - Fuse, cut, common

- **Divide, Protrude, Transform**
  - Divide by surface, extrude, revolve, loft, sweep, mirror, scale, project

- **Trim / Divide**
  - Trim
  - Divide

- **Sweep (Extrude along a guided curve)**
  - Profile
  - Guide Curve

- **Divided (define excavation stages)**
  - Divide by Multiple Surfaces (Excavation Stages)

- **Model created by extruding and sweeping**

- **Boolean Operation**
  - Fuse (A U B)
  - Cut (A - B)
  - Common (A n B)
Terrain Geometry Auto-Generation

Use digital maps and boring data to generate 3D models that more closely resemble in-situ conditions and will consequently yield more realistic results. Modeling 3D surface contours and soil strata can be either cumbersome or impractical in other software, but GTS NX only takes a few steps.

TGM (Terrain Geometry Maker)

3D Stratum Wizard

3D ground surface and contour lines

3D strata created using boring data

TGM and strata creation
Geometry Modeling

Geometry Modeling Automation

GTS NX automatically generates geometries such as shared faces and imprints. These functions ensure nodal connectivity between all adjacent mesh sets, thus ensuring reliable analysis of soil-structure and soil-soil interaction.

Modeling mistakes can also be automatically detected and corrected to prevent analysis from executing with failure warnings.

Shared face auto-generation

Shared faces between adjacent solids can be generated automatically. This makes it easier to ensure nodal connectivity of adjacent mesh sets.

Imprint auto-generation

The auto-imprint function allows lines and nodes to penetrate through 3D geometry (Solid).

Modeling error detection and correction

Irregular faces, lines that may cause analysis errors can be automatically detected and deleted. Erroneously overlapped geometries such as small faces and edges will also be detected and deleted.
CAD Compatibility / Interface with other MIDAS Software

GTS NX imports model information from other MIDAS software (Gen, Civil & SoilWorks). The CAD interface transfers project data for expanded analysis requiring soil-structure interaction and detailed 3D investigation such as bridge pier and tall building foundations.

2D ground structure models can be also transferred to GTS NX for 3D analysis of ground engineering problems such as tunnel systems with connecting galleries.
Mesh Generation

Optimized mesh generation of various element types

User friendly modeling functions generate complex geometries and mesh sets of various types with ease. Such capabilities enable engineers to quickly generate high quality mesh even with limited or no experience in finite element modeling.

- **Surface Auto-Mesher**
  - Loop, Grid, Delaunay (triangle, quadrangle)

- **Solid Auto-Mesher**
  - Tetrahedral, Hexahedral, Hybrid (hexahedral centered)

- **2D → 3D Element Auto-Generation**

- **Protrude Mesh (2D → 3D)**
  - Extrude, Revolve, Sweep, Project, Offset, Fill

- **Extract Mesh (3D → 2D)**

- **Interface, pile, and structural element generation**

- Element generation considers interior edges and points

- **Smooth Transition**
  - Linear grading of mesh size
  - Size control optimizes mesh in the areas of high strain and displacement by assigning fine mesh elements.

- **Fine Mesh**

- **Coarse Mesh**

- **Uniform Size**

- **Combination of 1D, 2D and 3D elements**
  - (Solid, shell and frame elements)

- **Extrude 2D mesh into 3D**

- **Extrude (2D → 3D)**
Mesh Generation

Quality Assurance & Checking Controls

Mesh quality can be automatically checked and managed. This allows the generation of high quality mesh with minimum effort even for complex ground structural models resulting in optimal analysis time and producing reliable and comprehensive results.

Hybrid Meshing

To provide more reliable analysis results, GTS NX can automatically generate hexahedral centered mesh. Hexahedral elements are the most stable for stress and displacement results.

Bonded Contacts Auto-generation

Adjacent elements without shared nodes can be detected and contacts can be applied automatically.

Mesh Check

- Non-manifold edge
- Free face
- Clamped element
- Overlapped element

Mesh Quality Check

- Aspect ratio, skew angle, twist angle, taper,
- Jacobian ratio, element length
- (Maximum, Minimum), poor mesh sets definition
Element Library

The GTS NX element library includes various elements for structural and ground modeling. These elements are conveniently classified based on application purposes. Ground, structures, various links, springs and interfaces can be selected and modeled from the extensive element library.
Material Models & Structural Properties

Comprehensive database of material models to simulate the behavior of various ground types

GTS NX provides various linear / nonlinear material models to simulate ground behavior under different loading and water level conditions.

Material models are generally classified into elastic, plastic, drained, undrained, and seepage categories. Material / equivalent linearity and nonlinearity of elements can be simulated through internal functions.

Elastic Materials
- Linear Elastic Isotropic
- Linear Elastic
- Transversely Isotropic
- Interface Elastic
- Nonlinear Elastic (1D)
- Jardine
- D-Min
- Hyperbolic (Duncan-Chang)

Plastic Materials
- von Mises (Nonlinear)
- Tresca
- Mohr-Coulomb
- Drucker-Prager
- Strain-Softening
- Modified Cam Clay
- Jointed Rock
- Modified Mohr Coulomb
- Hoek Brown
- Inverse Rankine
- Coulomb Friction (Interface)
- Janssen
- Soft Soil / Soft Soil Creep
- Sekiguchi-Ohta (Viscid/Inviscid)
- Hardening Soil (small strain stiffness)
- Modified UBCSAND (Liquefaction)
- S Clay 1 Model

Undrained Materials
- Effective Stiffness / Effective Strength
- Undrained Stiffness / Undrained Strength

Functions
- General non-spatial functions (pile / pile tip bearing nonlinear function)
- Nonlinear elastic functions (truss / point spring / elastic link)
- Unsaturated property functions (Gardner, Frontal, Van Genuchten)
- Strain compatibility functions (2D equivalent linear)
- Concrete Creep and Shrinkage functions automatically as per global codes

Unsaturated property (Individual)

Unsaturated property (Relation)

Generalised Hoek Brown
- Hysteresis Models
- User Defined
Load assignment reflecting field conditions

GTS NX can simulate various in-situ loading conditions. The dynamic function database includes a variety of code-based response spectra and time history functions. Customized functions for vibration, blast and seismic loading can also be generated.

Static Loads
- Self weight
- Concentrated load
- Moment load
- Prescribed displacement
- Pressure load
- Water pressure (auto-consideration option)
- Beam linear load
- Beam element load
- Temperature load
- Prestress load
- Initial equilibrium load
- Combined load

Dynamic Loads
- Response spectrum
- Ground acceleration
- Time history static load
- Dynamic nodal load
- Dynamic surface load
- Load - mass conversion
- Railway dynamic load table

Load conditions Generation and Application

Structural Loads
- Force (concentrated load / pressure)
- Gravity
- Prescribed displacement
- Temperature load

Static / Dynamic Loads

Loads in Construction Stages
- Load distribution factor

Nonlinearity of Load
In geometric nonlinear analysis, the direction of loads can change with the deformation of the structure. (Follower Load)

Loads from Results
- Nodal forces, moments, translational/rotational displacements can be created to loads for another analysis case
Different boundary conditions can be generated to simulate in-situ conditions

GTS NX provides various boundary conditions for all analysis types. Essential boundary conditions for analysis can be defined automatically. By defining the water level surface, the pore water pressure can be considered in stress analysis. Time dependent water levels can be defined to simulate rapid draw down as well as a gradual rise in water level due to rainfall.

The Change Property function can simulate a change in material properties over time. This function is useful for simulating the hardening of concrete as well as excavation projects in which soil layers are replaced by structural elements. Boundary conditions for 2D equivalent linear analysis and linear / nonlinear dynamic analysis can be generated automatically as well.
Excellent result displays supported by a new and powerful graphics engine

Through its advanced graphic processing engine, GTS NX provides a variety of output methods for users to visualize and extract their analysis results. The extensive output options present results in an elegant and comprehensible form.
Results output and report for practical design

The results output functions allow users to combine different results and selectively extract only the pertinent results. The 3D PDF report generator exports 3D model and analysis results directly into a PDF file.

The report generation creates aesthetic and comprehensive reports in a fraction of the time that it would take through manually copying and pasting spreadsheets and images.
Total Solutions for Geotechnical Analysis

GTS NX is proven numerical modeling software used by many international geotechnical firms. Selected practical applications of the software are shown below.

The Tunnel Wizard can model tunnels having standard pattern and define excavation methods such as full face cut, bench cut and direction (one, both). For each case, load relaxation can be considered by applying load distribution factor (LDF). Modelling shrinkage or simulate a volume loss around a lining of TBM tunnel through Contraction function. Subsequently, Tunnel Lining Design can be executed accurately and efficiently.
Total Solutions for Geotechnical Analysis

GTS NX not only analyzes 2D / 3D slope stability according to Strength Reduction Method (SRM) but also calculates the slope safety factor according to Limit Equilibrium Method using potential sliding surfaces. Analysis results in each calculation step can be obtained, so the progressive failure behavior of the slope can be analyzed.

Stress analysis and seepage analysis considering cutting stages can be coupled to investigate slope stability in short / long term. Especially by coupling with nonlinear time history analysis results, earthquake resistance of a slope can be assessed.
Total Solutions for Geotechnical Analysis

Foundations

GTS NX analyzes abutment stability subjected to lateral pressure and differential settlements. Bearing capacities of piles can be parametrically verified for different materials and construction methods.

- Shallow foundation: Direct foundation, Mechanic (Vibration) foundation
- Deep foundation (Pier / Abutment): Pile (Steel Pipe, PHC, Drilled Shaft (RCD), Driven Pile), Well foundation, Caisson, Raft foundation

Excavation and Temporary Structures

GTS NX simulates installation of retention walls for excavation of ground structures such as subway stations, tall building foundations. Temporary structures can be incorporated in excavation stages, which include piles, waler, struts, anchors and tie-backs. Changes in earth pressure and ground water level and complex strata can be also accommodated in conjunction with existing adjacent ground structures such as tunnels, subways, foundations and utility chambers.

- Retaining wall: H-Pile + slurry wall, Sheet Pile, CIP, SCW, D-Wall
- Strut: Steel Strut, Earth Anchor, Rock Bolt, Soil Nail, Tie Rod, Raker

Stability analysis for adjacent structures

- Subway station (H-Pile+slurry wall)
- Diaphragm Wall
- Ground shoring for excavation for a tall building foundation
- Stress distribution of subway line and ventilation shaft by staged excavation
Total Solutions for Geotechnical Analysis

Soft Soil / Embankment

GTS NX calculates dissipation of excessive pore water pressure and consolidation settlement through staged consolidation analysis. Fully coupled seepage analysis reflects changes in excessive pore water pressure and water level in real time.

Hydraulic / Underground Structures

Steady state and transient seepage analysis for dams, embankments, tunnels, etc. can be performed. Seepage in an unsaturated area can be also analyzed by applying Darcy’s Law. GTS NX inherently handles ground – structure interaction with water and ground water related problems.

- **Soft soil**:
  - SCP-reinforced, Dewatering method (PBD, PSD, SD), Suction drain
- **Embankment**:
  - Revetment and quay wall, Dock, Breakwater

- **Hydraulic structures**:
  - Earth Dam, CFRD, Levee, Water way tunnel (pipe & culvert)
- **Underground Structures**:
  - Box, Underground driveway

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[Images and diagrams related to the text]
About MIDAS IT

“MIDAS IT is taking flight with endless passion and devotion to provide technological solutions worldwide”

MIDAS Information Technology Co., Ltd. develops and supplies mechanical / civil / structural / geotechnical engineering software and provides professional engineering consulting and e-Biz total solutions. The company began its operation since 1989, and currently employs 530 developers and engineers with extensive experience. MIDAS IT also has corporate offices in US, UK, China, Japan, India and Russia. There are also global network partners in over 30 countries supplying our engineering technology. MIDAS IT has grown into a world class company.
Introduction to MIDAS Family Programs

“MIDAS Family Programs are advanced CAE (Computer Aided Engineering) solutions that have been and are being developed using the latest technology”

GTS NX
GeoTechnical analysis System

SoilWorks
Geotechnical Solutions for practical Design

midas Civil
Integrated Solution System for Bridge and Civil Structures

midas FEA
Advanced Nonlinear and Detailed Analysis System

midas Gen
Integrated System for building and General Structures

midas DShop
Auto Drawing Module to generate Structural drawings and Bill of Materials

midas Design+
Structural engineer’s tools

midas NFX
Total Solutions for Mechanical Engineering in structural mechanics and CFD

midas FX+
General Pre & Post Processor for Finite Element Analysis

MIDAS Program Applications

Burj Khalifa (UAE)
- World’s tallest building to date
- Height: 840m, 168 floors

Beijing Olympic Main Stadium (China)
- Area: 78,000 sq. m.
- Allowed Seating Capacity: 91,000 people

Russky Island Bridge (Russia)
- World’s longest cable stayed bridge
- Main span: 1,104m

http://www.midastnx.com
GTSNX

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