MIDAS

midas Civil

INTEGRATED SOLUTION SYSTEM FOR
BRIDGE AND CIVIL ENGINEERING

midas Civil

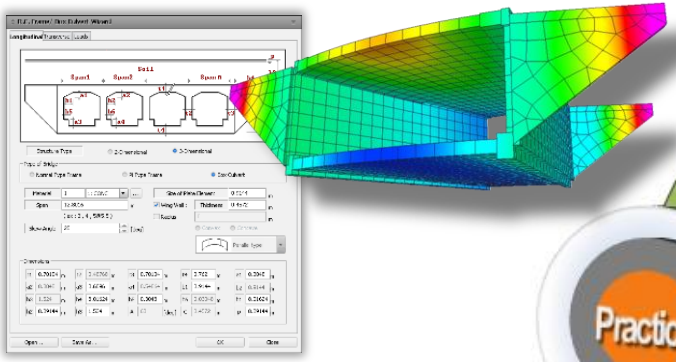
Integrated Solution System
for Bridge and Civil Structures

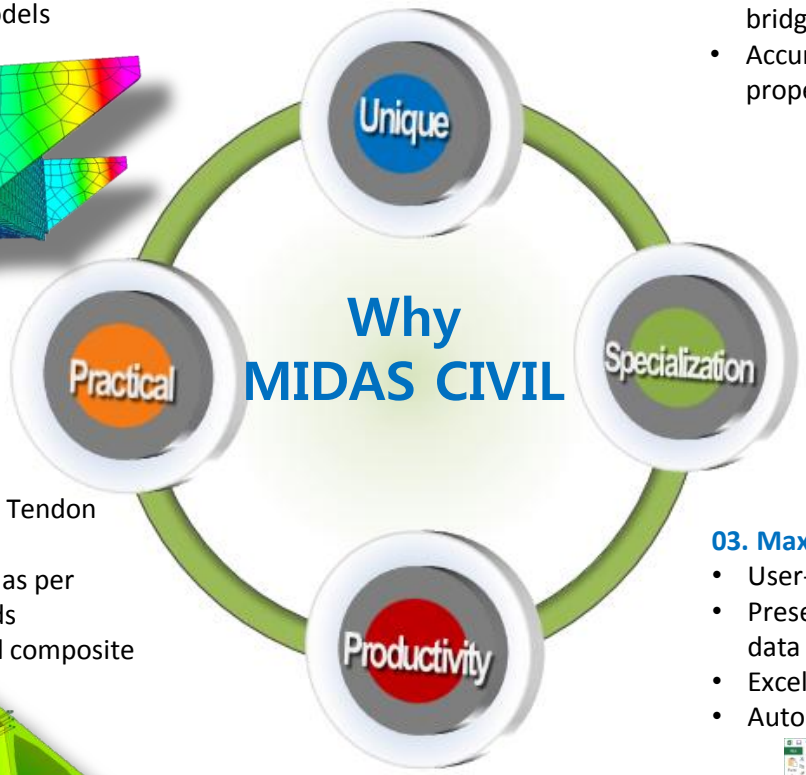
Bridging Your Innovations to Realities

Why MIDAS CIVIL

01. Unique Modeling

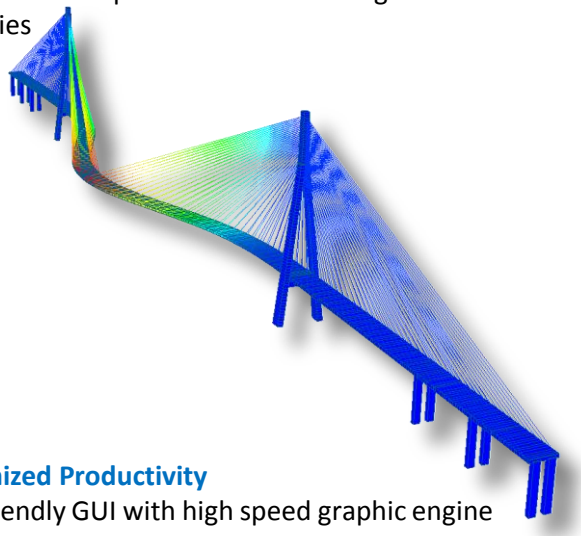
- Advanced bridge wizard such as Box Culvert, FCM, ILM, FSS, MSS, Grillage, Cable Stayed Bridge Wizard.
- Powerful moving load optimizer
- Auto-generation of Railway Analysis models





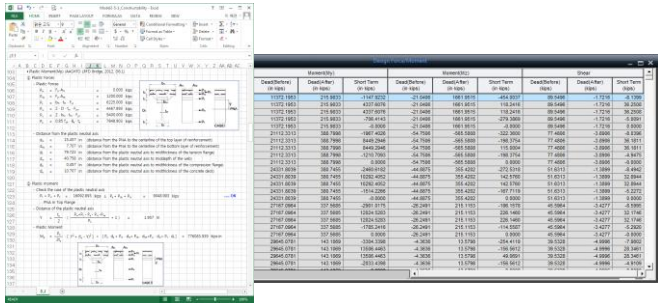
02. Specialized on High-end Analysis

- Segmental post-tensioning including tendon losses and camber results
- Cable force tuning in forward stage analysis and suspension bridge analysis with geometric nonlinearity
- Accurate seismic performance reflecting nonlinear properties



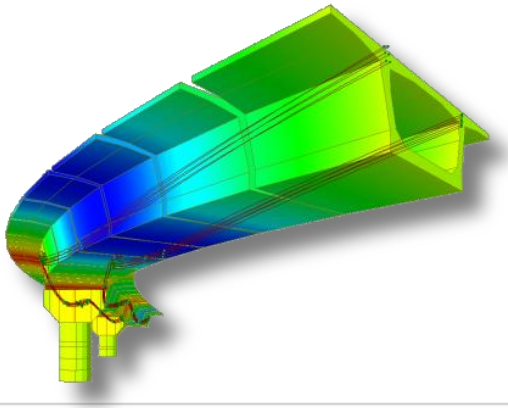
03. Maximized Productivity

- User-friendly GUI with high speed graphic engine
- Presenting input data in Works Tree and manipulating the data by Drag & Drop
- Excel compatible input & output tables
- Automatic generation of analysis and design reports



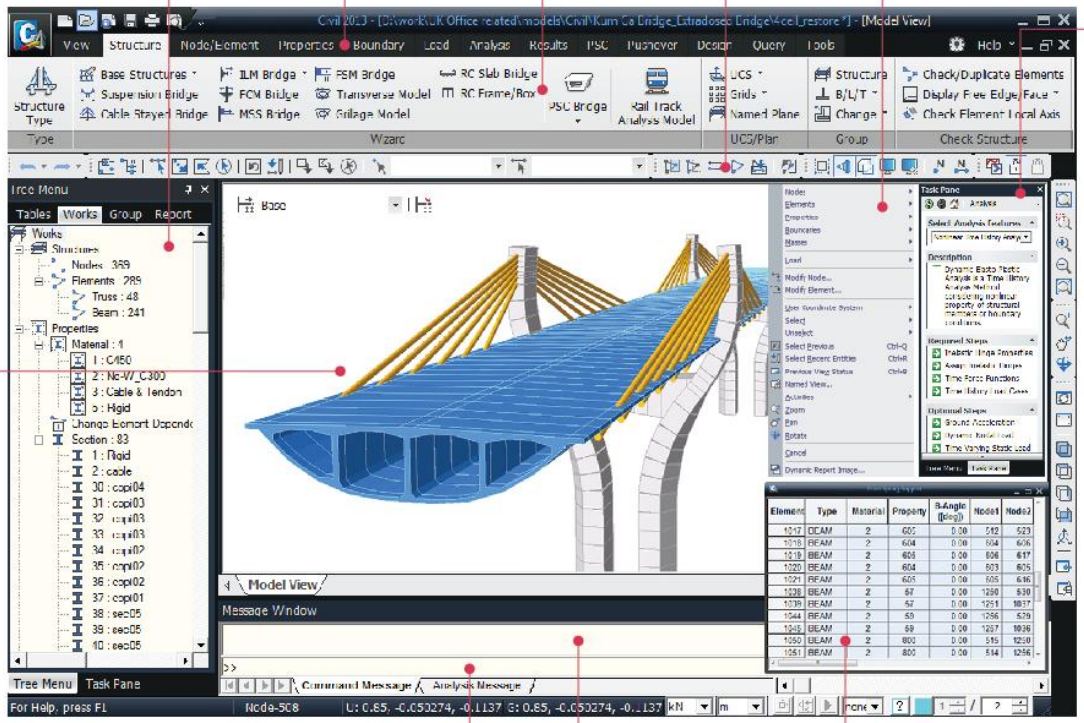
04. Practical Design Process

- Practical modeling features such as SPC, Tendon Template and Transverse Model Wizard
- RC/Steel/PSC/Composite section design as per Eurocodes, AASHTO, and other standards
- Bridge Load Rating for PSC box and steel composite girder



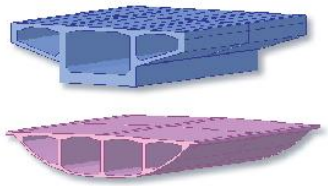
01. Innovative User Interface

"Stretch your imagination & extend your ideas without restrictions. midas Civil will help you achieve the goals."



Full graphical representation of all shapes

- Display of line & plane type section shapes
- Combined analysis results & design display



Hidden view processing of a user-specified section

Ease of modelling in Civil

- Data input via main menu ribbon interface
- Quick mouse access from context menu
- Modelling by command input
- Tabular data entry directly from excel
- Dynamic interaction between works tree and model window

Command Line

- Modelling function similar to autoCAD commands
- Modelling by one key commands

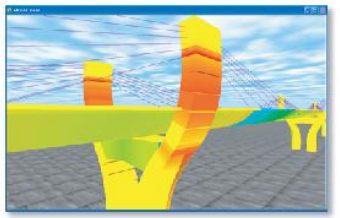
Task Pane

A new concept tool, which enables the user to freely set optimal menu systems

- A new concept menu system comprising frequently used menus
- Procedural sequence defined by the user for maximum efficiency
- Auto-links to manuals, technical papers and tutorials
- Links to corresponding dialogue boxes for ease of checking input data

Walk Through Mode

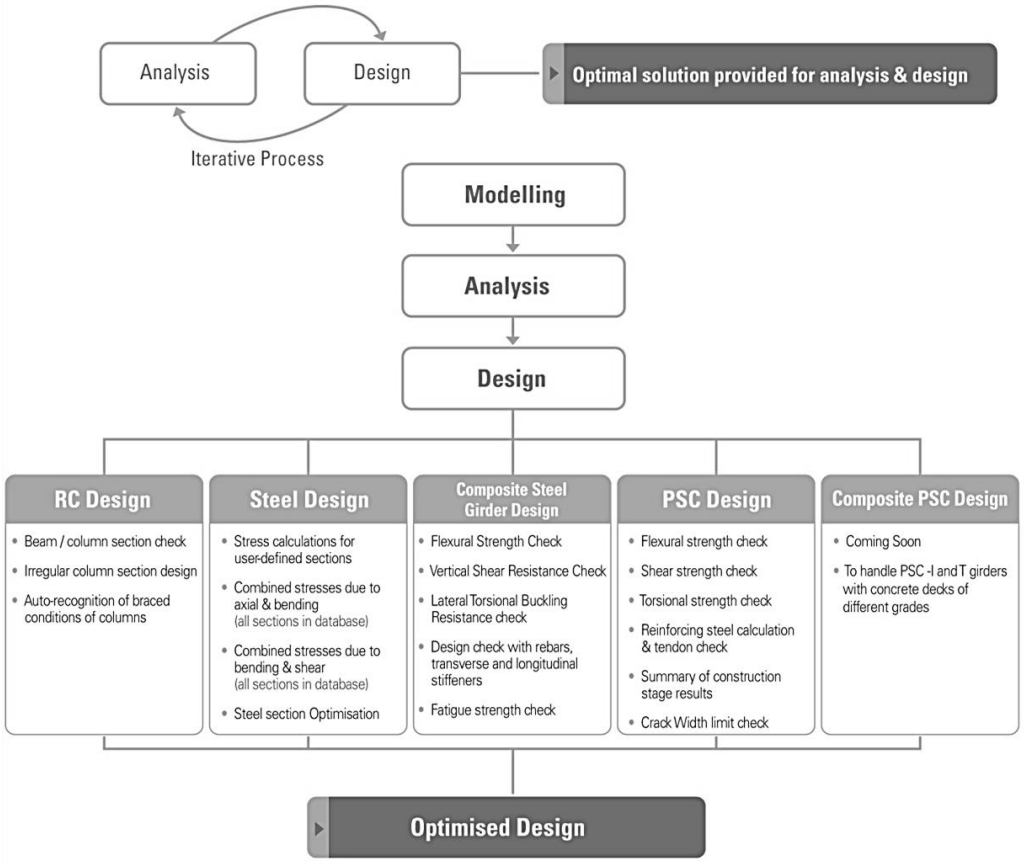
- Model rendering provided in various view points



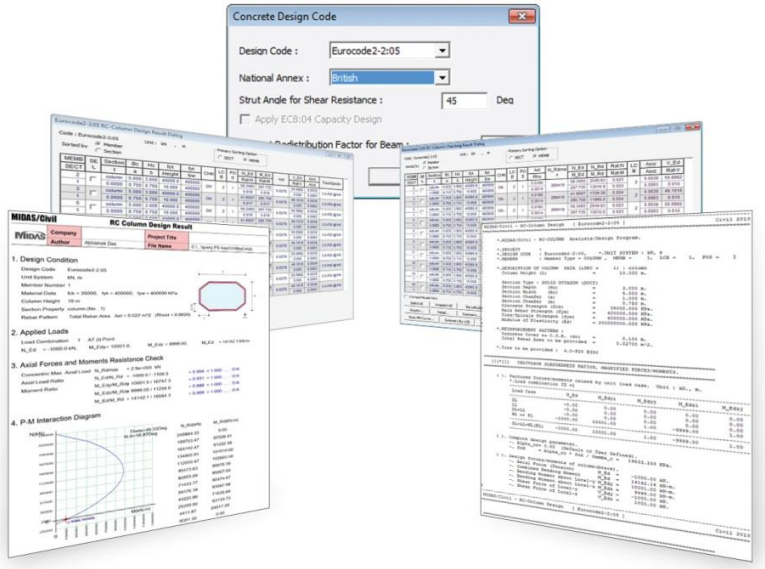
02. Optimal Solutions for Bridges

"One stop solution for practicing bridge engineers
With RC, steel, PSC and Composite design"

○ Design Process for Bridges



○ Reinforced Concrete Design (Beam / Column)



RC section check summary report

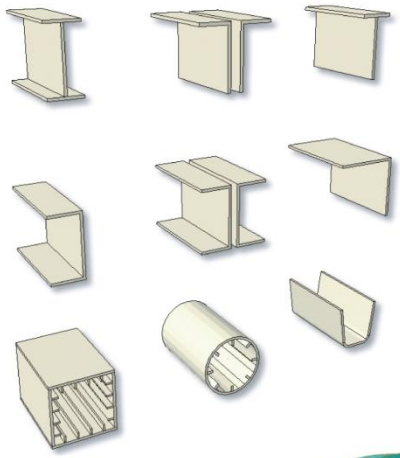
RC section check detail report

- RC/Steel/Composite/PSC design as per Eurocodes, AASHTO LRFD and other codes
- Iterative analyses for calculating optimal sections & rebars
- One stop solution combining static & dynamic analyses carried out in a same file with member design

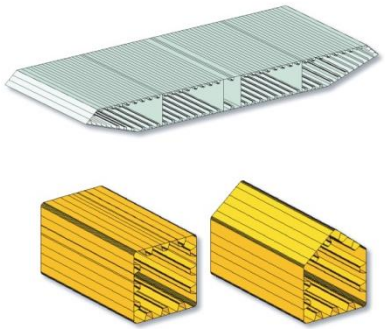
02. Optimal Solutions for Bridges

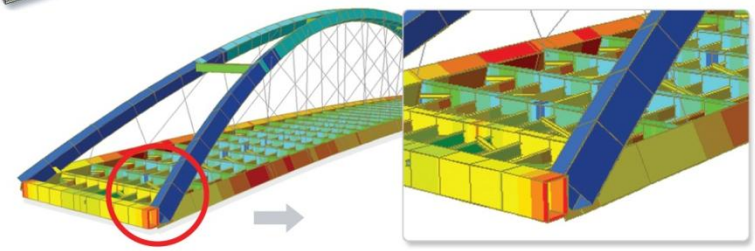
○ Steel Design (combined stress checks)

Section types in database



User-defined irregular sections



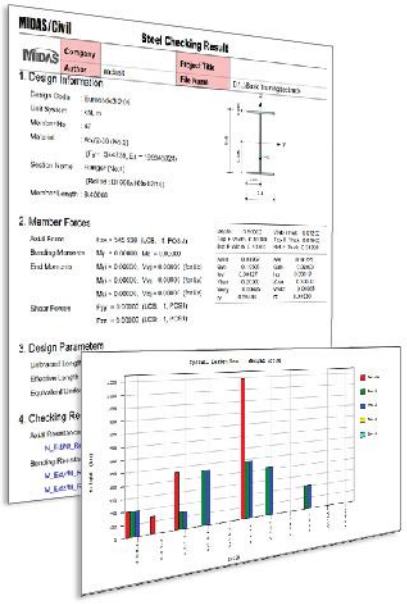


Graphical results of stress checks

- Stress checks for user-defined sections
- Combined stress check for bending & shear (all sections in database)
- Combined stress check for axial & bending (all sections in database)

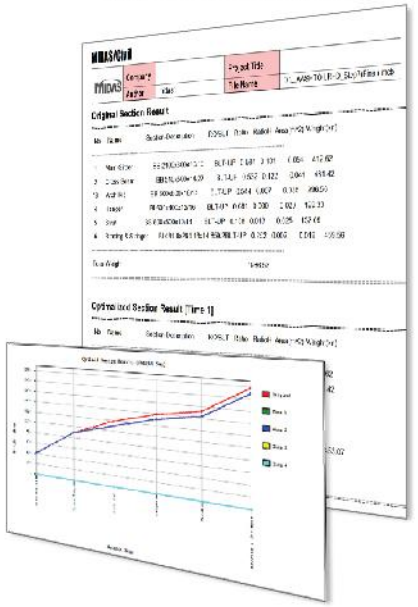
○ Steel Optimal Design

Steel Code Check Report



Steel section weight graphs during optimisation

Optimised steel section comparison report

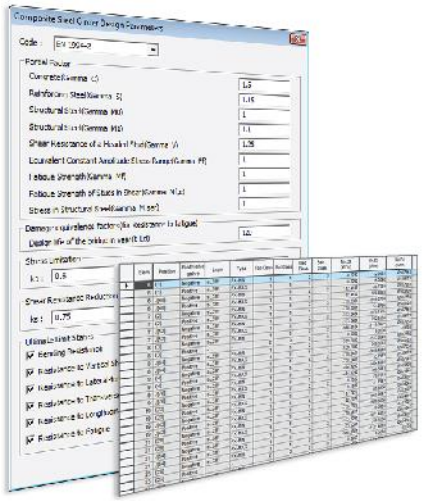


Steel weight ratio comparison graph

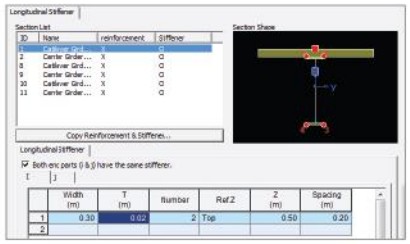
- Steel combined stress check as per Eurocode 3-2, AASHTO LRFD and other codes
- Automatically searches for the optimised steel section with minimal section area(minimal weight) whilst satisfying the design strength checks

02. Optimal Solutions for Bridges

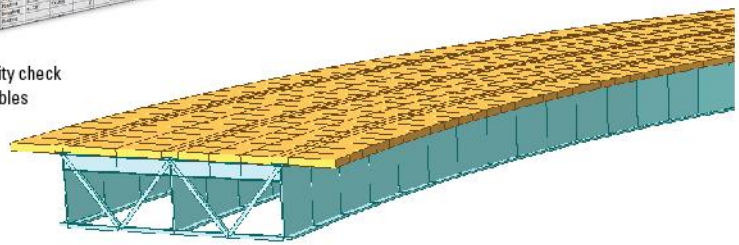
○ Composite Girder Design



Strength and serviceability check parameters and result tables

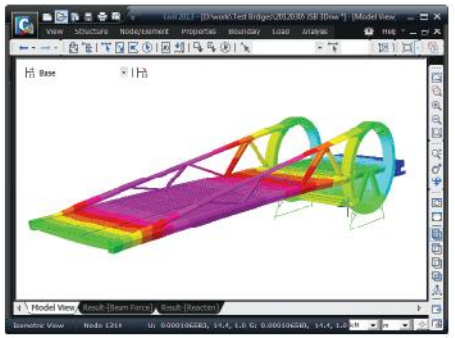


Complete design including reinforcement and stiffener data



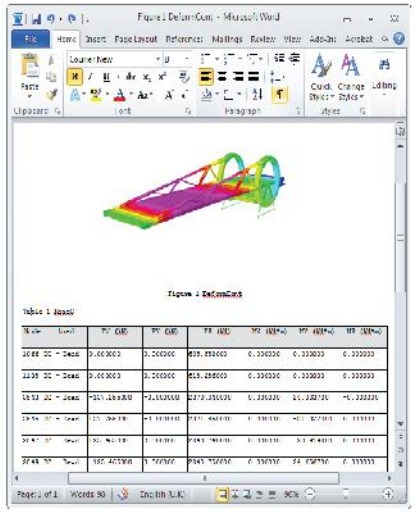
- Automated design of composite steel-I and steel box girder bridges with concrete deck as per EN 1994-2
- Automatic calculation of member forces and stresses separately for steel girder and concrete deck in construction stages
- Stage-wise stress checks during composite construction
- Complete Excel design report with shear connectors, reinforcement, transverse and longitudinal stiffeners

○ Dynamic Report Generator



Reporting dynamic images

Reporting dynamic input/output tables



MS Word report

- midas Civil enables the user to auto-generate an MS Word report using analysis and design results
- All the input and output data can be plotted (ie. material properties, section properties, reactions, member forces, displacements, stresses, section verification results, etc.) in a diagram, graph, text or table format
- The report updates itself automatically when changes are made in the model

03. PSC Bridge Design

"Integrated solution for practical PSC bridge design
(Longitudinal & transverse direction analysis and strength checks)"

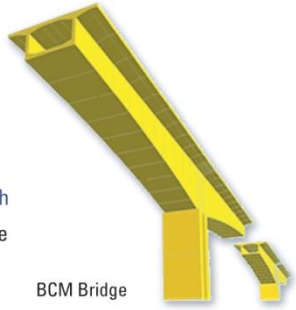
○ Procedure and main features for PSC bridge design

Global analysis along the spans → Transverse analysis → Strength check → **Integrated solution for PSC bridge design**

- Construction stage analysis reflecting change in elements, boundary conditions & loadings
- Creep & shrinkage calculation based on codes
- Time dependent steel relaxation (CEB-FIP, AASHTO, Magura & JTG 04)
- Irregular sections displayed to true shapes

- 3D/2D tendon placement assignment (lumped representative tendon analysis)
- Strength check to Eurocode, AASHTO LRFD and other codes

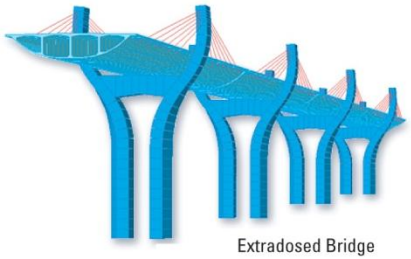
- Confinement effect of rebars considered for creep
- Auto-calculation of section properties considering effective width
- Easy generation of non-prismatic tapered sections over the entire or partial spans



BCM Bridge

- Beam stress check for PSC bridges
- Automatic reaction summary at specific supports through staged launching in ILM bridges
- Compression-only element provided for modelling temporary supports & precasting platform

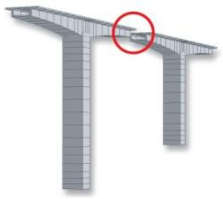
- Completed state analysis reflecting effective width by construction stages
- Special type of PSC bridge analysis (extradosed bridge)
- Automatic generation of transverse analysis model
- RC design of irregularly shaped columns



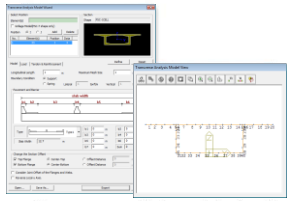
Extradosed Bridge

○ Automatic generation of transverse analysis model

Global analysis along the spans → Transverse model generation → Partial modification of model data → RC design → **End of design**

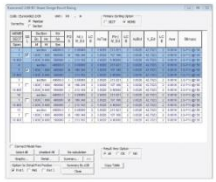


Defining positions for transverse analysis

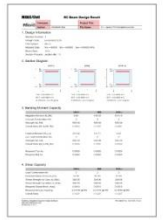


Transverse analysis model wizard

Generation & analysis of a transverse model



RC Design Result Table



Text Design Report

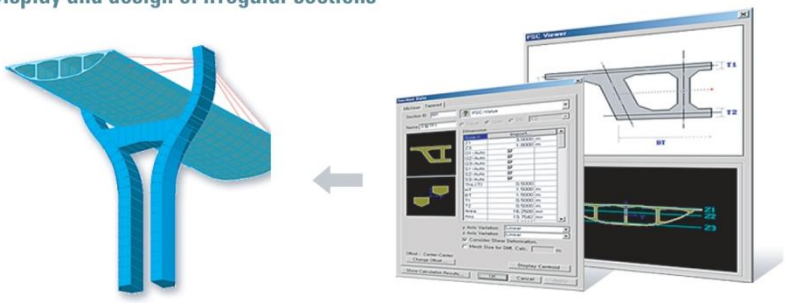
Detail Design Calculation Sheet

- Auto generation of transverse analysis models through global analysis models
- Transverse analysis model generation wizard & auto generation of loading and boundary conditions (transverse tendon assignment)
- Automatic placement of live load for transverse analysis
- Automatic positioning of loadings for plate analysis
- Section check using RC / PSC design function

03. PSC Bridge Design

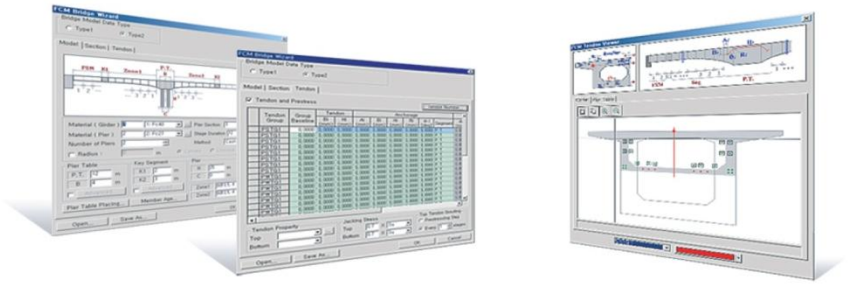
○ Modelling features suited for practical design

Display and design of irregular sections



Irregular section defined by user using SPC

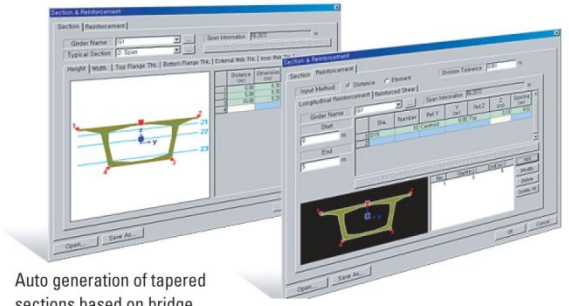
PSC wizard reflecting design practice



Tendon profile input and real-time display

- Modelling PSC bridges of irregular sections using Section Property Calculator
- PSC bridge wizards (BCM, ILM, MSS & FSM): user-defined tendons & sections possible

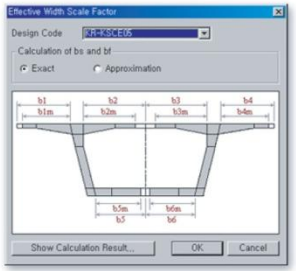
Auto generation of non-prismatic tapered sections



Auto generation of tapered sections based on bridge spans

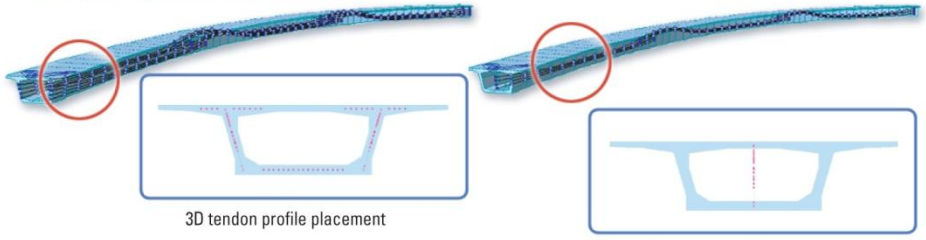
Schedule-based input of rebars

Automatic calculation of effective width



Automatic calculation of effective width for PSC bridges

Lumped representative tendon analysis



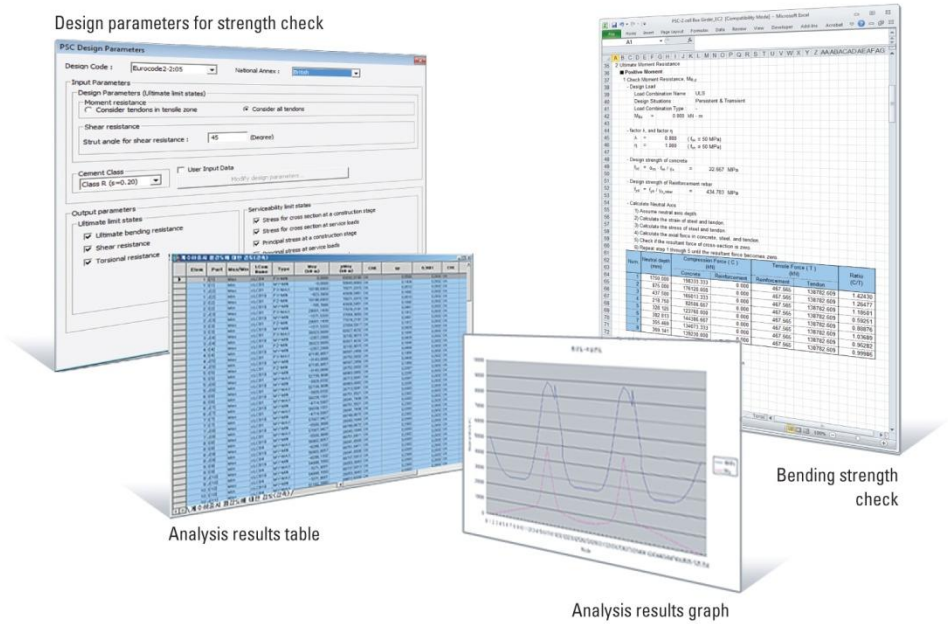
3D tendon profile placement

2D placement of tendons using the representative tendon function

- Convenient auto generation of tapered sections (change in thicknesses of top/bottom flanges and web separately considered)
- Construction stage analysis and completed state analysis reflecting auto calculated effective width
- Exact 3D tendon and simplified 2D tendon placements

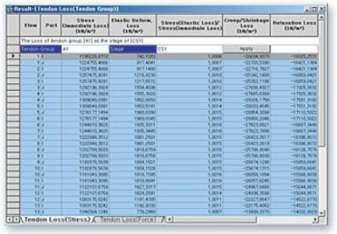
03. PSC Bridge Design

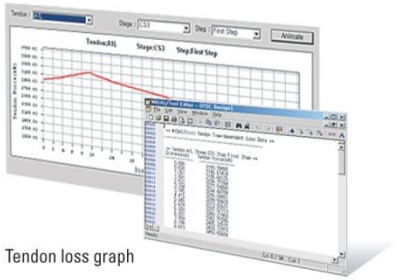
○ Automatic strength check



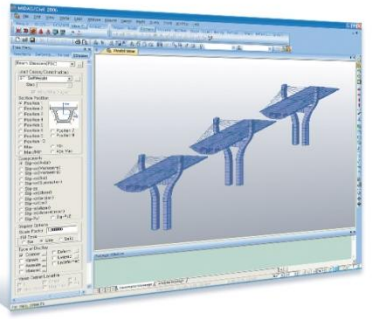
- Eurocode, AASHTO LRFD and other specifications
- Bending strength, shear strength & torsional strength checks
- Transverse rebars check and resistance & factored moment diagrams
- Stress check for completed state by construction stages
- Generation of member forces & stresses by construction stages and maximum & minimum stresses summary
- Excel format calculation report (Crack Control check as per Eurocode)

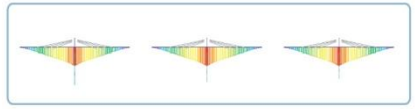
○ Various analysis results for practical design

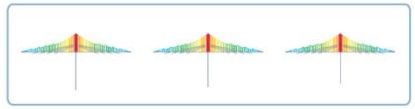

Tension losses in tendons


Tendon loss graph

PSC bridge-specific stress diagrams


PSC bridge-specific stress output


Maximum normal stress distribution for a PSC bridge

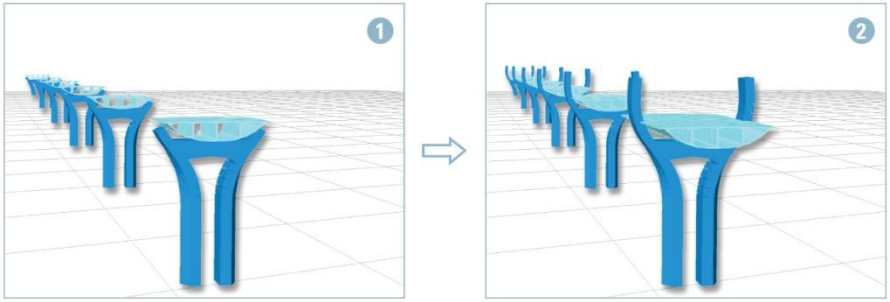

Principal stress distribution for a PSC bridge

- Separate immediate and time-dependent tension losses by tendons (graphs & tables)
- Generation of tendon weights and coordinates (calculation of tendon quantity)
- Normal / principal / shear / inclined stresses using PSC Stress Diagram command
- Generation of erection cambers
- Summary of reactions at specific supports in ILM bridges

03. PSC Bridge Design

○ Special type of PSC bridges

Construction stage analysis of an extradosed bridge (BCM)



Construction stage analysis - tower erection

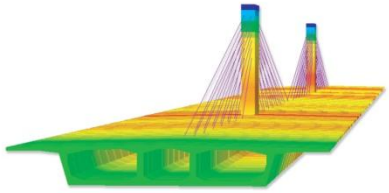
Construction stage analysis - staged construction of girders

Construction stage analysis - cable erection

Completed state model

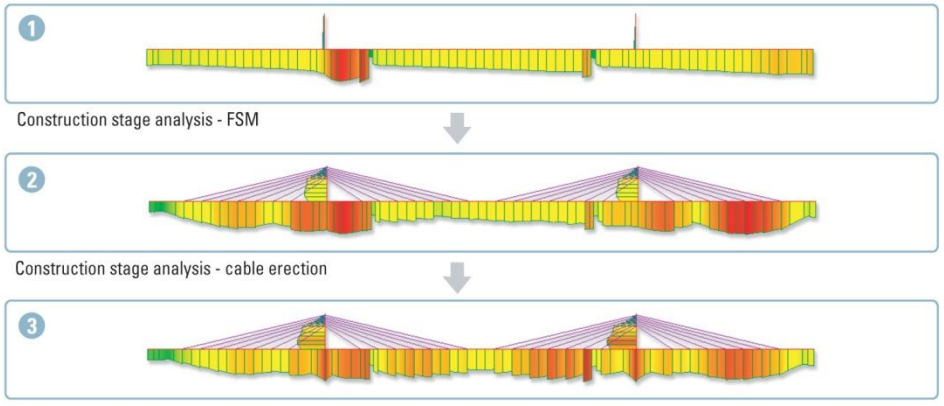
- Construction stage analysis reflecting time-dependent material properties and pretensioning forces
- External type pretension loads provided for inducting cable tensioning forces

Construction stage analysis of an extradosed bridge (FSM)



Analysis results of a completed state model

Construction Stage Analysis Control dialogue box



Construction stage analysis - FSM

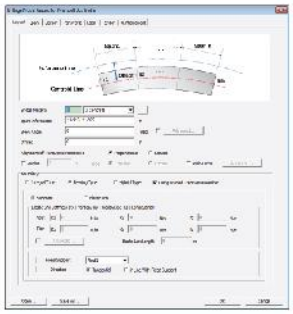
Construction stage analysis - cable erection

Construction stage analysis - removal of shoring

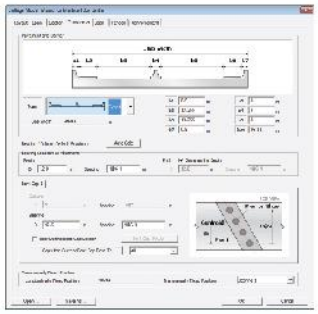
- Compression-only element provided to reflect the effects of temporary bents
- Calculation of section properties of an irregular section using AutoCAD and SPC
- Calculation of normal / principal / inclined stresses using the Beam Stress (PSC) command

03. PSC Bridge Design

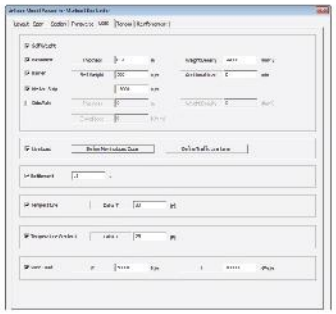
○ Grillage analysis model wizard



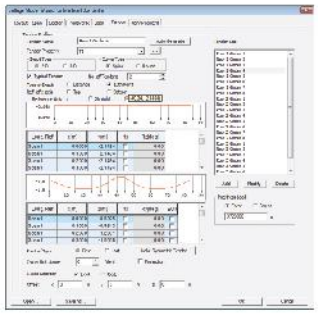
Defining bridge layout with span information and bearings data



Transverse member and bent cap definition



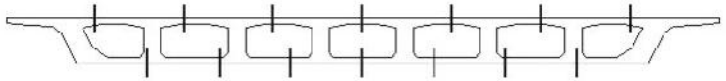
Tendon and reinforcement auto-generation



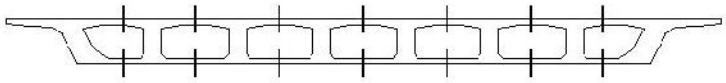
Permanent and variable actions definition with traffic lane arrangement

- Grillage analysis model wizard automatically converts wide multi-celled PSC box girder sections into a grillage mesh of longitudinal and transverse elements to perform a grillage analysis.
- Both slab based and web based divisions are supported to automatically calculate the section properties such as total area, transverse shear area, torsional moment of inertia, etc for the longitudinal and transverse beam elements.
- The grillage analysis wizard supports tapered bridges with horizontal curvatures, multiple types of spans, user defined bearing conditions, diaphragm and bent definition, auto live load generation, auto-placement of tendon profiles and reinforcement definitions

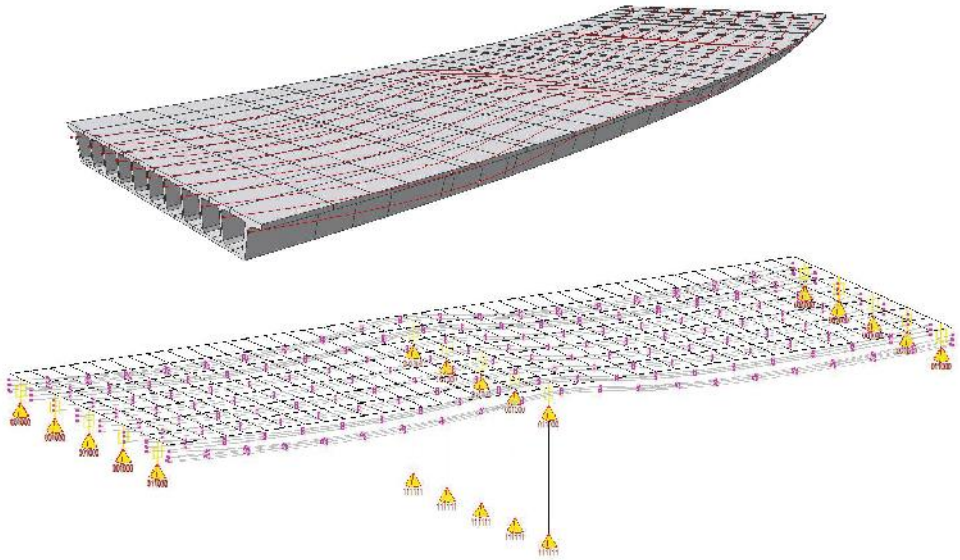
○ Prestressed multi-celled box girder bridges



Slab Based Division



Web Based Division

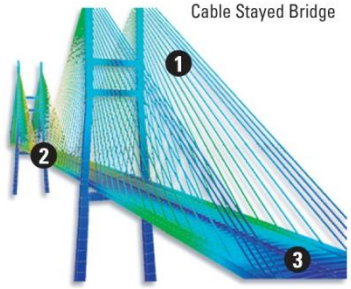


- Multi-celled box girder bridge grillage model completed with prestressing tendons and boundary conditions

04. Cable bridge analysis

"Optimal solution for cable bridge analysis (completed state & construction stage analysis with advanced analysis functions)"

○ Optimal solution for cable bridge analysis



1. Auto generation of construction stage pretensions using the tensions in the completed state (linear & nonlinear)
2. Behaviours of key segments in real construction reflected
3. Large displacement analysis reflecting creep & shrinkage

Initial equilibrium state analysis

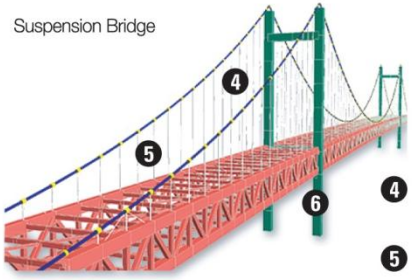
- Cable nonlinearity considered (equivalent truss, nonlinear truss & catenary cable elements)
- Calculation of initial pretensions for cable stayed bridges & initial shape analysis for suspension bridges

Construction stage analysis reflecting geometric nonlinearity

- Finite displacement method (P-delta analysis by construction stages and for completed state)
- Large displacement method (independent models for backward analysis & forward construction stage)

Completed state analysis & tower / girder design

- Linearised finite displacement method & linear elastic method
- Linear buckling analysis / moving load analysis / inelastic dynamic analysis
- Steel column design of irregular sections

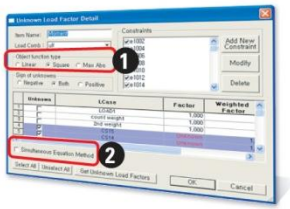


4. Backward construction stage analysis using internal member forces (reflecting large displacement)
5. Auto calculation of tensions in main cables and coordinates for self-anchored and earth-anchored suspension bridges
   Detail output for suspension cables (unstressed lengths, sag, etc.) & detail shape analysis
6. Steel column design of irregular sections

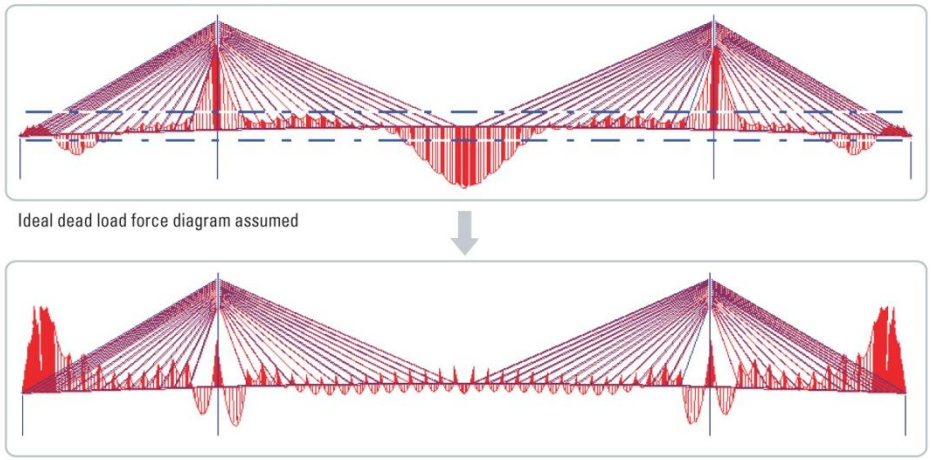
○ Initial equilibrium state analysis for cable stayed bridges

Generation of optimal cable pretension forces satisfying design constraints

1. Optimum solutions produced by an optimisation theory based on object functions
2. Solutions obtained by simultaneous equations if the numbers of constraints and unknowns are equal



Optimum stressing strategy



Ideal dead load force diagram assumed

Initial equilibrium state analysis results satisfying constraints

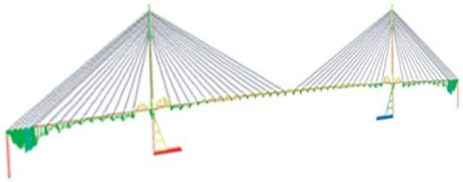
- Optimal initial pretensions generated to satisfy desired girder, tower & cable force and displacement constraints

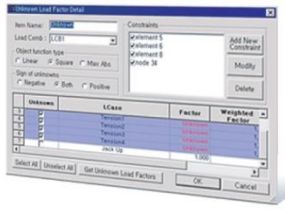
04. Cable bridge analysis

○ Construction stage analysis for cable stayed bridges

01. Forward staged analysis using the pretensions in the completed state

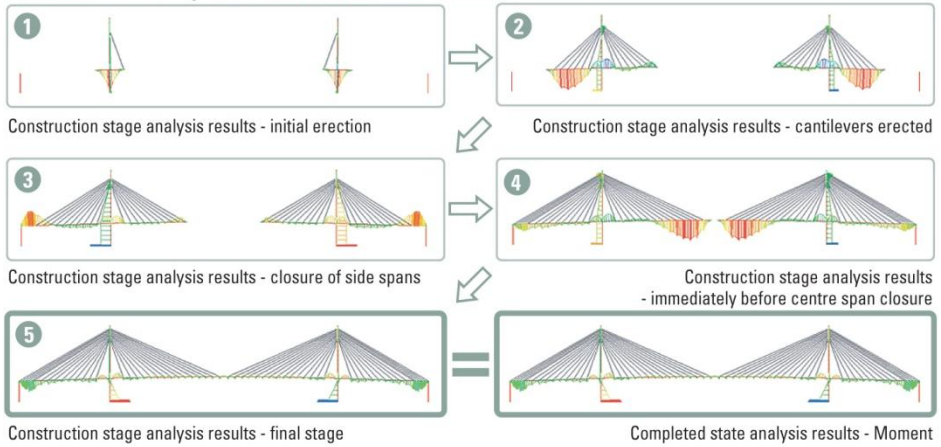
STEP 01. Calculation of pretensions using Unknown Load Factor





Optimal tensions in cables found satisfying constraints

STEP 02. Forward stage analysis for a cable stayed bridge using the pretensions of the completed state and Lack of fit force



Construction stage analysis results - initial erection

Construction stage analysis results - cantilevers erected

Construction stage analysis results - closure of side spans

Construction stage analysis results - immediately before centre span closure

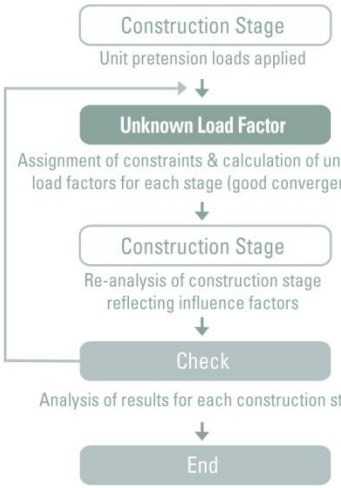
Construction stage analysis results - final stage

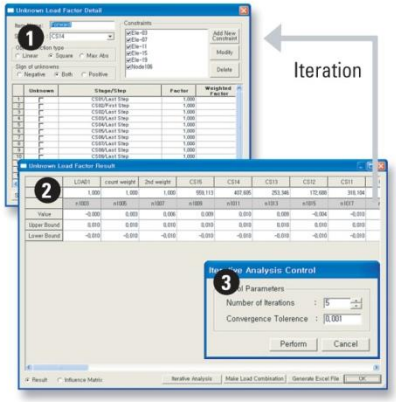
Completed state analysis results - Moment

- Auto calculation of erection pretensions by entering only the pretensions of the completed state & adding Lack of fit force without having to perform backward analysis
- Applicable for both large displacement and small displacement analyses
- Initial equilibrium state analysis reflecting the behaviours of the closure of key segments during erection
- Auto calculation of construction stage pretensions accounting for creep & shrinkage

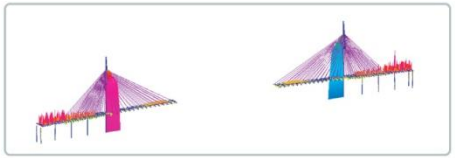
02. Forward staged analysis based on application of constraints

Procedure for a construction stage analysis

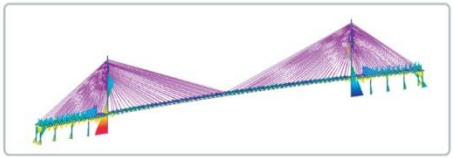




1. Set up constraints and unknowns
2. Load Factors found
3. Iteration control



Construction stage analysis results

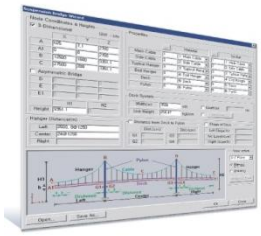


Analysis results of the completed state

- Calculation of cable pretensions by construction stages satisfying the constraints for the completed state
- Auto-iterative function provided to reflect creep & shrinkage
- Superb convergence for calculating unknown load factors using simultaneous equations & object functions

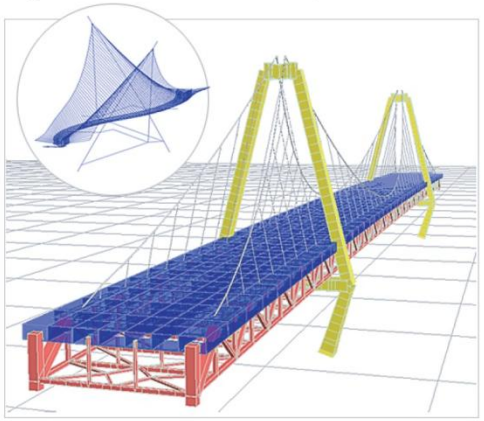
04. Cable bridge analysis

○ Initial shape analysis for suspension bridges



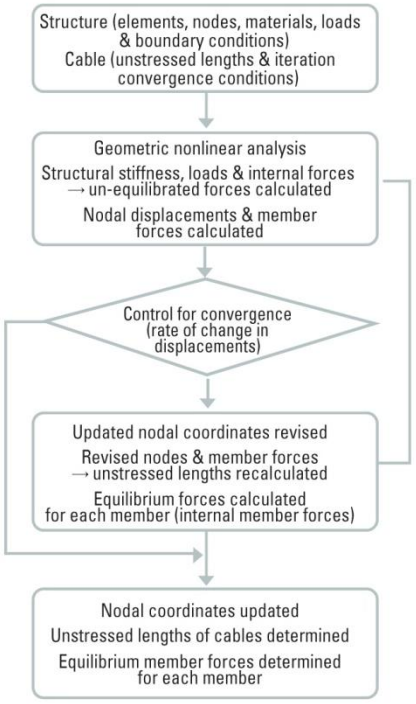
A self-anchored suspension bridge model using Suspension Bridge Wizard

Accurate analysis method using Suspension Bridge Analysis Control



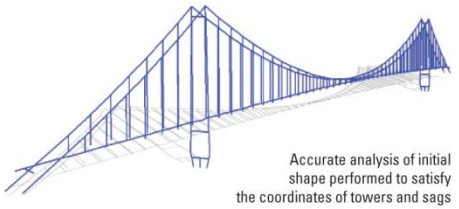
Initial shape model of a suspension bridge

Procedure for accurate analysis method

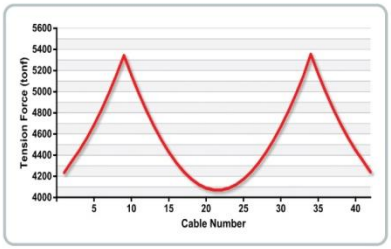


- Conventional earth anchored suspension bridges - initial shape analysis performed in Wizard through simple method / accurate analysis
- Initial shape analysis function for special suspension bridges with hangers located on different planes (accurate analysis)
- Shape analysis function reflecting initial member forces of self anchored suspension bridges

○ Construction stage analysis of earth anchored suspension bridges

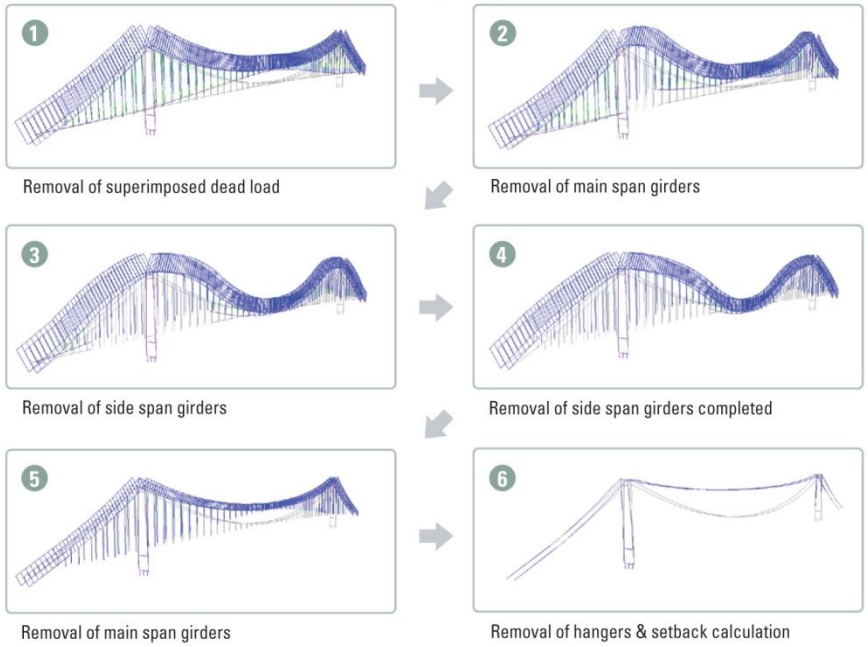


Accurate analysis of initial shape performed to satisfy the coordinates of towers and sags



Initial tension forces in cables of a suspension bridge

Backward construction stage analysis - large displacement analysis



Removal of superimposed dead load

Removal of main span girders

Removal of side span girders

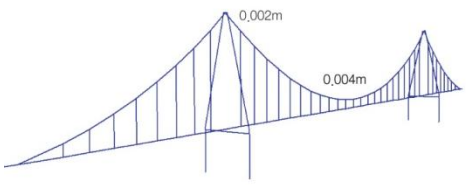
Removal of side span girders completed

Removal of main span girders

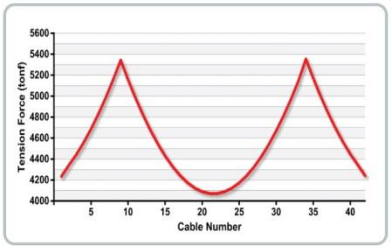
Removal of hangers & setback calculation

04. Cable bridge analysis

○ Construction stage analysis of self anchored suspension bridges

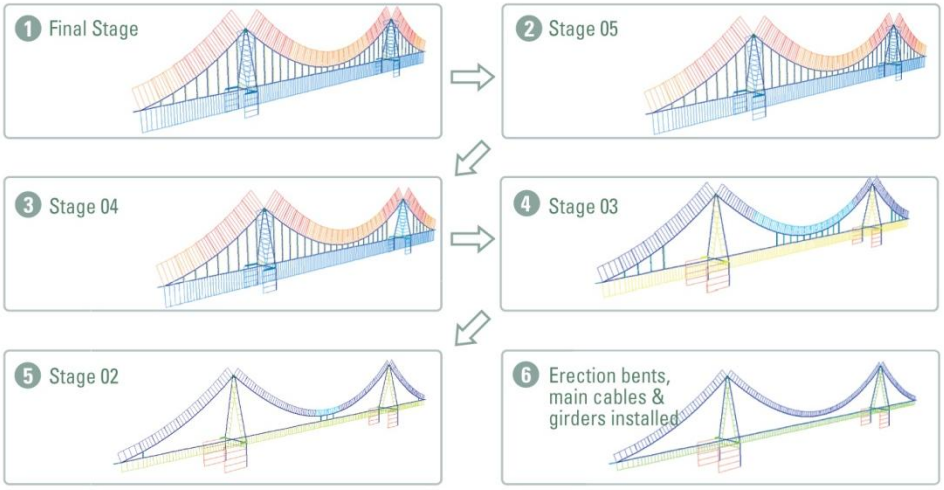


Initial shape analysis



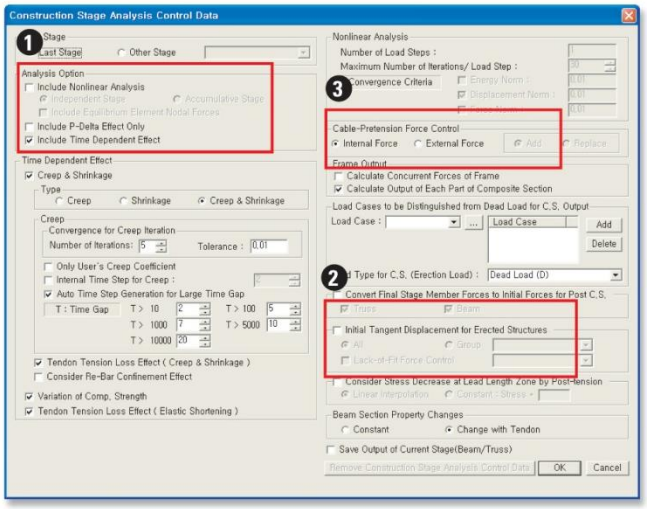
Initial tension forces of a self anchored suspension bridge

Backward construction stage analysis - large displacement analysis



- Accurate analysis with initial member forces to reflect the behaviour of a self anchored suspension bridge subjected to axial forces in girders
- Typical construction methods applicable for self anchored suspension bridges such as hanger insertion and Jack-down construction methods

○ Cable Bridge Analysis Options



1 Large displacement analysis by construction stages

- Independent Stage: backward analysis (independent model)
- Include Equilibrium Element Nodal Force: backward analysis reflecting internal forces (independent model)
- Accumulative Stage: Accumulative model for forward analysis

P-delta analysis by construction stages

- Include P-delta Effect Only

2 Reflection of tangential girder erection

- Initial Tangent Displacement for Erected Structure (fabrication camber calculated)

Auto calculation of cable tensions by construction stages

- Lack of fit force control: construction stages using tensions in the completed state automatically produced

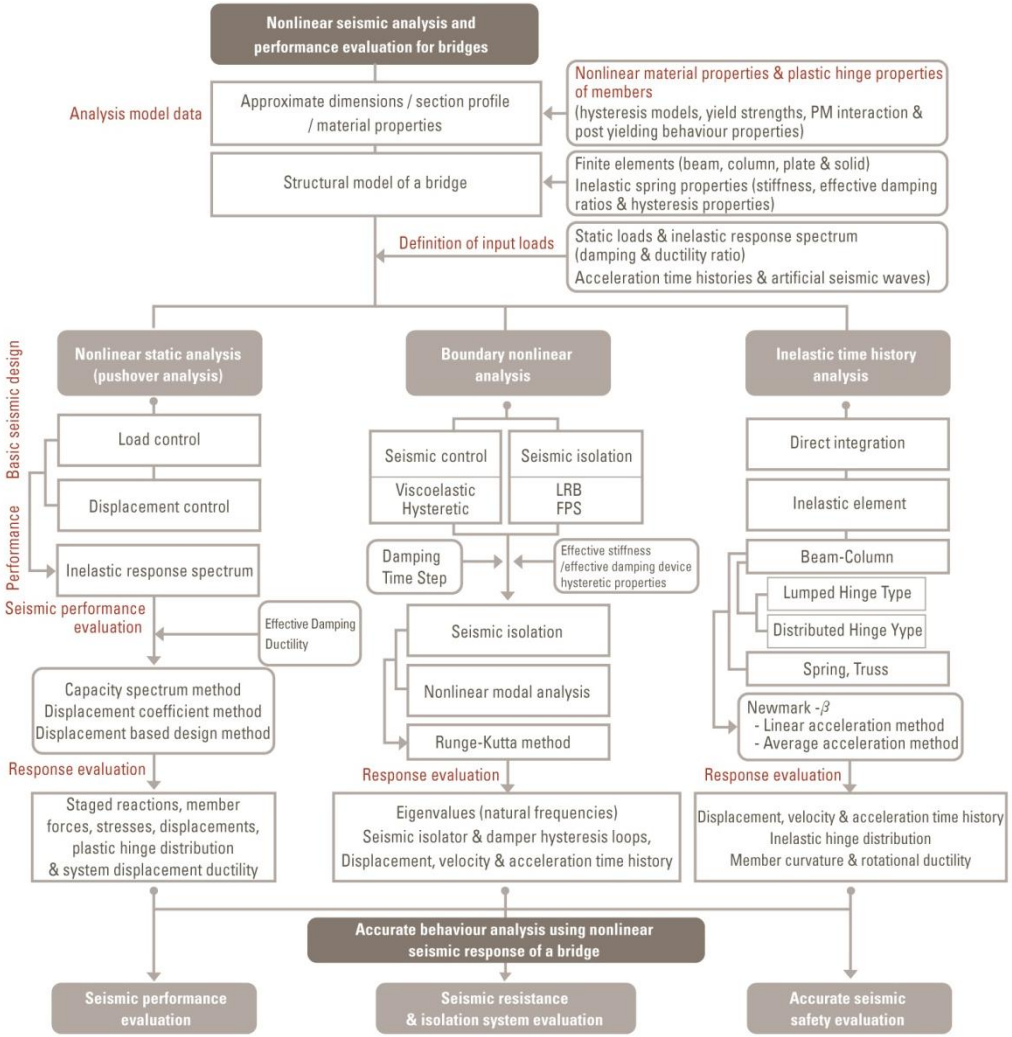
3 Cable Pretension Force Control

- Initial Force: Initial tensions inducted into as internal forces (inducted loads ≠ internal cable forces)
- External Force: Initial tensions inducted into as external forces (inducted loads = internal cable forces)

05. Nonlinear analysis

"Seismic & earthquake resistant system and seismic performance Evaluation for bridges using high-end nonlinear analysis"

○ Nonlinear analysis process in midas Civil

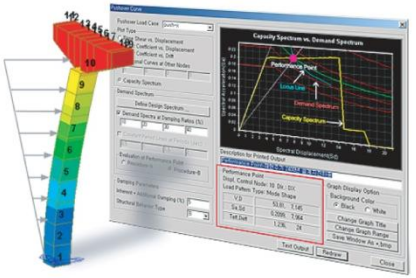


○ Pushover analysis

- Load control & Displacement control methods
- Gravity load effects considered
- Pushover analysis reflecting P-delta effects
- Various load patterns supported (Mode Shape / Static Load / Uniform Acc.)
- Multi-linear hinge & FEMA hinge types supplied
- Analysis results checked by pushover steps (hinge status / distribution, displacements, member forces & stresses)

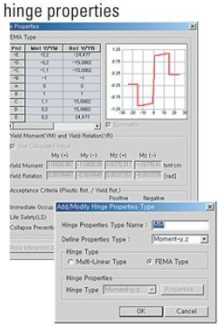
Capacity spectrum method

- Various types of capacity curves supplied
- Demand spectrums supplied for each design standard
- Seismic performance evaluated using Performance Point



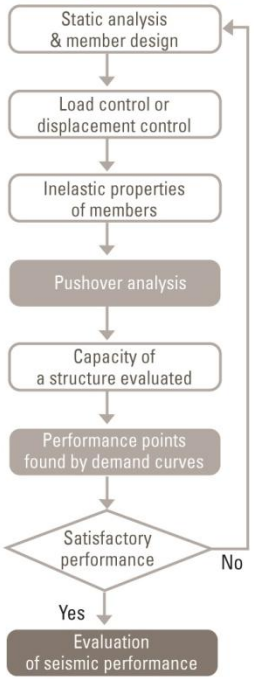
Capacity spectrum method

Auto generation of plastic hinge properties



Various plastic hinge models

Process of pushover analysis



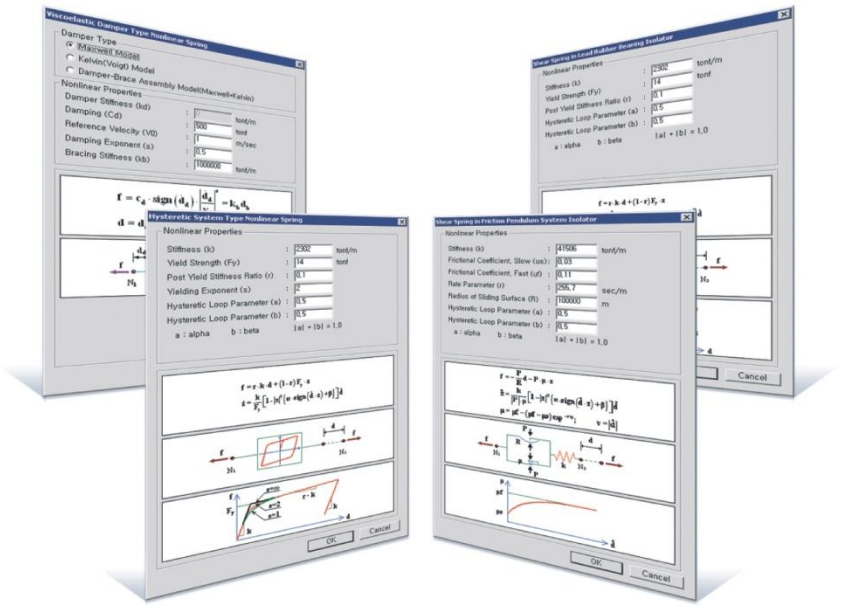
- Checking the status of safety limits of a system, which has been considered with dynamic behaviours & load redistribution, after yielding
- Structural inelastic behaviours & resistance capability calculated efficiently
- Capacity spectrum method provided to efficiently evaluate nonlinear seismic response & performance

05. Nonlinear analysis

○ Boundary nonlinear analysis

Viscoelastic Damper

Lead Rubber Bearing Isolator

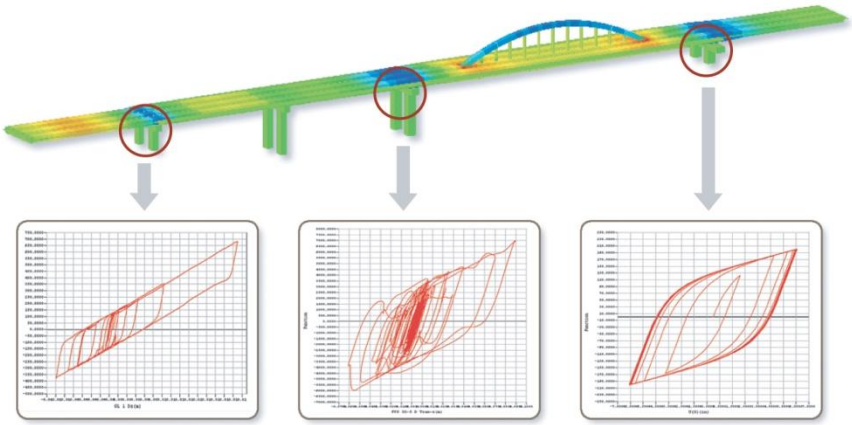


Hysteretic System

Friction Pendulum System Isolator

- Structural analysis function including nonlinear link elements (General Link)
- Structural analysis using spring elements having nonlinear properties (Inelastic Hinge Property)
- Various dampers & base isolators (Gap, Hook, Viscoelastic Damper, Hysteretic System, Lead Rubber Bearing Isolator & Friction Pendulum System Isolator)
- Static loads converted into the form of dynamic loads (Time Varying Static Loads)

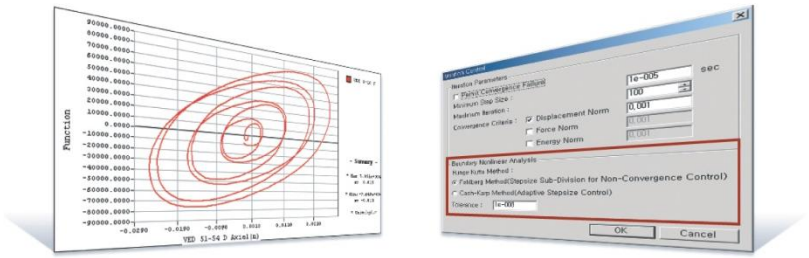
○ Analysis capabilities for dampers & base isolators



Lead Rubber Bearing

Friction Pendulum System

Hysteretic System



Viscoelastic Damper

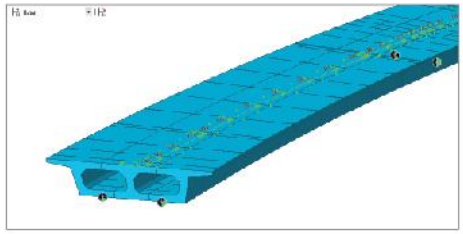
Runge-Kutta method analysis condition

- Dampers, base isolators & inelastic elements simultaneously considered in nonlinear time history analysis (nonlinear direct integration method)
- Good convergence by Runge-Kutta method (Step Sub-Division Control & Adaptive Stepsize Control)

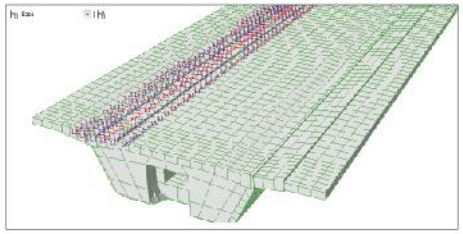
06. Moving Load Optimiser

"Generation of influence lines and surfaces for multiple lanes Of traffic to produce the most adverse live load patterns"

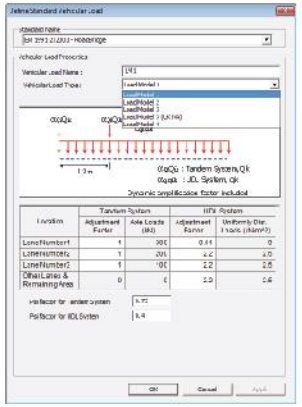
○ Moving load analysis Pre Processor



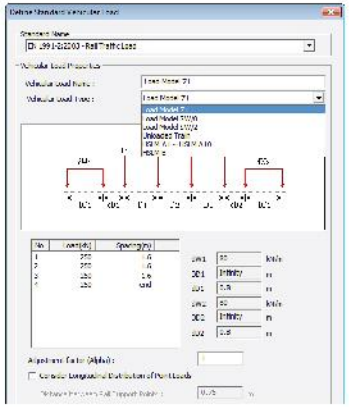
Traffic line lane with crossbeam type load distribution



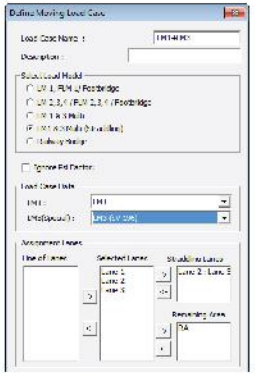
Traffic surface lane for shell elements



Motorway vehicles



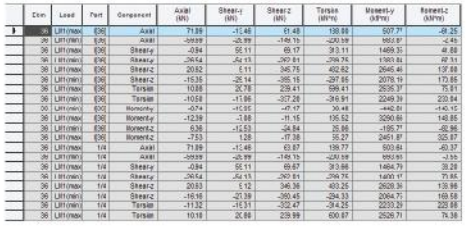
Rail loads



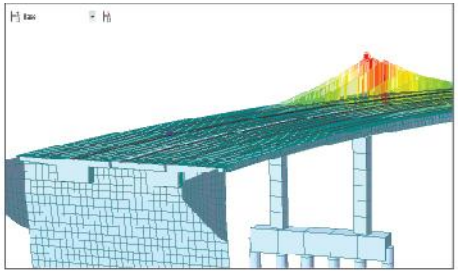
Auto moving load combination considering straddling of axles between two lanes for special vehicles

- Easy and multiple lane generation techniques along any type of curvilinear path
- Load models and vehicles from Eurocode, AASHTO LRFD, BS and other specifications
- Highway traffic loads, railway traffic loads and footway pedestrian loads can be combined automatically for moving load analysis.
- Construction stage analysis and moving load analysis can be done in the same model
- Special vehicles can be made to straddle between two lanes

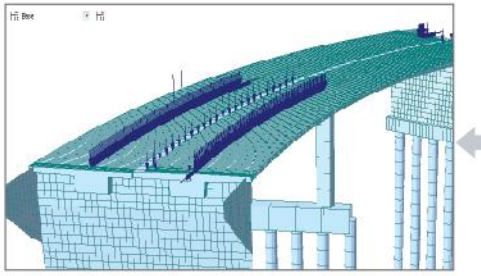
○ Moving load analysis Post Processor



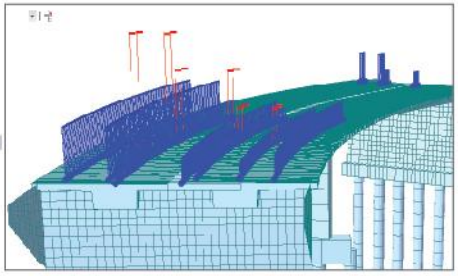
Concurrent force table for a given max/min force component due to live load



Influence line diagram for bending moment



Vehicular loads converted to equivalent static loads for detail analysis



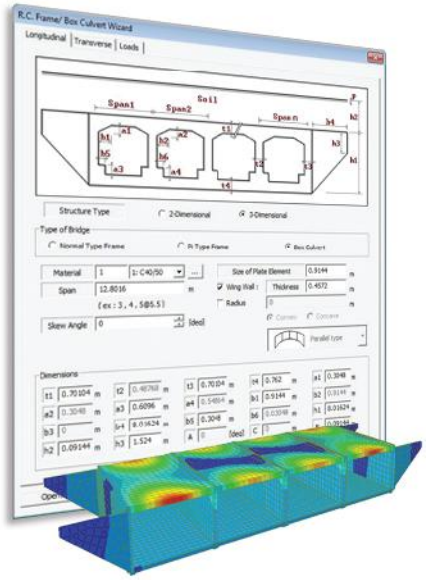
Moving load tracer diagram to identify the adverse location of vehicle for minimum / maximum force & bending moment

- Fast generation of analysis results using clever result filtering techniques that saves physical memory and time
- Combined member force checks are possible due to availability of corresponding force components for the max/min force effects. Eg: At maximum bending moment, combined shear + bending result can be seen
- Moving load tracer displays the adverse live load pattern for all vehicle combinations
- Moving loads can be converted into equivalent static loads for detail analysis

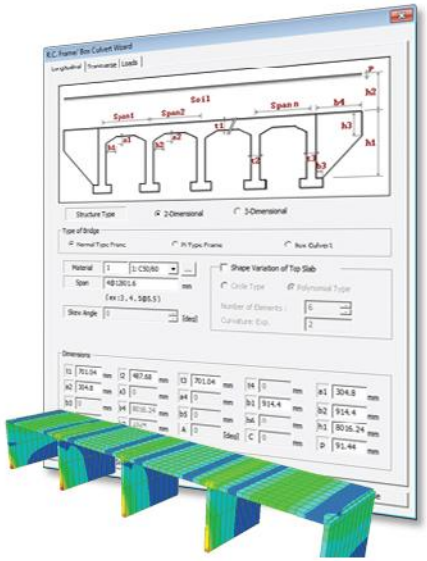
07. Soil-Structure Interaction

"Automatic modelling of soil-structure interface facilitating the analysis of integral bridges and box culverts"

○ Integral bridge and culvert wizard



Box culvert wizard

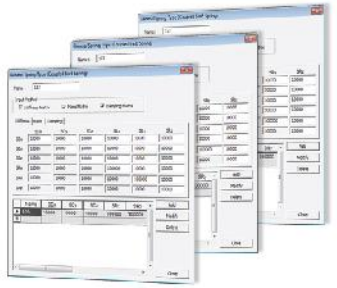


Integral bridge (frame) wizard

- Built-in wizard for RC frame/box culvert can model a 3 dimensional plate model of box culverts with all boundary conditions and ground pressure loads
- Auto calculation of soil springs from simple modulus of subgrade reaction input
- Automatic calculation of earth pressure loads considering the submerged condition of soil and the ground water level

○ Integral bridge spring supports

Integral abutment nonlinear soil spring supports



6x6 mass, stiffness and damping matrices to simulate dynamic soil-structure interaction

- Nonlinear soil behaviour can be automatically modelled
- Soil structure interaction around the abutment and pile can be simulated by entering basic geotechnical inputs.
- Stress distribution along the depth of the abutment can be visualised
- Detail analysis with soil models can be performed using midas GTS
- Dynamic soil structure interaction can be assumed with general links with 6x6 stiffness, mass and damping matrices to represent the foundation impedance of the substructure

DESIGN OF CIVIL STRUCTURES

Integrated Solution System for Bridge and Civil Engineering

midas Civil

Bridging Your Innovations to Realities

Additional Options and Modules

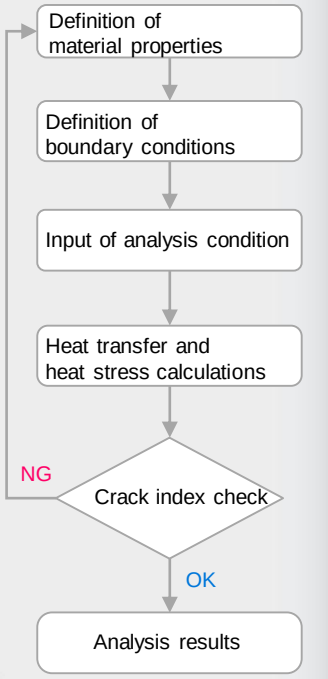
Option 1. Heat of Hydration Analysis

Option 01

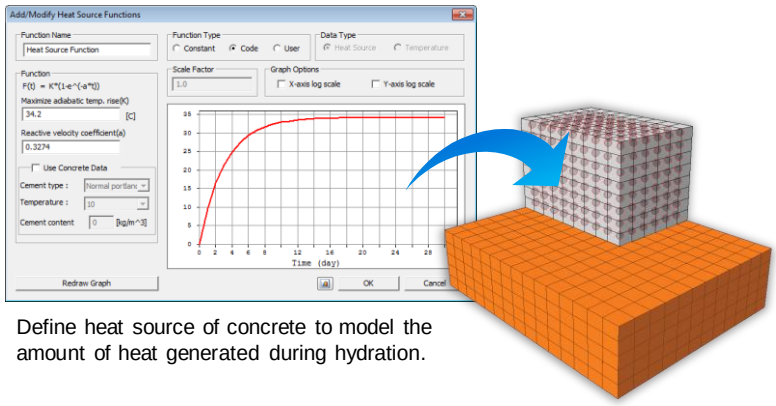
Heat of Hydration Analysis

Midas Civil provides heat of hydration analysis capabilities through heat transfer and heat stress analyses. Heat of hydration analysis by construction stages reflects the change in modulus of elasticity due to maturity, effects of creep/shrinkage, pipe cooling and concrete pour sequence.

Analysis Flow

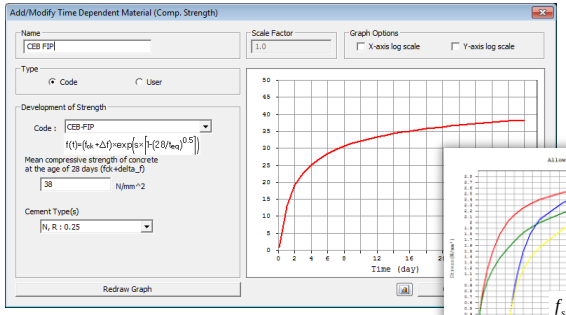


- **Definition of heat source of concrete**

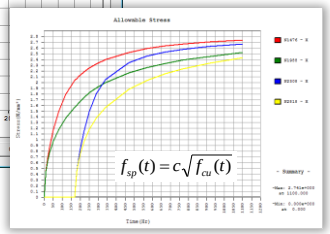


Define heat source of concrete to model the amount of heat generated during hydration.

- **Definition of material properties of concrete**



Compressive strength of concrete

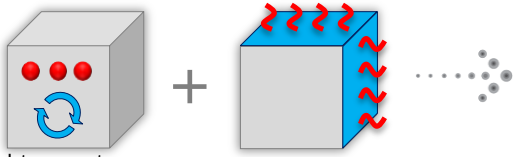


Tensile strength of concrete

- **Heat transfer analysis**

Definition of heat transfer

Definition of ambient temperature

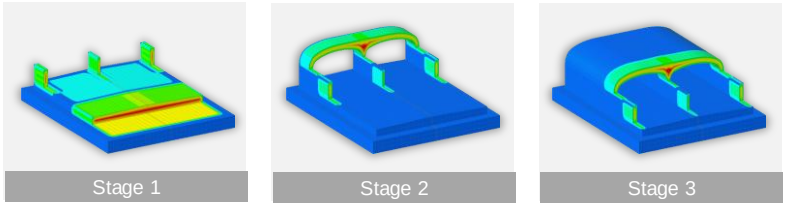


Initial temperature, exothermic temperature, and conduction

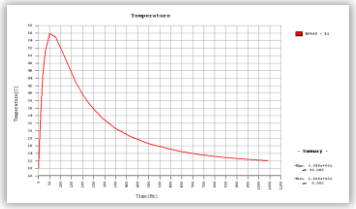
Convection limit and prescribed temperature

Calculate stress using temperature load obtained from heat transfer analysis

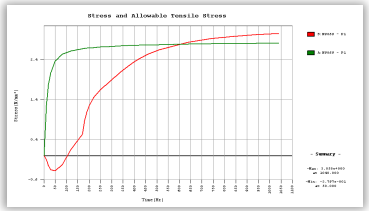
- **Temperature distribution based on the placement height**



- **various types of analysis results**



Temperature during construction stage



Stress during construction stage

Consideration of various parameters for accurate crack index analysis

- Adiabatic temperature rise considering maximum adiabatic temperature(K) and relative velocity coefficient(a)
- Creep/Shrinkage, compressive strength data base / Heat source function by code
- Changes in ambient temperature and convective coefficient
- Various convective coefficient depending on the existence, type and thickness of formwork, curing method, and wind velocity

Various results considering placement sequence

- Pipe cooling to reduce cracks
- Control of temperature for the use of ice plant by demining initial temperature for newly activated elements at a corresponding construction stage

Option 2. Material Nonlinear Analysis

Option 02

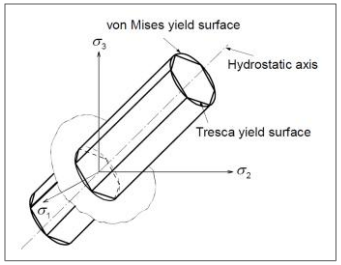
Material Nonlinear Analysis

Material nonlinear analysis is high end analysis function to represent nonlinear behaviours of structures after elastic limits.

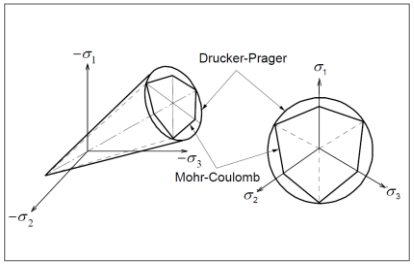
Analysis Flow

- Definition of Nonlinear material model
- Nonlinear analysis control
- Nonlinear static analysis of material nonlinearity
- Evaluation of yielding stress and deformation

- **Material nonlinear properties**

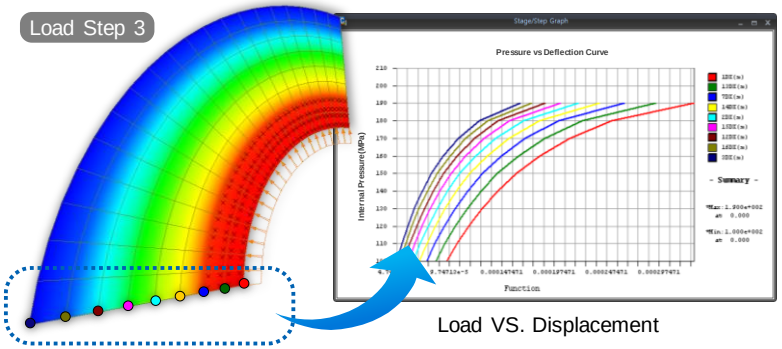


Ductile material



Brittle material

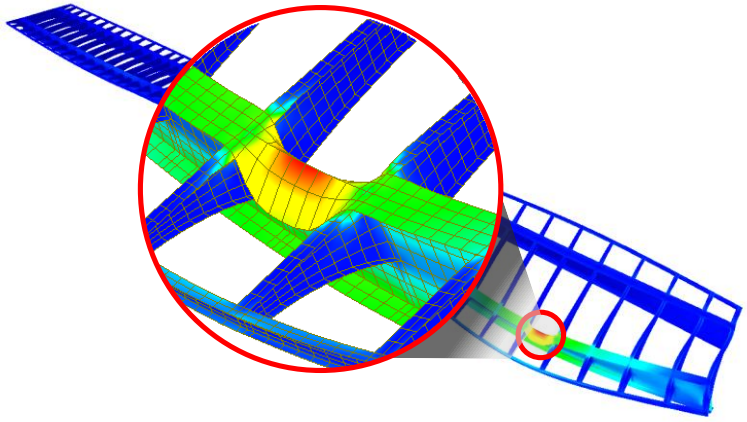
- **Analysis results**

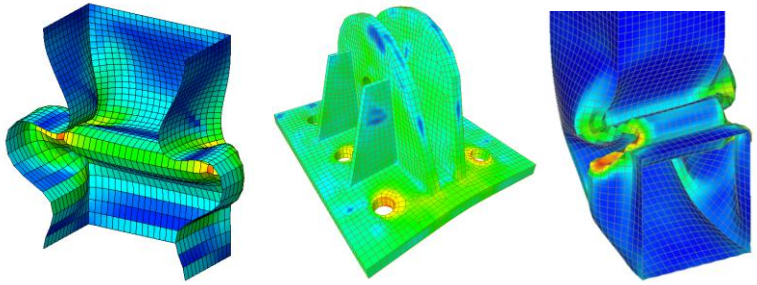


Load VS. Displacement

- Various hardening models which define the behaviours from the elastic limits to maximum stress points (Isotropic hardening, Kinematic hardening & Mixed hardening)
- Various failure models frequently encountered in civil engineering practice
- Good convergence for nonlinear analysis using shell elements, which reflect large displacements & large rotations

- **Simultaneous analysis of geometric and material nonlinearity**





Von-Misses Stress + Deformed Shape

- Representation of material nonlinearity of degenerated shell elements by integrating stresses in the thickness direction using a layered approach
- Plastic zone display function, which shows the status of yielding of shell elements in the thickness direction to obtain detail information on material nonlinearity

Option 3. Inelastic Time History Analysis

Option 03

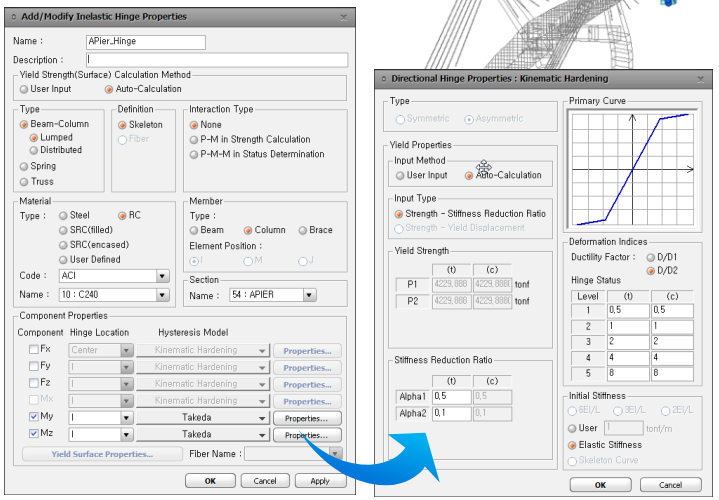
Inelastic Time History Analysis

For the seismic design and assessment of a structure, midas Civil offers a wide range of hysteresis hinge models such as kinematic hardening, Takeda, slip, etc. in the inelastic time history analysis.

Analysis Flow

- Static analysis and design of members
- Definition of inelastic hinge properties
- Define earthquake load
- Inelastic time history analysis
- Analyze Inelastic response and behavior
- Evaluation of Seismic performance and safety

- **4 Hinge type models**
  - √ Lumped Type Hinge
  - √ Distributed Type Hinge
  - √ Spring Type Hinge
  - √ Truss Type Hinge
- **Inelastic hysteresis models**
  - ✓ Uni-axial hinge model
  - ✓ Multi- axial hinge model
  - ✓ Over 20 hinge models including bilinear, tri-linear, Clouhg, Slip, Multi-linear Takeda, and Kinematic, etc.
  - ✓ Translational hardening type model / fibre model



Various hysteresis models

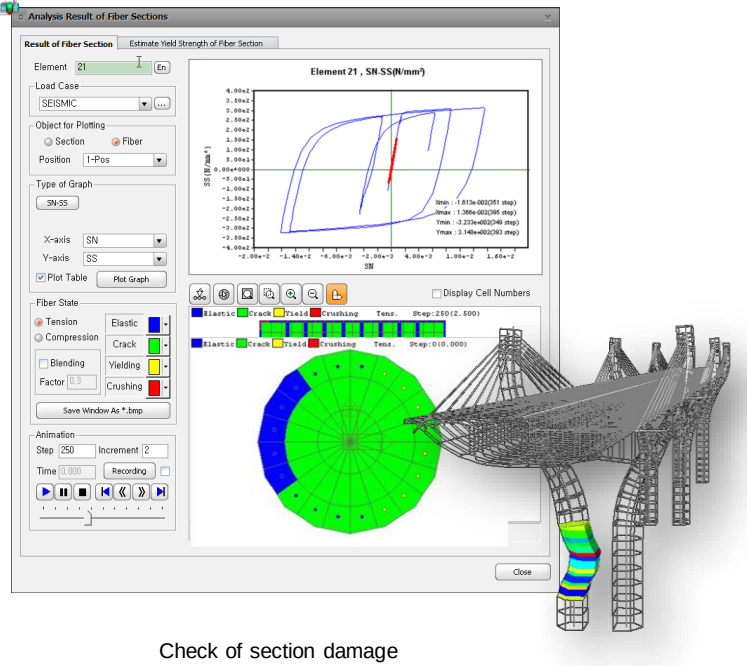
Automatic definition plastic hinge

- **Inelastic concrete material model**

  Kent & Prak / Japan Concrete Standard Specification/ Japan Road Bridge Specification / Nagoya Highway Cooperation / Trilinear Concrete / China Concrete Specification(GB50010-02) / Mander Model

- **Inelastic steel material model**

  Menegotto-Pinto / Bilinear / Trilinear Steel / Asymmetrical Bilinear / Park / Japan Roadway Specification Model



Check of section damage

Evaluation of performance in earthquake

- Accurate analysis by simultaneously considering nonlinear & time dependent properties of members to evaluate seismic safety
- Over 50 built-in earthquake acceleration records in DB & import of artificial seismic waves
- Versatile nonlinear analysis results (hinge distribution, max. & min. displacement / velocity / acceleration, time history graphs & simulations)

Versatile inelastic hysteresis models

- Limitation of nonlinear hinge models eliminated, which are based on experience such as pushover analysis, seismic analysis, etc.
- Change in axial forces accurately reflected through fibre models in structures whose axial forces change significantly
- Accurate representations of confinement effects of tie reinforcing steel, crashing and cracking in concrete members and tensile yielding in steel members under nonlinear analysis

Module 1. FX+ modeler

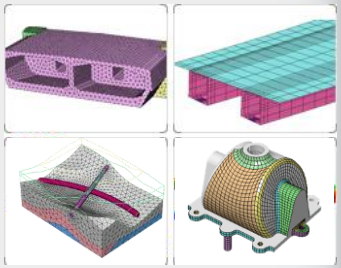
Module 01

FX+ modeler

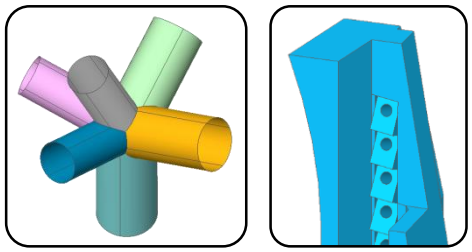
midas FX+ Modeler can create complex geometric data for accurate FE modeling. midas FX+ Modeler is capable of modeling any complex configuration encountered in civil structures and industrial facilities. Generated meshes can be produced in various types of data files that are fully compatible with midas Civil.

Application Areas

- Civil / Geotechnical
- Automotive / Aerospace
- Marine / Offshore
- Consumer Products
- Research / Education

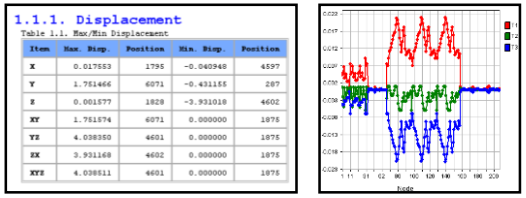


Geometry Modeller

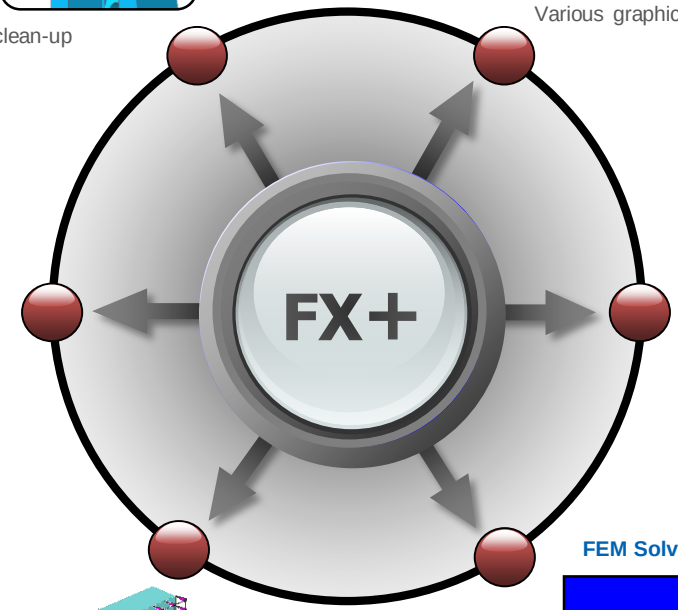


Geometry modelling and clean-up

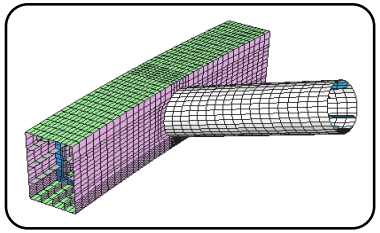
Report Generator



Various graphic plots and result tables

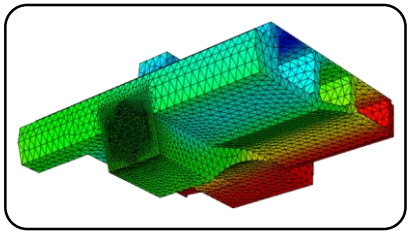


Mesh Generators

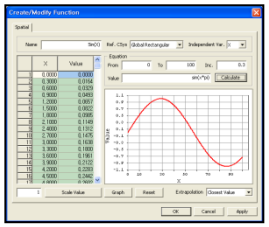


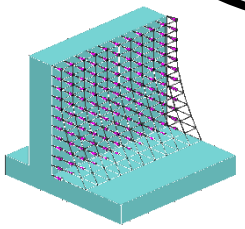
Auto, mapped and manual meshing

Post-processor

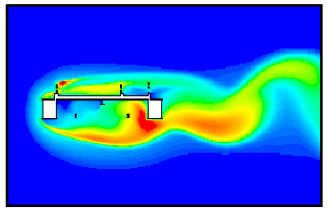


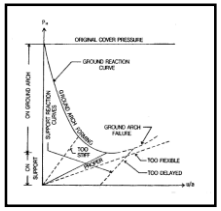
FEM Pre-processor





FEM Solvers



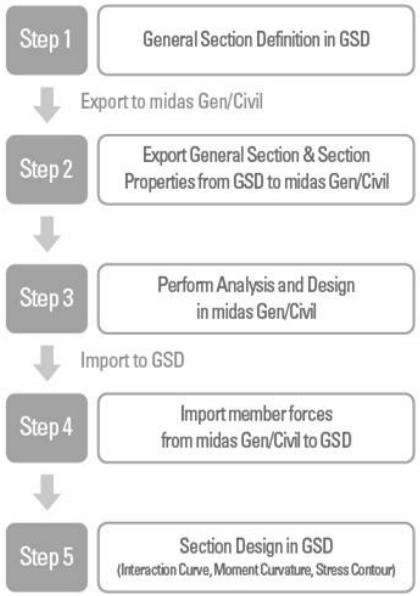


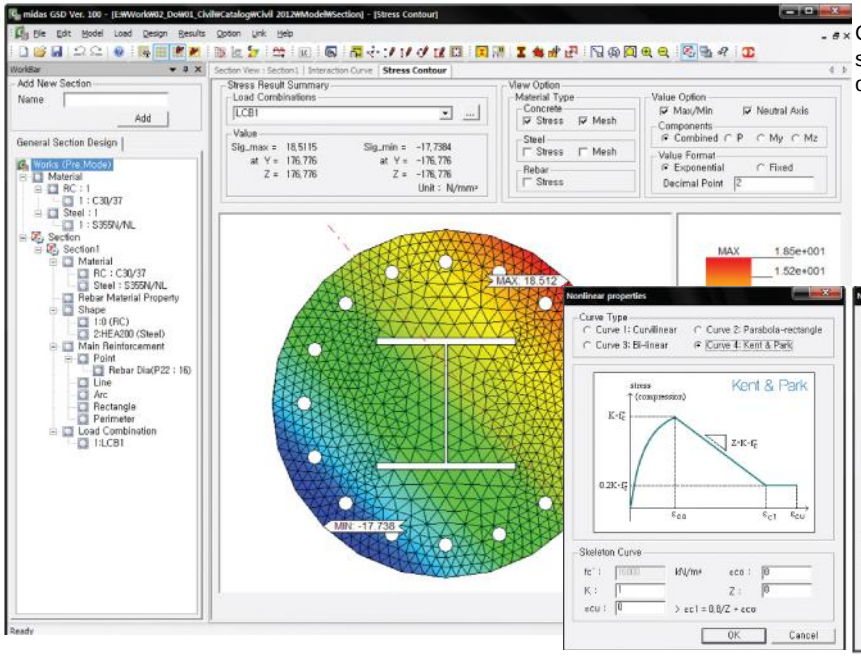
Module 2. GSD (General Section Designer)

Module 02

General Section Designer

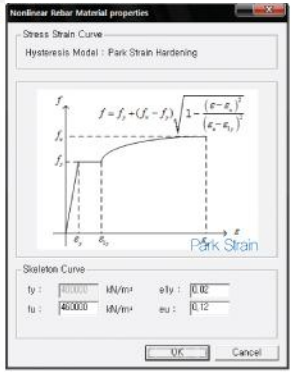
- Safety checks for any irregular RC, steel, composite section
- Definition of any irregular cross-section and calculation of section properties
- Mander model to define nonlinear properties to concrete
- Generation of P-M, P-My-Mz, M-M interaction curves as per Eurocode, AASHTO LRFD
- Calculation of section capacity (in flexure) and safety ratio based on member forces
- Generation of moment-curvature curve
- Plot of stress contour for all the corss-sections



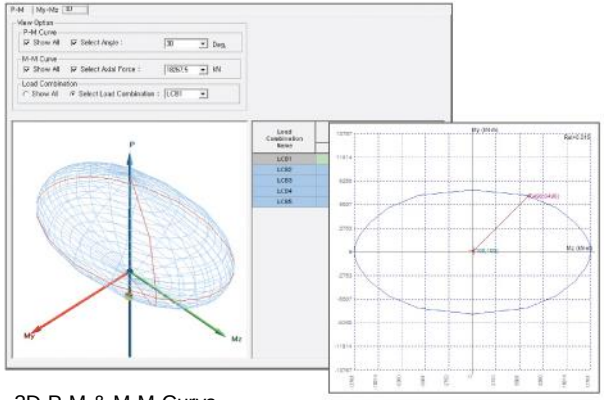


Check of SRC section stiffness with consideration of material non-linearity

Concrete non-linear material properties

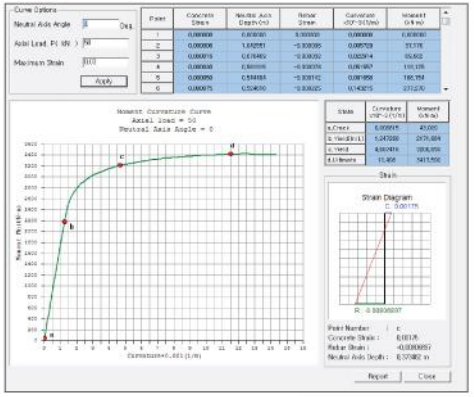


Rebar non-linear material properties

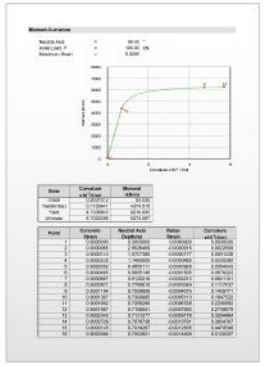


3D P-M & M-M Curve

다양한 각도에서 확인



Moment Curvature Curve

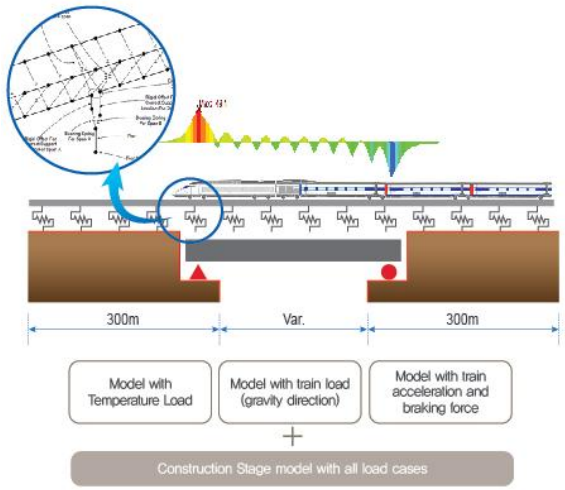


Print out of Report

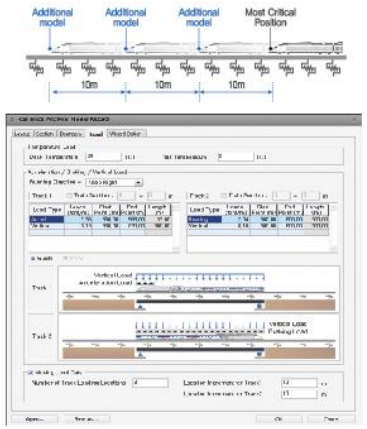
Module 3. Rail Track Analysis

• Rail track analysis wizard for light speed rail

Auto-generation of multi-linear type elastic links

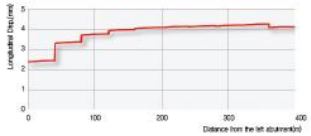


Generation of additional moving load analysis models with referring to the most critical position

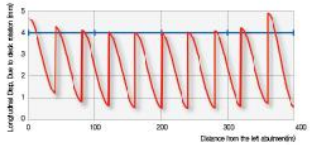


- Fast modelling of multi span bridges using Wizard supporting multiple span types for parametric study, tapered bridges, Rail Expansion joints, etc.
- Automatic nonlinear boundary condition for ballast and concrete bed for loaded and unloaded condition
- In complete analysis model, construction stages with different boundary conditions for each stage are generated.
- Auto-generation of model files for additional verifications whilst considering proper boundary conditions and load cases
- Longitudinal relative displacement of deck and displacement due to bridge rotational angle
- Stress and displacement due to temperature gradient by ZLR (Zero Lateral Resistance) and REJ (Rail Expansion Joints)

Longitudinal displacement of deck due to acceleration and breaking force

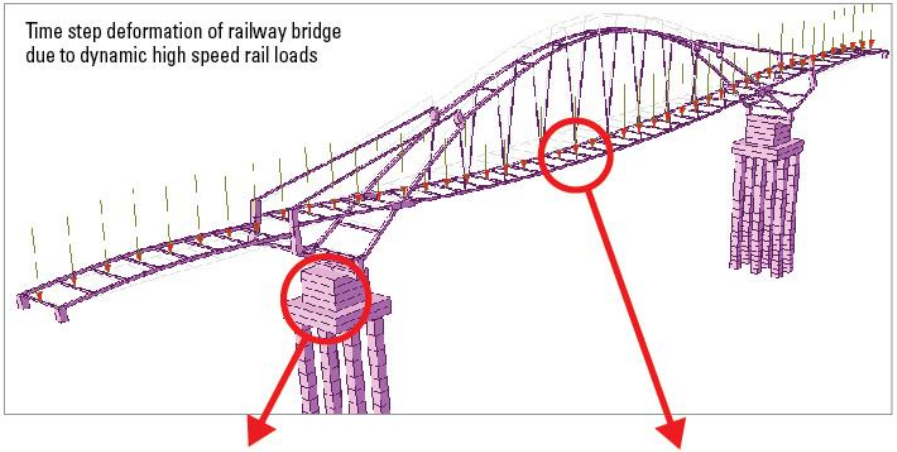


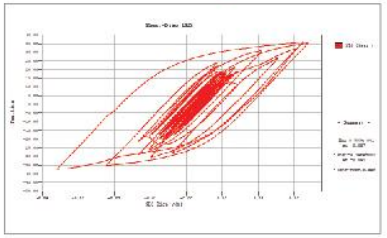
Longitudinal displacement due to rotation



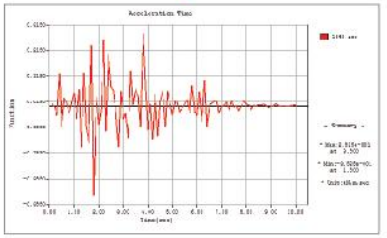
• Modal time history analysis for high speed rail

Time step deformation of railway bridge due to dynamic high speed rail loads





Shear vs displacement behaviour of Lead Rubber Bearing Isolator due to train loads



Acceleration vs time reponse at mid-span of the bridge under high speed train load

- Fast dynamic analysis approach for nonlinear boundaries
- Easy entry of train loads via Excel sheet input in the dynamic nodal loads table
- Wide variety of graphs and tables displayed in the post processor for time history forces, stresses and displacements under the dynamic effects of high speed rail
- Peak acceleration, displacement checks and bearing behaviours can be obtained for high speed rails

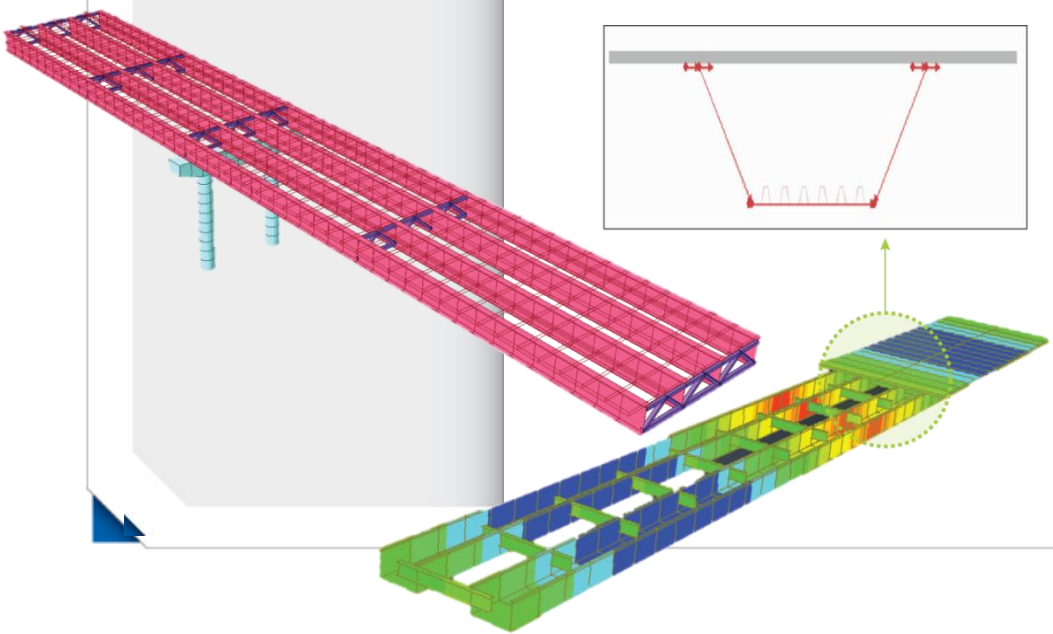
Module 4. AASHTO Steel Composite Design

Module 04

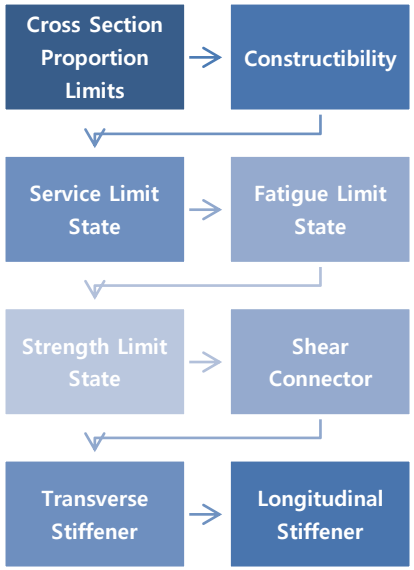
Steel Composite Design as per AASHTO LRFD, LRFR

Steel composite design module enables engineers to perform design check as per latest AASHTO LRFD code and rating as per latest AASHTO LRFR code in 3D models. Engineers will be able to consider erecting sequence of the girders with different deck pours and temporary supports.

Girder bridge wizard automatically generates steel and PC composite girder bridge model with longitudinal reinforcements / tendons, bracings, stiffeners, and loads.



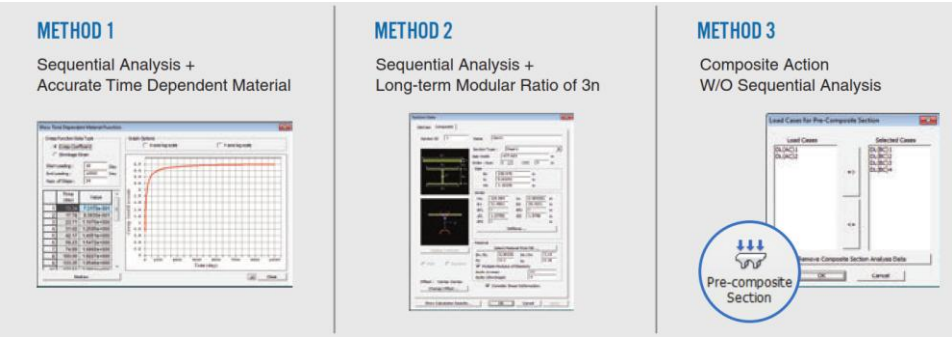
• Steel Composite Design Process



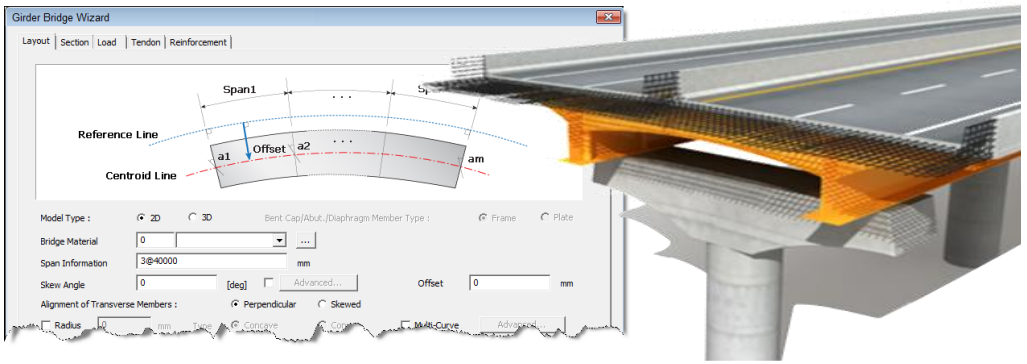
• Bridge Load Rating

Design Load Rating	•Performance of existing bridges •Bridge plan data block
Legal Load Rating	•Single safe load capacity •Bridge posting determination
Permit Load Rating	•Applied to bridges having sufficient capacity •Overweight permit determination

• Three modeling methods for composite action



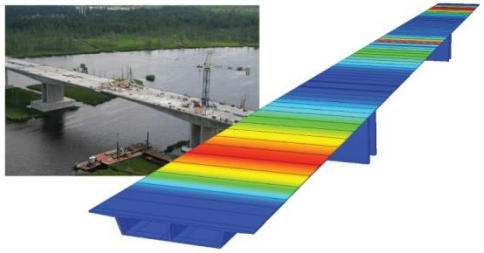
• Girder Bridge Wizard



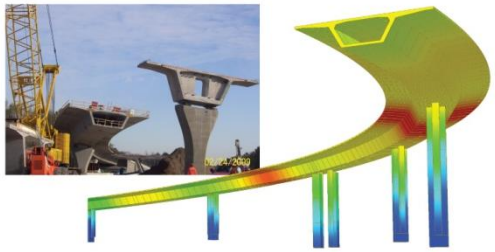
Project Applications

| Segmental Concrete Bridges |

US17 Wilmington Bypass (North Carolina, USA)



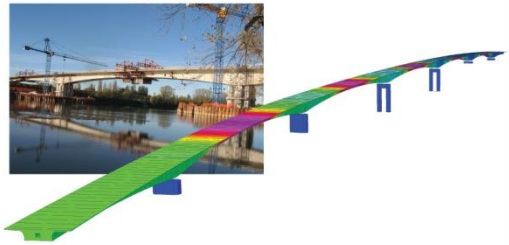
I-95/I-295 Lee Roy Selmon Flyovers (Florida, USA)



Galena Creek Bridge (Nevada, USA)

Jalan Travers Bansar (Kuala Lumpur, Malaysia)

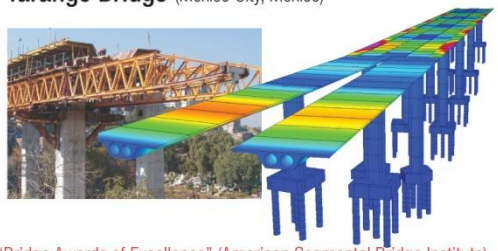
The bridge over the Adige river (Verona, Italy)



Basarab viaduct (Bucharest, Romania)

La Jabalina Bridge (Durango, Mexico)

Tarango Bridge (Mexico City, Mexico)



"Bridge Awards of Excellence" (American Segmental Bridge Institute)

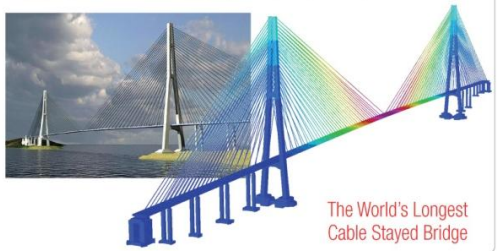
Intersección Elevada Av. Suba x Av. Boyacá (Cali, Colombia)

Project Applications

| Cable Stayed Bridges |

| Suspension Bridges |

Russky Island Bridge (Vladivostok, Russia)

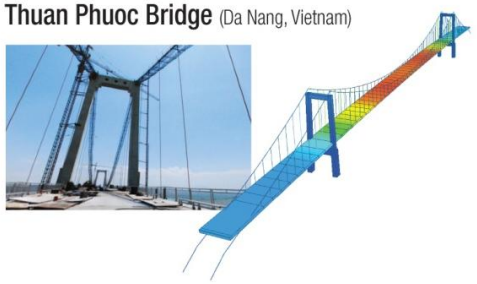


The World's Longest Cable Stayed Bridge

Stonecutters Bridge (Hong Kong, China)

3rd Longest Cable Stayed Bridge

Thuan Phuoc Bridge (Da Nang, Vietnam)

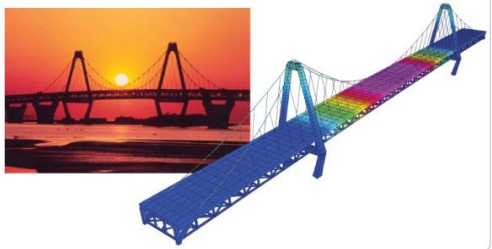


Ironton-Russell Bridge (Between Ironton and Russell, USA)

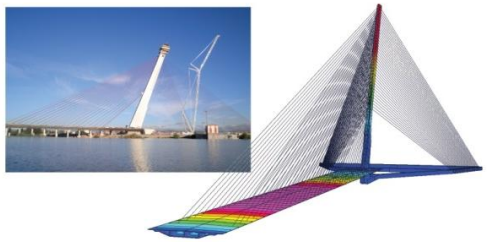
New Wear Bridge (Sunderland, UK)

An Award Wining Bridge in UK

Young Jong Bridge (Incheon, South Korea)

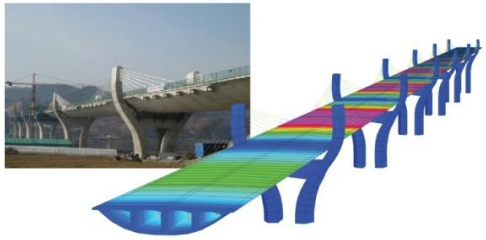


Talavera Bridge (Castile-La Mancha, Spain)



Korabelny Farvater Bridge (Saint-Petersburg, Russia)

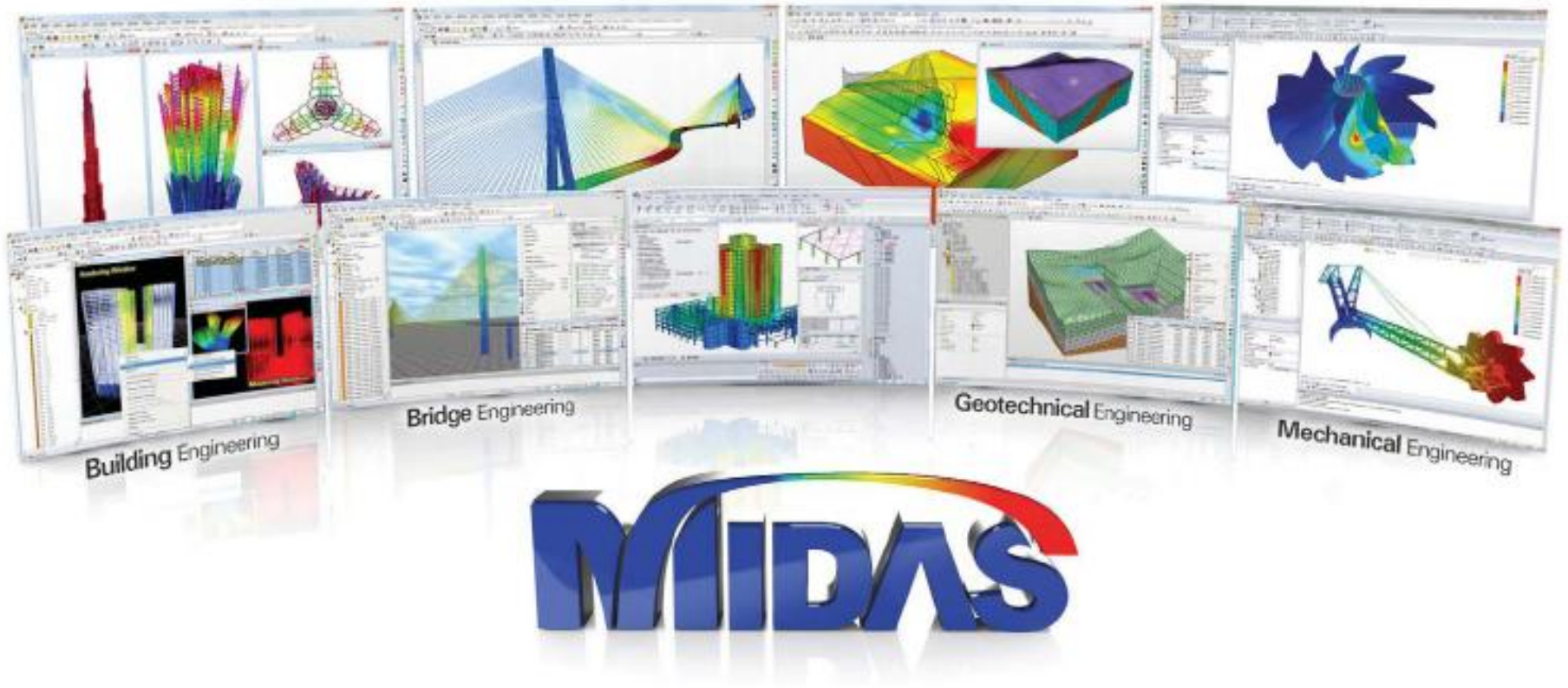
Kum Ga Bridge (Chungju, South Korea)



About MIDAS IT

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

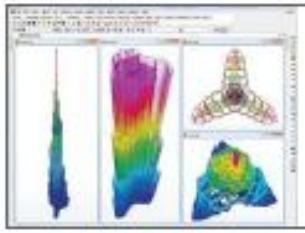
MIDAS Information Technology Co., Ltd. develops and supplies mechanical / civil / structural / geotechnical engineering software and provides professional engineering consulting and e-Biz total solutions. The company began its operation since 1989, and currently employs 530 developers and engineers with 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

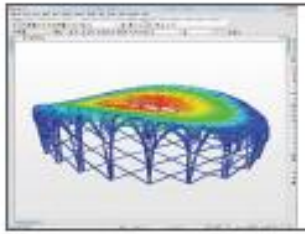
"MIDAS Family Programs are advanced CAE (Computer Aided Engineering) solutions that have been and are being developed using the latest technology"

MIDAS Program Applications



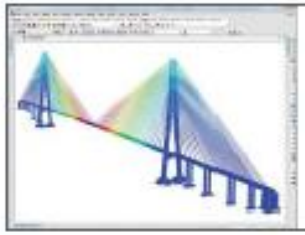
Burj Khalifa (UAE)

- 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

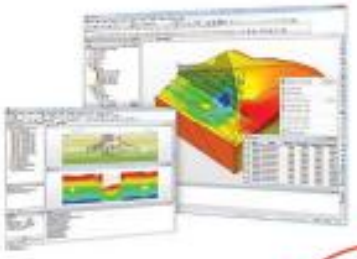


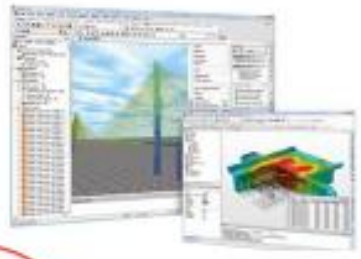
Russky Island Bridge (Russia)

- World's longest cable stayed bridge
- Main span: 1,104m

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

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Integrated System for building and General Structures

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

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

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

Global Network

a total of over 30,000 licences used worldwide in over 150 countries

Largest CAE Software Developer in Civil Engineering

midas Civil

Bridging Your Innovations to Realities