



Mokpo Bridge by GS Engineering & Construction Corp. Korea

## RM Bridge Advanced

Bridge Structural Modeling, Analysis, Design, and Construction Engineering

RM Bridge Advanced V8i is comprehensive 2D/3D/4D software used by bridge engineers for all types of bridges, materials, and construction methods. A fully integrated modeling, analysis, and design process and rapid results processing bring economy to bridge design. RM Bridge Advanced produces deliverables derived directly from the models being analyzed – improving bridge constructability and ensuring smooth project delivery.

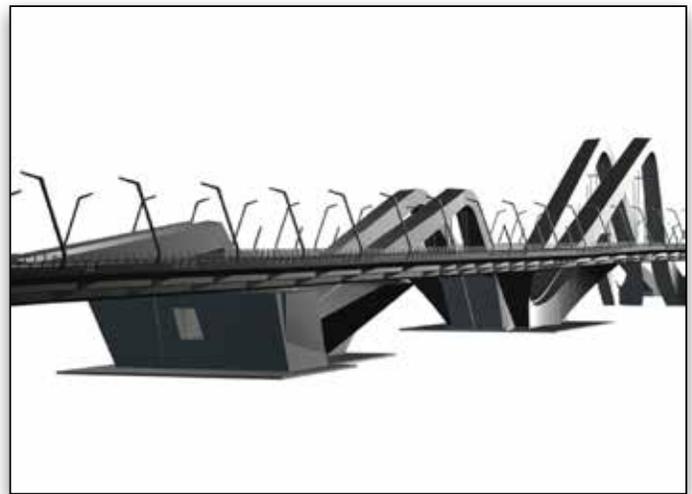
### All-in-One Bridge System

RM Bridge Advanced follows an iterative modeling and analysis process that gives users remarkable flexibility in the bridge design process. It puts an end to costly start-over tasks that occur in midstream and has the added benefit of ensuring that an efficient and balanced project is delivered. This enables engineers to achieve extreme accuracy and go to unprecedented levels of analytical exploration and simulation. The software provides seamless support for required international design codes.

RM Bridge Advanced is the core software of the RM Bridge family, which offers integrated modules for bridge engineering and construction. RM Bridge software comprises a selection of advanced modules for the intensive analysis requirements of complex bridge types, such as long-span, cable-stayed, and suspension bridges. Add-on modules address specialized activities such as advanced earthquake analysis, rolling stock analysis, erection control, simulation of wind-tunnel tests, wind buffeting, as well as a variety of construction and fabrication methods such as incremental launching, in-situ casting, and others.

### Develop a Complete Bridge Project

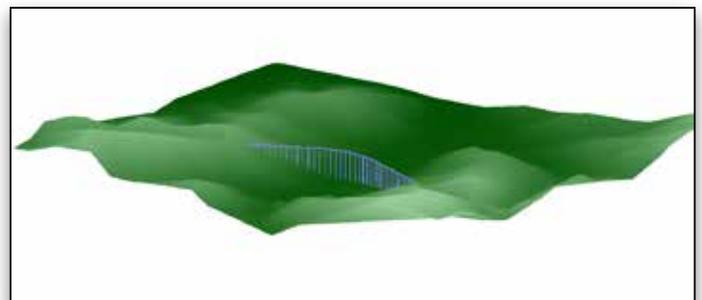
RM Bridge Advanced is an iterative system that provides engineers broad flexibility in the development of a complete bridge project, saving time and improving project delivery. Complete static and dynamic analysis capabilities help them address virtually any structural issue. The ability to model time-dependent material effects and analyze construction staging provides distinct competitive advantages. Expert parametric geometry definition and control, as well as easy modification, aid in construction management, erection simulation, and seismic analysis. Automated processes like direct delivery of design data to casting and fabrication help save time and shorten project cycles. Users can even provide project stakeholders with open, browser-like access to the bridge design project for viewing, redlining, printing, and plotting. Batch and interactive mode as well as programming capabilities make the application very attractive for quick and easy use. Connection to Bentley inspection applications highlights RM Bridge as an all in one solution – even in the maintenance process of the bridge lifecycle.



Sheik Zayed Bridge in United Arab Emirates, by High Point Rendell.

### Infrastructure Project Definition

Unlike comparable bridge software, RM Bridge Advanced performs well in the context of the infrastructure project. The software shares data in MicroStation® DGN, LANDXML, DWG, and other formats. This capability enables the engineer to accurately define the bridge based on the roadway or railway axis geometry from Power Rail Track®, Power InRoads®, Power GEOPAK®, or alternatively from AutoCAD, Civil 3D, and other partial applications. With RM Bridge Advanced, the bridge engineer has a wealth of civil project information at hand: roadway horizontal alignments, vertical profiles, photogrammetric data, digital terrain models, isolines (contour lines), raster graphics, and rail line designs. All bridge design and construction data contributes to the process of bridge information modeling (Brim).



Terrain model.

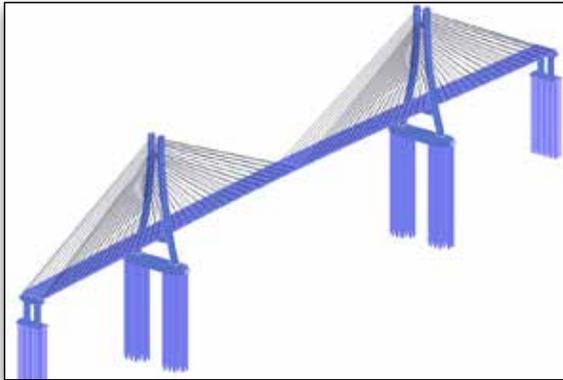


## *RM Bridge ensures bridge constructability and improved design.*

BrIM is a new and innovative approach to bridge engineering and project delivery that fosters the use of data beyond design and engineering needs to inform downstream processes such as fabrication, construction, operation, maintenance, and inspection.

### **Design Any Bridge Type**

RM Bridge Advanced with special add-on modules addresses all types of bridges, from reinforced and pre-stressed concrete to steel and composite bridges, arch bridges, suspension and cable-stayed bridges, and more. It performs consistent time-dependent analysis of creep and shrinkage and steel relaxation. Users analyze the deformability of the superstructure and consider in detail the used construction methods and sequences as well as interactions between the superstructure and substructure or structure and soil.

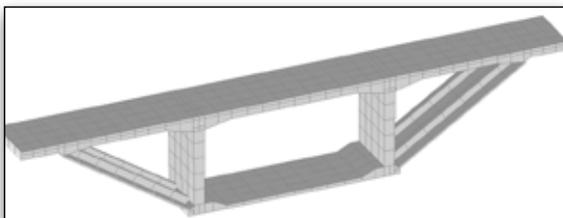


*Predict performance with RM Bridge Advanced.*

RM Bridge Advanced streamlines analysis of pre- and/or post-tensioned concrete structures (for internal and external tendons), steel and composite structures with pre-stressed structural parts. The software also solves a full range of common composite structure problems and calculates the effects of different strengths and ages of concrete, accounting for creep and shrinkage differences among the various components. In addition, the software supports both prefabricated and cast-in-place construction methods.

### **Integrated Modeling and Analysis**

A bridge modeler runs in sync with an ingenious bridge solver to streamline the management of geometry data for detailed design and drawing production. Using the bridge modeler, engineers define the entire structural system, including support conditions, substructures,



*Composite cross-section.*

and cross members. The software ensures that geometric cross-sectional data and the structural calculation model correspond. It produces a fully defined structural model with complex definition of individual cross sections, ready for structural analysis. The bridge solver performs an impressive array of analytical operations, calculating bridge performance in virtually any condition or situation. Data is reprocessed by the modeler and the solver as many times as necessary to reach the desired results.

The possibility of defining tables and formula as database objects assigned to individual data is an efficient means to account for variability of the model geometry as well as of governing parameters in the analysis process. RM Bridge Advanced with special add-on modules is renowned for its dynamic analysis capabilities, which manage traditionally complex engineering problems with ease and accuracy. A full array of mass and damping matrices and time-history capabilities – combined with fast calculation times – puts RM Bridge Advanced in a class of its own. The types of analysis cover the gamut of bridge analysis needs: free-response analysis, response spectrum analysis, linear time-integration analysis, nonlinear time-integration analysis. Another topic of RM Bridge excellence is its comprehensive functionality pre-stressing, including tendon geometry.

Unique to RM Bridge Advanced is its hybrid FEM analysis capability for detailed modeling of individual beam, wall, plate, shell, and vol-



*Hardanger Bridge in Norway, by Statens Vegvesen.*

ume elements. The concept of a hierarchical hybrid solution allowing for using beam elements and or FEM elements together in one model or at different stages of refinement in the design process.

### **4D Stage Analysis and Schedule Variants**

With a fully defined 3D bridge model, users evaluate all aspects of a stage-wise erection of the bridge structure. The 4D analysis capability makes it easy to develop a construction schedule that defines the sequence and content of arbitrary construction stages. Users can define the stages up to the level of complexity required. Activation, deactivation of any part of the bridge structure at any time during construction process remarks RM Bridge as real time bridge design and construction application. National code requirements are

predefined in RM Bridge Advanced, enabling users to quickly design to code. Creep, shrinkage, and steel relaxation are defined in the "construction schedule." A special time-dependent E-modulus function accounts for concrete hardening.

Schedule Variants may be used to analyze a structure in different ways: linear, non-linear, dynamic, stage per stage, and final calculation. The same geometrical model can be used for different analytical purposes, securing efficient handling and time savings.



Viaduct Petelinjek, Slovenia by GRADIS, Slovenia.

### Time-Dependent Effects

An integral part of the 4D analysis is considering the behavior of the structure in space and time. Engineers can draw from the full array of analytical capabilities to investigate the many phases of the structure up to completion, considering all time-dependent material characteristics, such as creep, shrinkage, and relaxation. All resulting redistributions of internal forces are accurately taken into account.

### Traffic Loading

RM Bridge Advanced enables users to analyze traffic loading according to design code or custom standards, including all loading combinations and details, while achieving substantial time savings. For standard structures, RM Bridge uses influence lines and influence surfaces for calculating the worst effects of traffic loading.

For cases in which nonlinearity must be considered, RM Bridge offers a fast and effective means to calculate influence lines based on

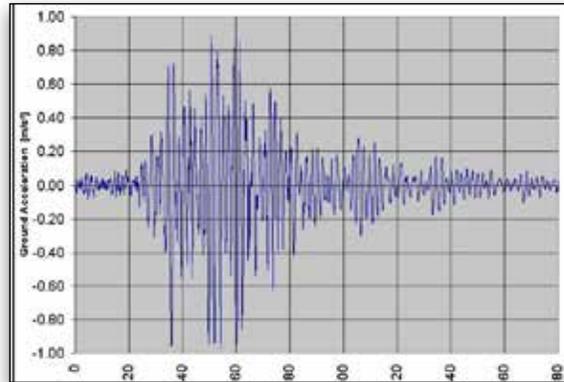


Sea Cliff Bridge on Lawrence Hargrave Drive, Australia by AECOM Maunsell Australia.

the tangential stiffness matrix, taking into account the nonlinearity effects due to permanent loads. Full nonlinear traffic load calculation is also achieved by generating the relevant load sets and nonlinear calculations of the respective load cases.

### Seismic Analysis

RM Bridge Advanced delivers response-spectrum analysis for determining the effects of potential seismic events. Users define the response spectrum in a table inclusive of any number of values given as displacement, velocity, or acceleration. Individual results are combined using different stochastic superposition rules: ABS-rule, SRSS-rule, DSC-rule, and CQC-rule. Special RM Bridge superposition rule is included, obtaining corresponding results to leading values in response spectra analysis.

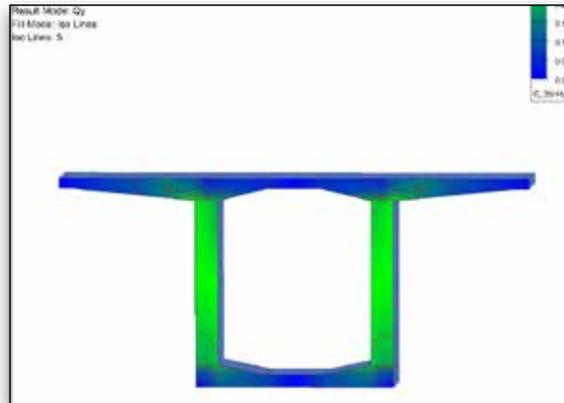


Acceleration diagram – time history calculation.

Envelopes for stresses, internal forces and displacements are given as results. By incorporating set-offs of time history for different structural elements, engineers can calculate phase differences between two foundations in earthquake conditions. Special damping effects and other conditions can also be considered during seismic analysis.

### Loading and Load Combinations

RM Bridge Advanced employs second-order theory with P-Delta effects to accurately calculate load cases. It performs both linear and nonlinear analyses, which when combined provide distinct advantages in the design of steel and composite structures, new or existing. During analysis, the bridge solver applies all loadings on the



Shear Stresses.



## System Requirements

### Processor:

Intel or AMD processor 2.0 GHz or greater

### Operating System:

Windows XP (SP2 or later), Windows Vista (SP2 or later), Windows 7, Windows 8

### RAM:

1 GB minimum, 4 GB recommended. More memory almost always improves performance, particularly when working with larger models.

### Hard Disk:

1.4 GB MB free disk space

### Display:

Windows-compatible graphics card and monitor supporting at least 1280 by 768 resolution and high or true colors. DirectX 9.0

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active structural subsystem at the most relevant point in time. The software automatically calculates differential load cases during construction-stage analysis by taking into account the correct nonlinearity effects. The results of a summation load case are used to calculate the nonlinear stiffness matrix for analysis and design.

Using load combination table allows for a clear and easy creation of design code related envelopes. By specifying multiplication factors (separately for favorable and unfavorable), combinations for serviceability and ultimate limit state checks are created in a consistent way.

### Stability Checks

Once load cases are calculated, the program automatically runs stability checks by increasing the loading until bifurcation occurs. Engineers run loads iteratively until reaching stability. The ultimate load capacity of the structure is calculated by performing nonlinear analysis for different load increments, and deduced from RM Bridge Advanced calculated load displacement diagrams.

### Rating and Design Code Checks

RM Bridge Advanced provides extensive design code checking and supports a full array of international design codes. Users

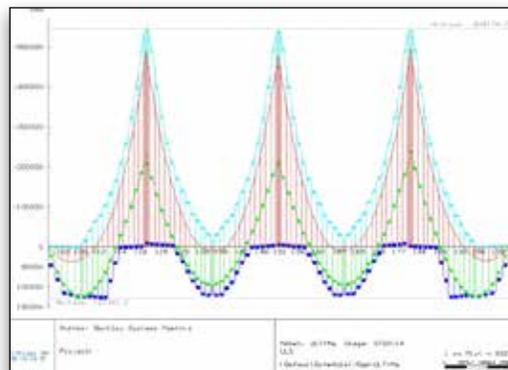
can activate code checks at any time during a particular construction phase or final stage. The system provides graphical viewing of all code checking and automatically notates points where design values exceed resistance values.

Based on the different result envelopes for dead loads and live loads the program allows for evaluating load rating factors in accordance AASHTO LRFD regulations.

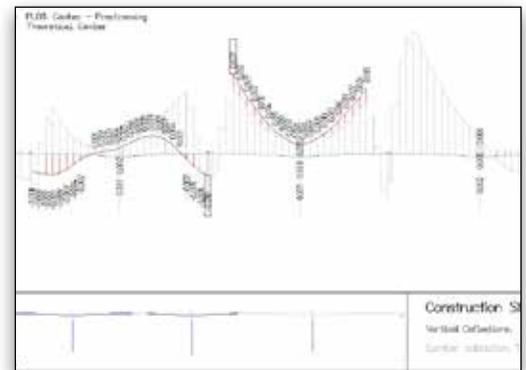
### Post Processing and Script Interface

RM Bridge Advanced offers different options of result control for each point of the bridge structure for any point in time in the bridge 4D schedule process. Due to its flexibility RM Bridge is very well suited for preliminary design as well as detailed design tasks. Easy refinement and modification of the mathematical model makes it also predestined for application in construction engineering.

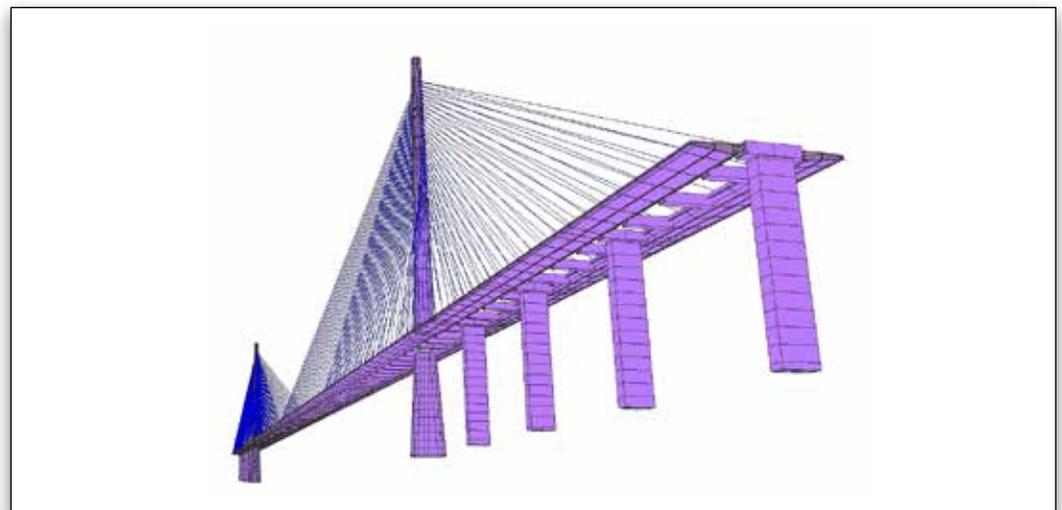
RM Bridge includes a comprehensive scripting interface in script language. The complete binary RM Bridge input database has a text equivalent in script commands. Those scripts are very concise and readable ASCII-text files containing optimally sized RM Bridge project data. Furthermore, those scripts may be used to access the result database of RM Bridge for user defined output and further processing.



Steel stresses due to ULS in composite girder.



Camber line.



Stonecutters Bridge by Ove Arup, Hong Kong.