



Image courtesy: mca s.r.l., New Po River Bridge in Piacenza, Italy

## RM Bridge

### Bridge Structural Modeling, Analysis, Design, and Construction Engineering

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

#### All-in-One Bridge System

RM Bridge 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 is the basic application of the RM Bridge family. RM Bridge can be upgraded to RM Bridge Advanced application, which comprises a selection of advanced modules for 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, and in-situ casting.

#### Develop a Complete Bridge Project

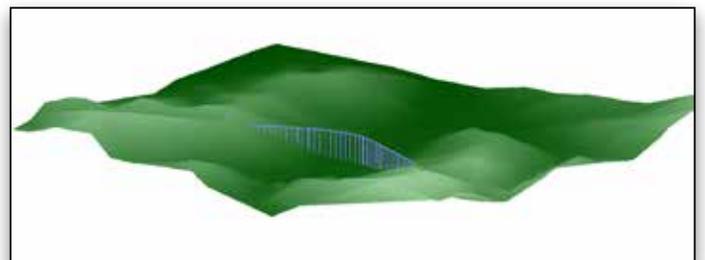
RM Bridge provides engineers broad flexibility in the development of a complete bridge project, saving time and improving project delivery. Substantial static and dynamic analysis capabilities allow for addressing a wide range of bridge engineering problems. The ability to model time-dependent material 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 all-in-one solution – even in the maintenance process of the bridge lifecycle.



Sheik Zayed Bridge, Abu Dhabi UAE by High-Point Rendel, UK.

#### Infrastructure Project Definition

Unlike comparable bridge software, RM Bridge 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 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). BrIM is a new



Terrain model.

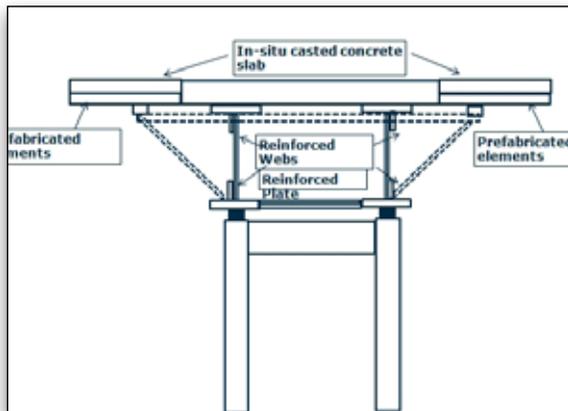


## RM Bridge ensures bridge constructability and improved design.

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.

### What Bridge Types Can Be Designed

RM Bridge addresses all typical bridges, from reinforced and pre-stressed concrete to steel and composite bridges. 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.

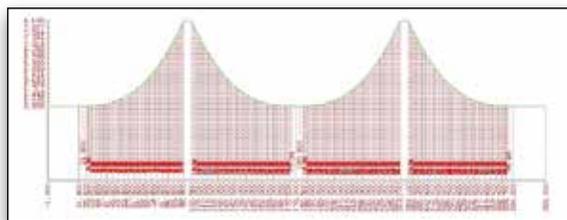


Composite multilevel cross section.

RM Bridge 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

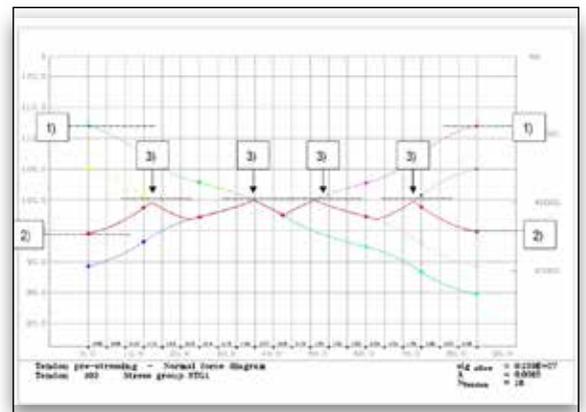


Variable diagram.

and drawing production. Using the bridge modeler, engineers define the entire structural system, including support conditions, substructures, 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 formulas as database objects assigned to individual data is an efficient means to account for variability of the model geometry as well as governing parameters in the analysis process. RM Bridge handles linear dynamic bridge analysis. The offering covers the relevant functionality for earthquake design, i.e. calculation of natural modes and response spectrum analysis.

Another relevant topic of RM Bridge excellence is its comprehensive functionality for pre-stressing, including sophisticated tendon geometry definition.



Tendon stress optimization diagram.

### 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 the construction process marks RM Bridge as a real time bridge design and construction application. National code requirements are predefined in RM Bridge, 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, dynamic, stage per stage, final calculation. The same geometrical model can be used for different analytical purposes and on this way 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 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 for calculating the worst effects of traffic loading.

### Seismic Analysis

RM Bridge delivers response-spectrum analysis for determining the effects of potential seismic events. Users define the response



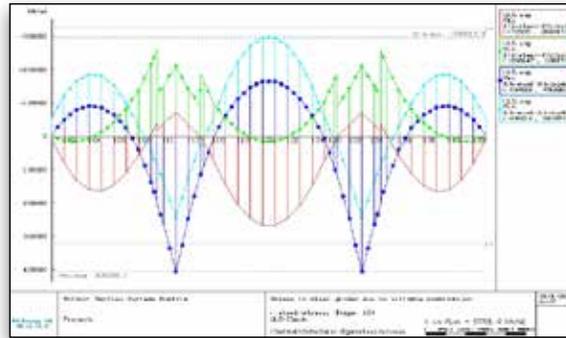
The Sea Cliff Bridge on Lawrence Hargrave Drive, Australia by AECOM Maunsell Australia.

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. Envelopes for stresses, internal forces, and displacements are given as results.

### Loading and Load Combinations

During analysis, the bridge solver applies all loadings on the 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.

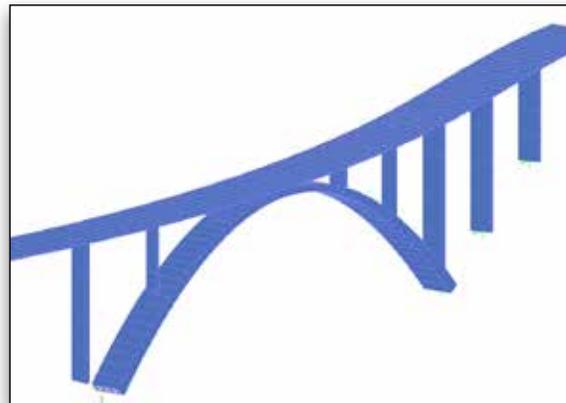
Using the load combination table allows for a clear and easy creation of design code related envelopes. By specifying multiplication factors (separately for favorable and unfavorable), combinations for serviceability and ultimate limit state checks are created in a consistent way.



Steel stresses due to ULS in composite girder.

### 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 calculated load displacement diagrams.



Stability checks are easier with RM Bridge.



## 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

Find out about Bentley at: [www.bentley.com](http://www.bentley.com)

### Contact Bentley

1-800-BENTLEY (1-800-236-8539)  
Outside the US +1 610-458-5000

### Global Office Listings

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## Rating and Design Code Checks

RM Bridge provides extensive design code checking and supports the locally relevant design code. An upgrade to RM Bridge Advanced application offers 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 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.

Camber calculation.



Tramway Bridge, Lyon, France by ARCADIS, France.