

TDV GmbH - AUSTRIA



Professional Engineering Software since 1970
Programming – Consulting – Calculation Center

Any Type of Structure

- Reinforced and pre-stressed concrete
- Steel, concrete and composite
- Continuous beam, grillage, box girder
- Cable-stayed bridges
- Suspension bridges

RM2006 **GENERAL CONCEPT** : one tool for all !

Any Erection Procedure

- Span-by-span
- Advanced shoring
- Incremental launching
- Balanced cantilever bridges
- Precast segmental

Any Type of Analysis

Any non linear and dynamic problem

Any Type of Analysis

- Stage by stage simulation
- Linear dynamics.
- Non-linear final stage.
- Non linear stage by stage simulation.
- Non linear material behaviour.
- Non-linear dynamics.

RM2006 **GENERAL CONCEPT : one tool for all !**

Any non linear problem

- P-delta consideration (2nd order).
- Cable sagging.
- 3rd order (large displacements).
- Non linear time history.
- Cracked concrete.

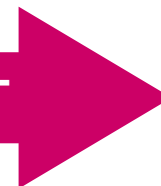


Geometry Definition

- Superstructure
- Substructure

- Axis
- Cross Sections
- Structural Units (Segments)
- Preparation for Design Checks:
 - Stress Points
 - Temperature Points
 - Perimeter...

ONE WAY EXPORT

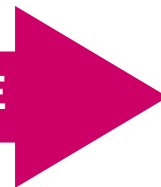


Any Type of Analysis

- Stage by stage
- Non-linear...

- Tendon definition
- Loading preparation
- Load Combinations
- Construction Sequence
- Analysis
- Design Code Checks:
 - Fibre Stress
 - Ultimate Capacity
 - Shear Capacity...

EXPORT ANY TIME



Modular structure of RM

BASIC module

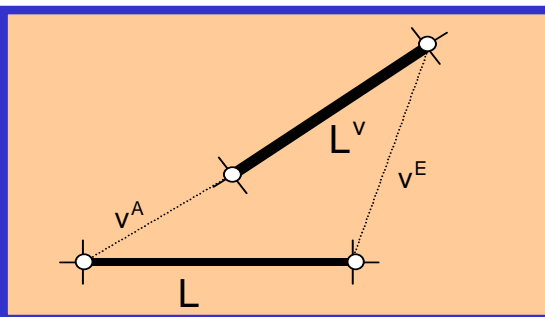
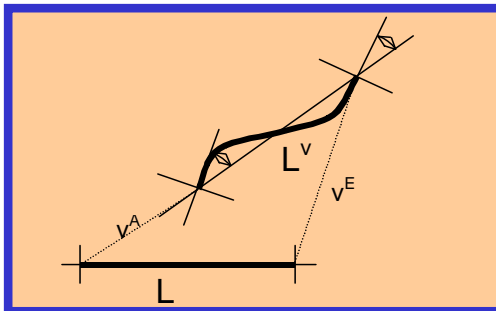
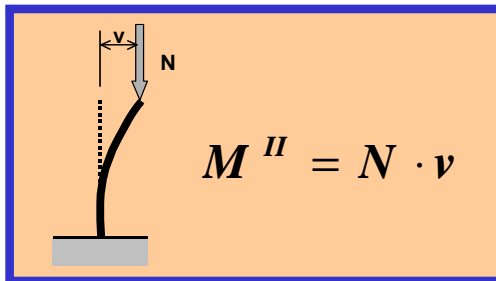
- Pre-processor GP
- Basic RM for 4D structural analysis
- Powerful TCL file operation

CONCRETE module

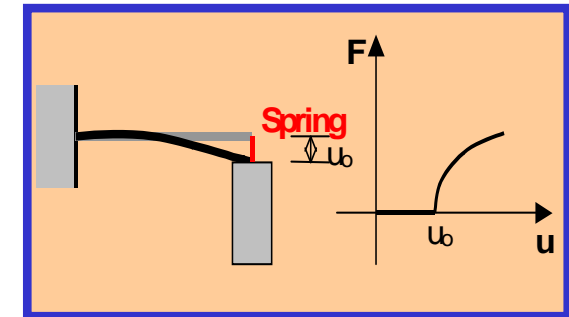
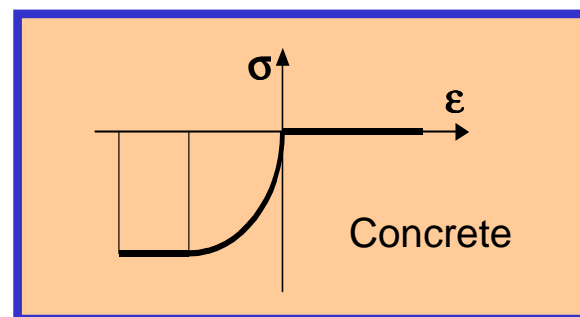
- Reinforced concrete design (CODE dependent – also user defined material work diagrams!!)
- Pre-stressed and Post-Tensioned concrete including ALL CODE dependent CHECKS!!
- COMPOSITE Structures (UP to 8 optional parts) including ALL CODE dependent CHECKS!!



ADVANCED STATIC Analysis



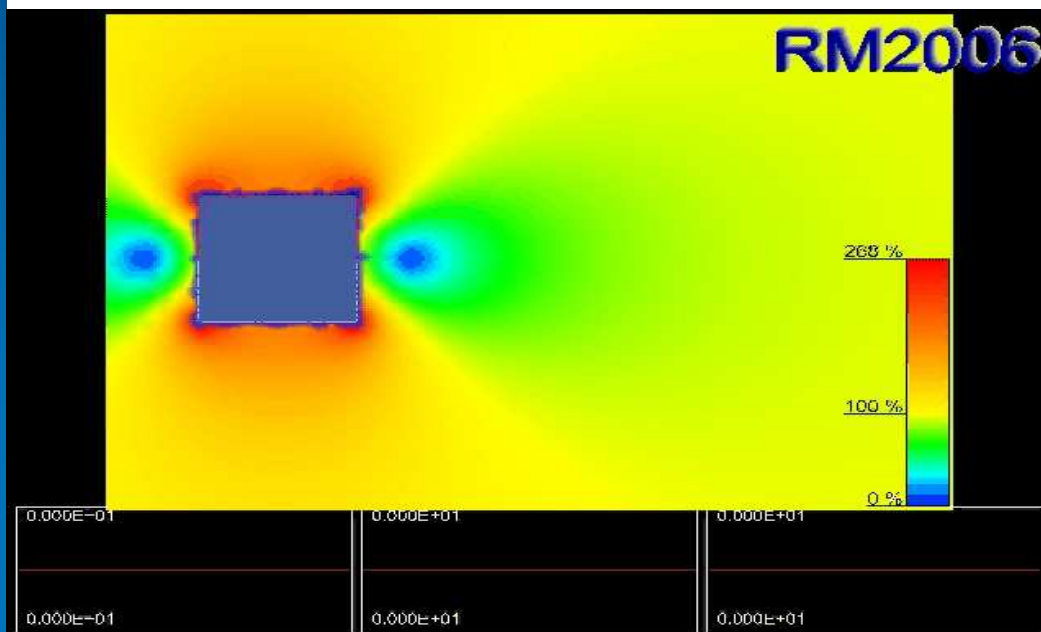
- P-Delta Effect, Eigen-values (Stability, Buckling, Failure)
- Large deflections (Suspension bridges, large cable structures)
- Cable elements (full implementation of non-linear effects of cable sag)
- Non-linear Material, Cracked Concrete
- Non-Linear Springs and Friction Elements



Modular structure of RM

DYNAMIC

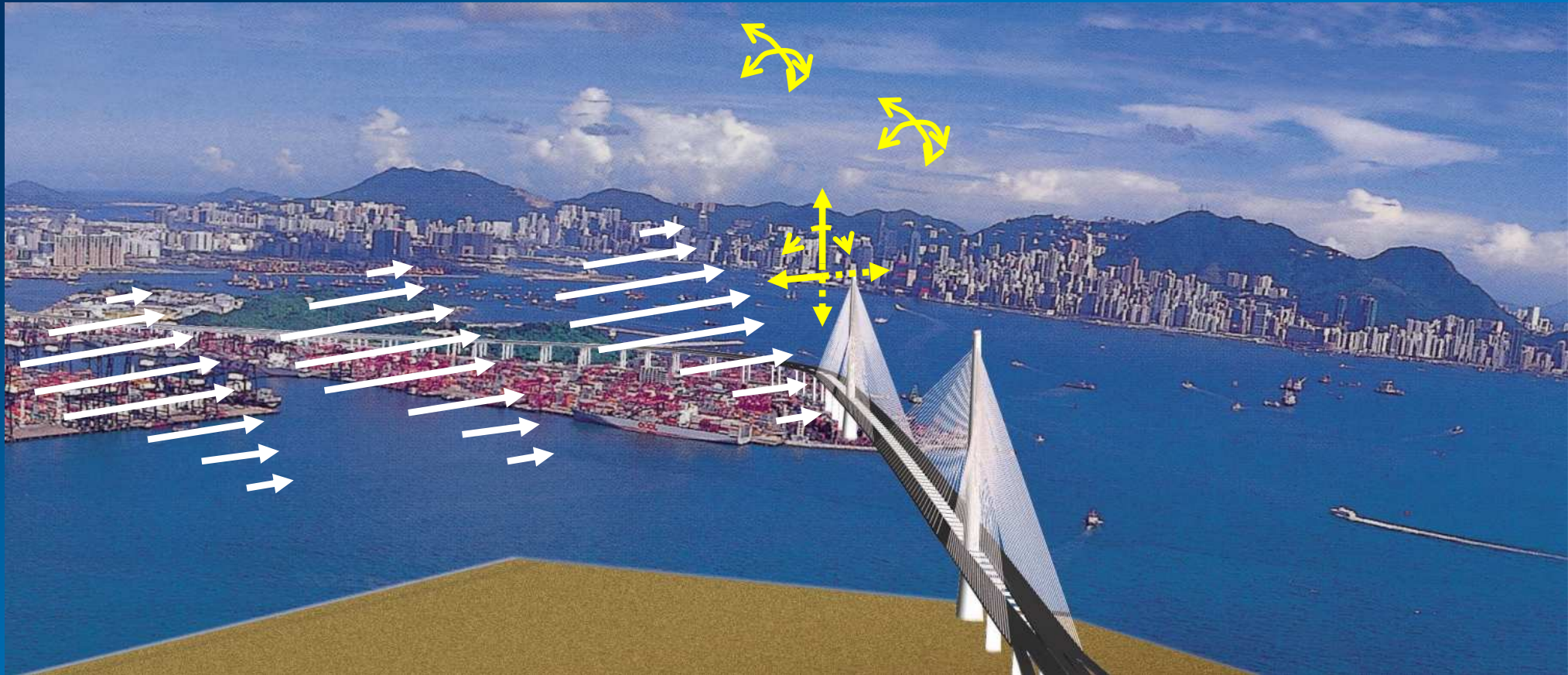
- Eigen-values (Masses, Eigen modes)
- Response spectrum – result: DESIGN forces and TRUE coexistence forces in superposition files)
- Other modal analysis (f.ex. Excitation spectrum)
- Non- linear TIME HISTORY (static load with load/unload history, moving load, moving mass, HSR) including ALL NON-LINEAR EFFECTS!



→ WIND – ONLY in RM2006!

→ CFD module – ONLY in RM2006!

WIND in RM2006



- The bridge will respond to the action of wind
- Types of response depend on the wind speed and turbulence characteristics of oncoming flow

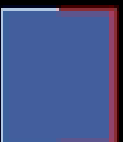
Individual CFD calculation

1. Enter direction and velocity of wind
2. Suggest set of parameters
3. Modify parameters
 - Time step
 - Number of iterations
 - Number of panels
 - Core size
4. Run calculation

The screenshot displays the RM2006 software interface for a CFD calculation. At the top, it shows wind direction options: Wind-Z, Wind-Y, Wind+Z, Wind+Y, and Other. Below this are three time-series plots for wind direction components, with values ranging from 0.127E+00 to 0.920E-01. The interface also displays calculated forces: Drag (No): 0.244, Lift (No): 0.028, and Moment (No): 0.007. A central panel lists parameters for modification, including Alpha (Deg) at 0.0000, v-ref (m/s) at 1.5000, dt (s) at 0.0170, Iter at 1140, Nr. of panels at 300, and Core size (m) at 0.0230. A 'Suggest' button is present below these parameters. The main visualization area shows a 3D model of a bridge structure with a turbulent flow field represented by colored particles. At the bottom, there are buttons for 'More options...', 'Set param.', and 'Get param.', along with a 'Recalc' button highlighted in yellow. The interface also shows 'Group' as GP-ORIG and 'Name' as G5, with options for 'Create movie', 'Options...', and 'Pause'.

Example: CFD in RM2006

RM2006



0.000E+01

0.000E+01

0.000E+01

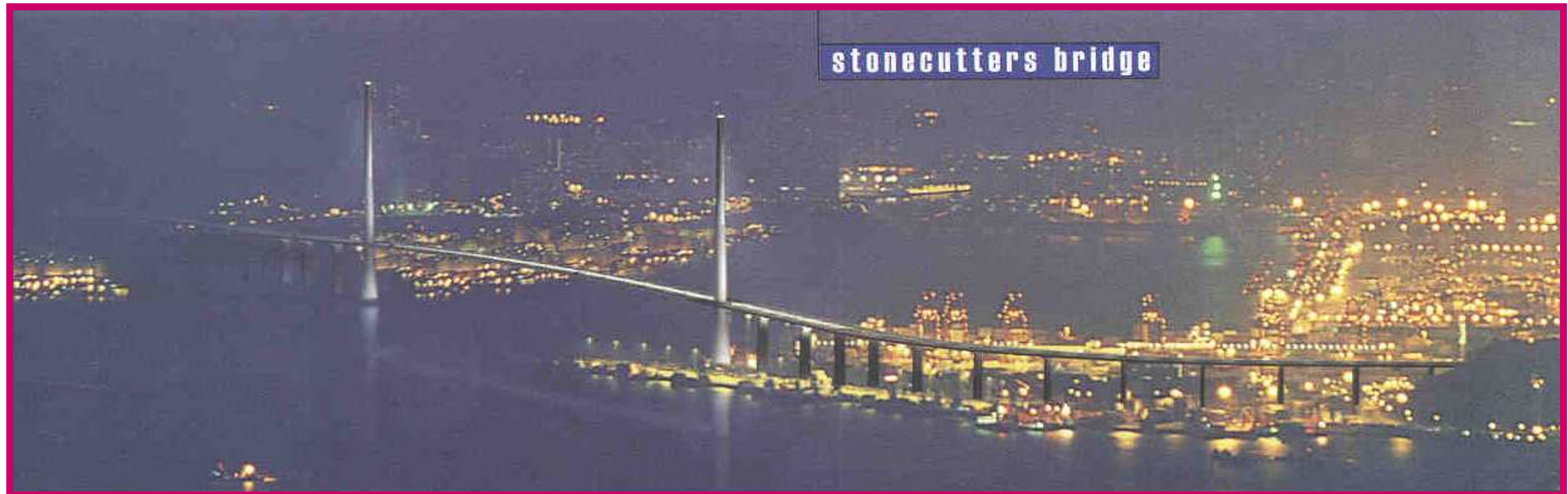
0.000E+01

0.000E+01

0.000E+01

Example: Stonecutters Bridge, Hong Kong

- **Shear deformations important**
- **Shortening compensation**
- **P-Delta effects and Large Displacements**
- **Cables sagging**
- **Time effects coupled with other non-linear effects**
- **Full calculation has to be done non-linear**
- **Special care is needed for stochastic wind events**



COUPLED NON-LINEAR EFFECTS

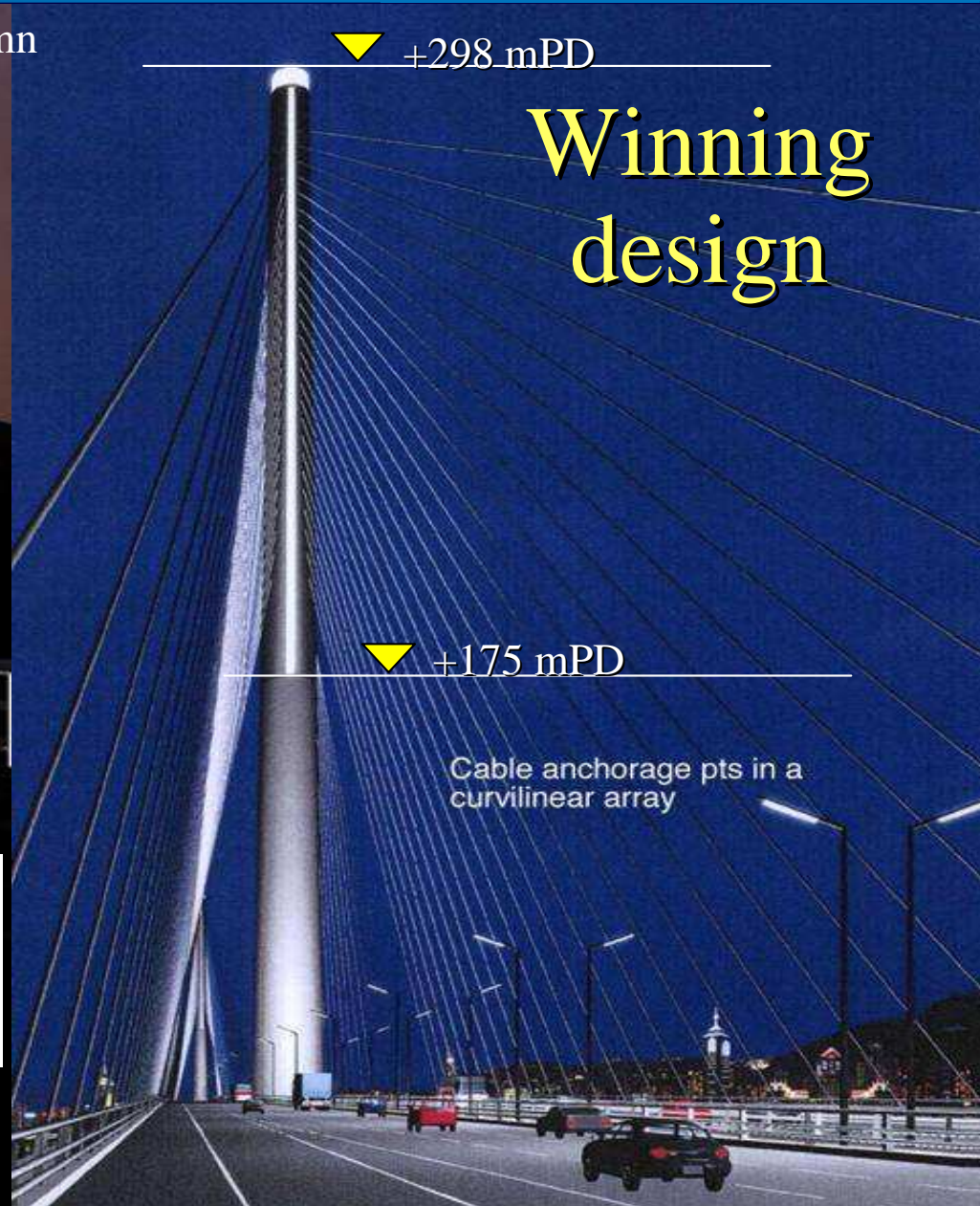
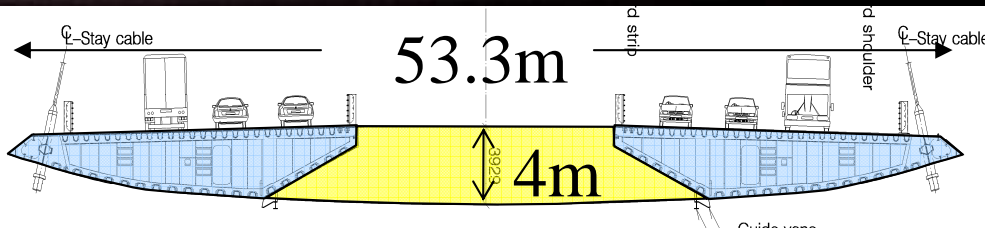
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Stonecutters Bridge Hong Kong

Professional Software Overview

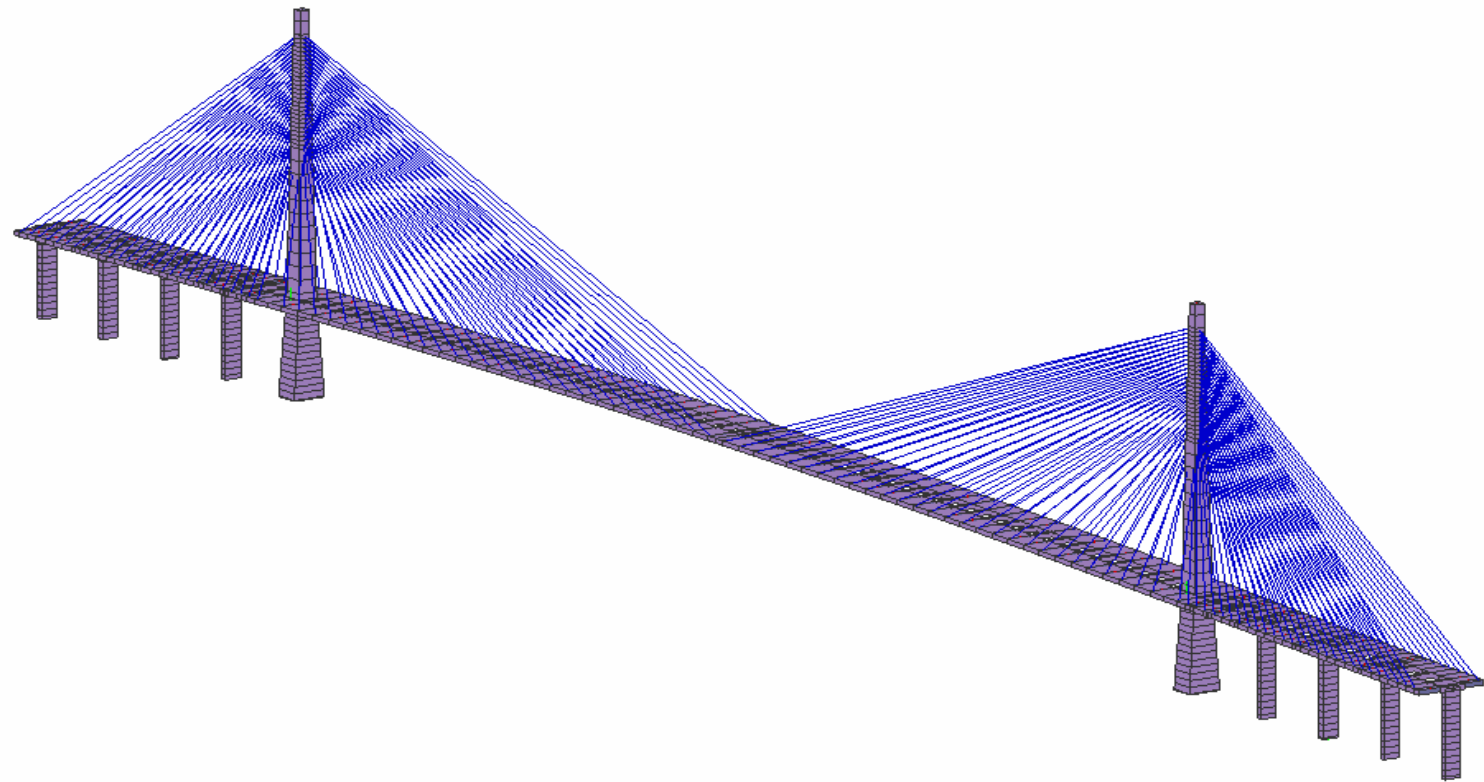


Separated streamlined twin-girder deck



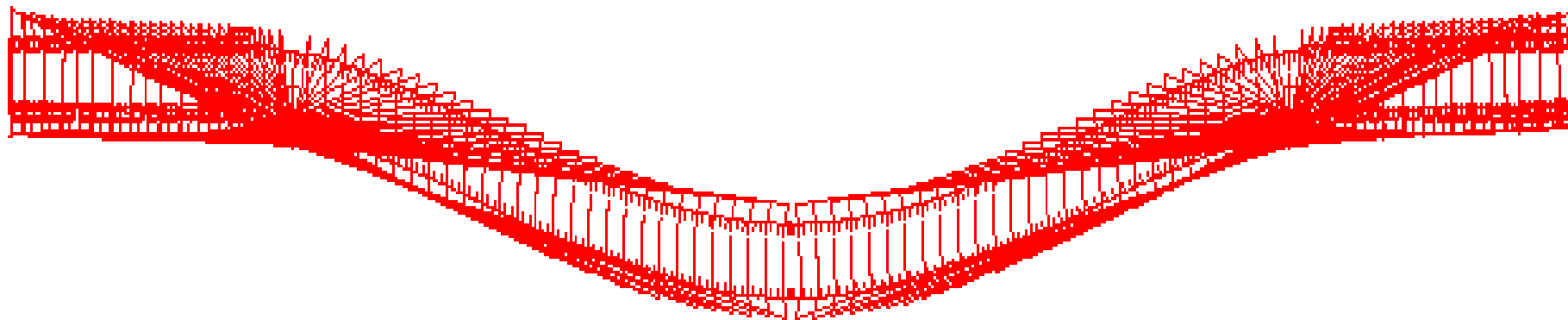
Stonecutters Bridge Hong Kong

Structural model in RM2006

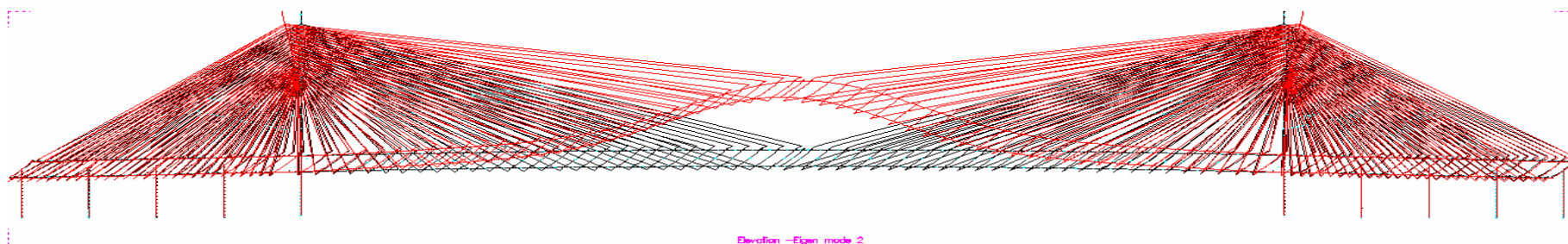


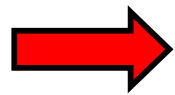
Stonecutters Bridge Hong Kong

Eigen-mode 1 and 2



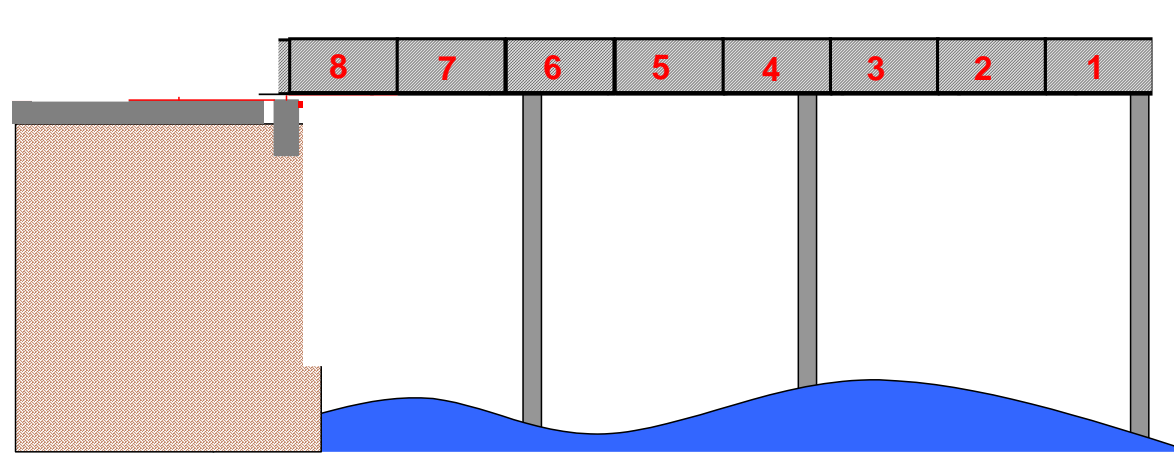
Plan View - Eigen Mode 1

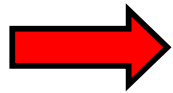




How does ILM work on the construction site

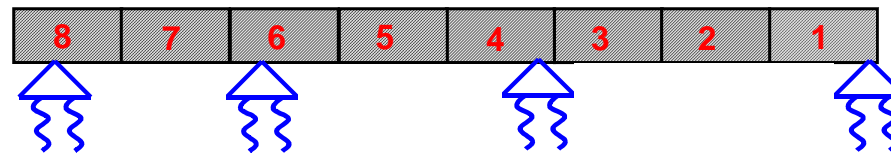
Launching Sequence Complete!





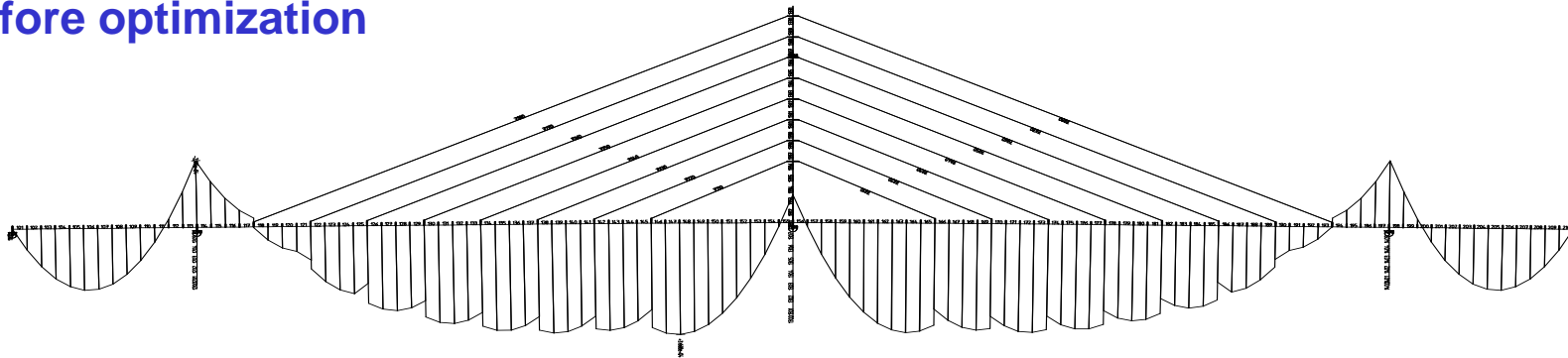
How does ILM work in RM2006

Launching Sequence Complete!

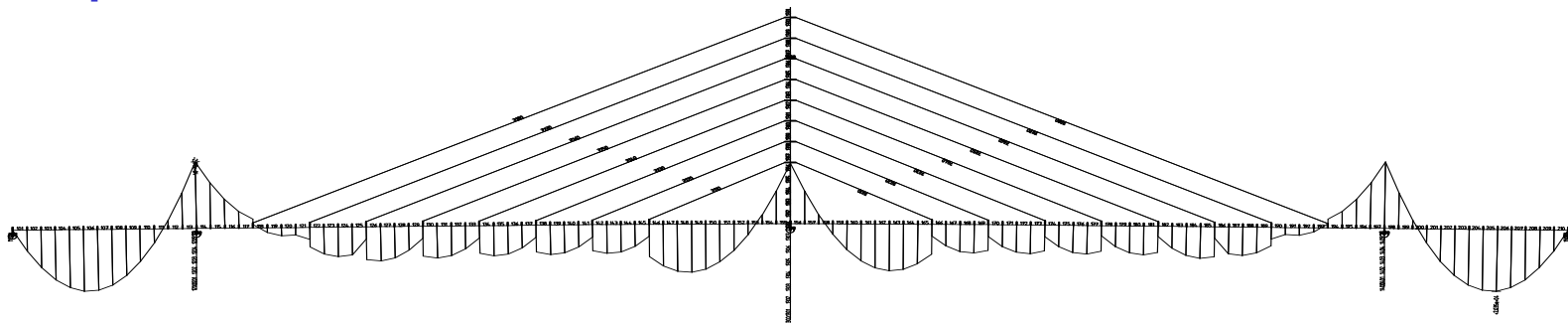


Advanced bridge design – Optimisation of tensioning sequence

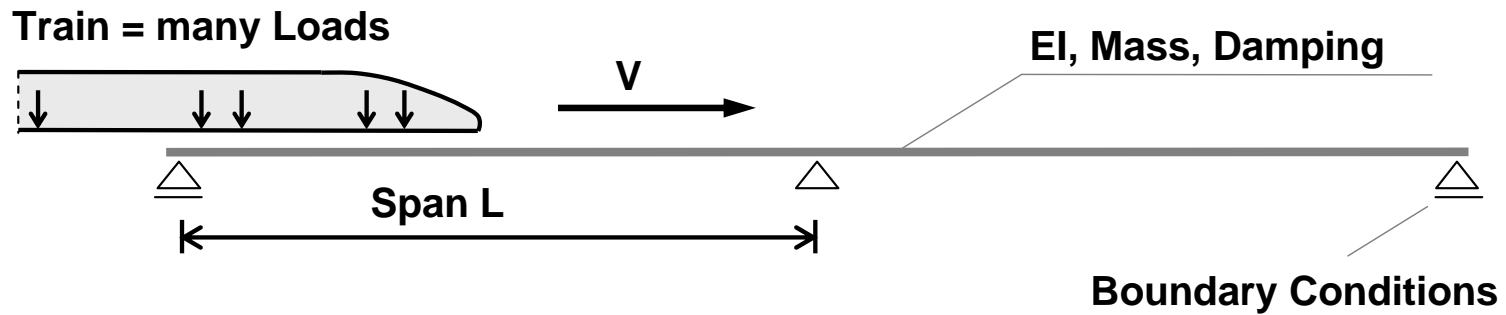
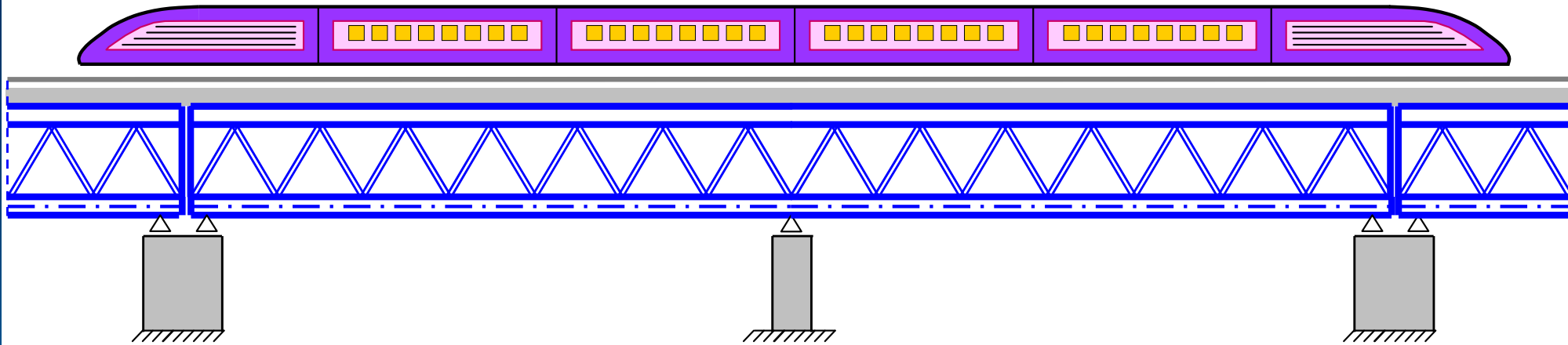
- **Before optimization**



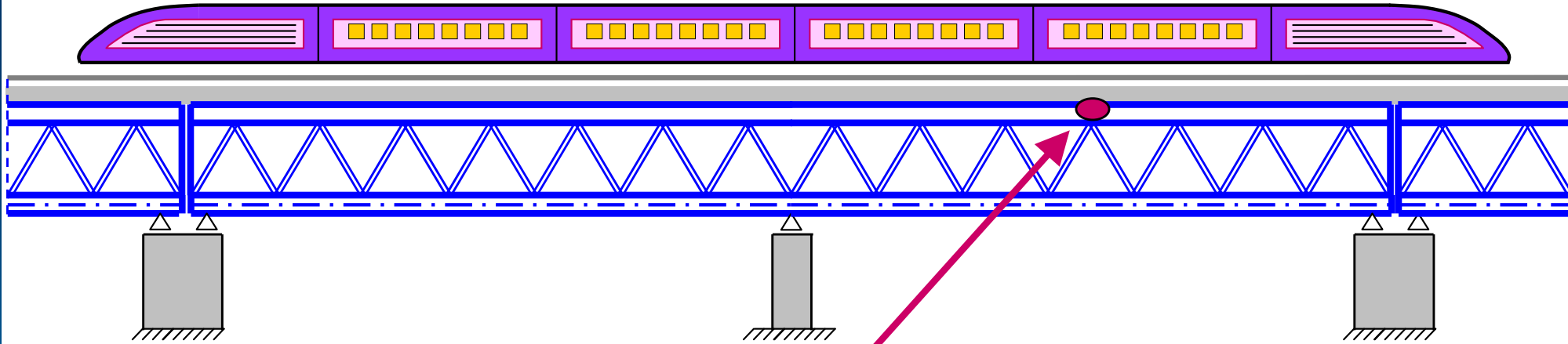
- **After optimization**



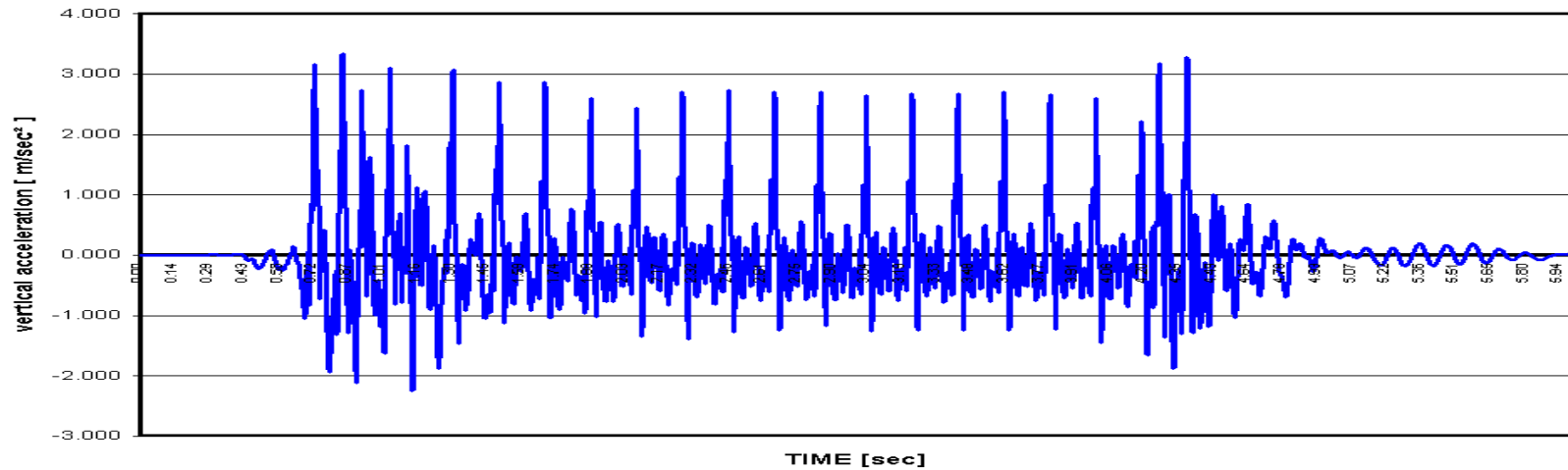
Advanced bridge design – Rolling Stock Analysis



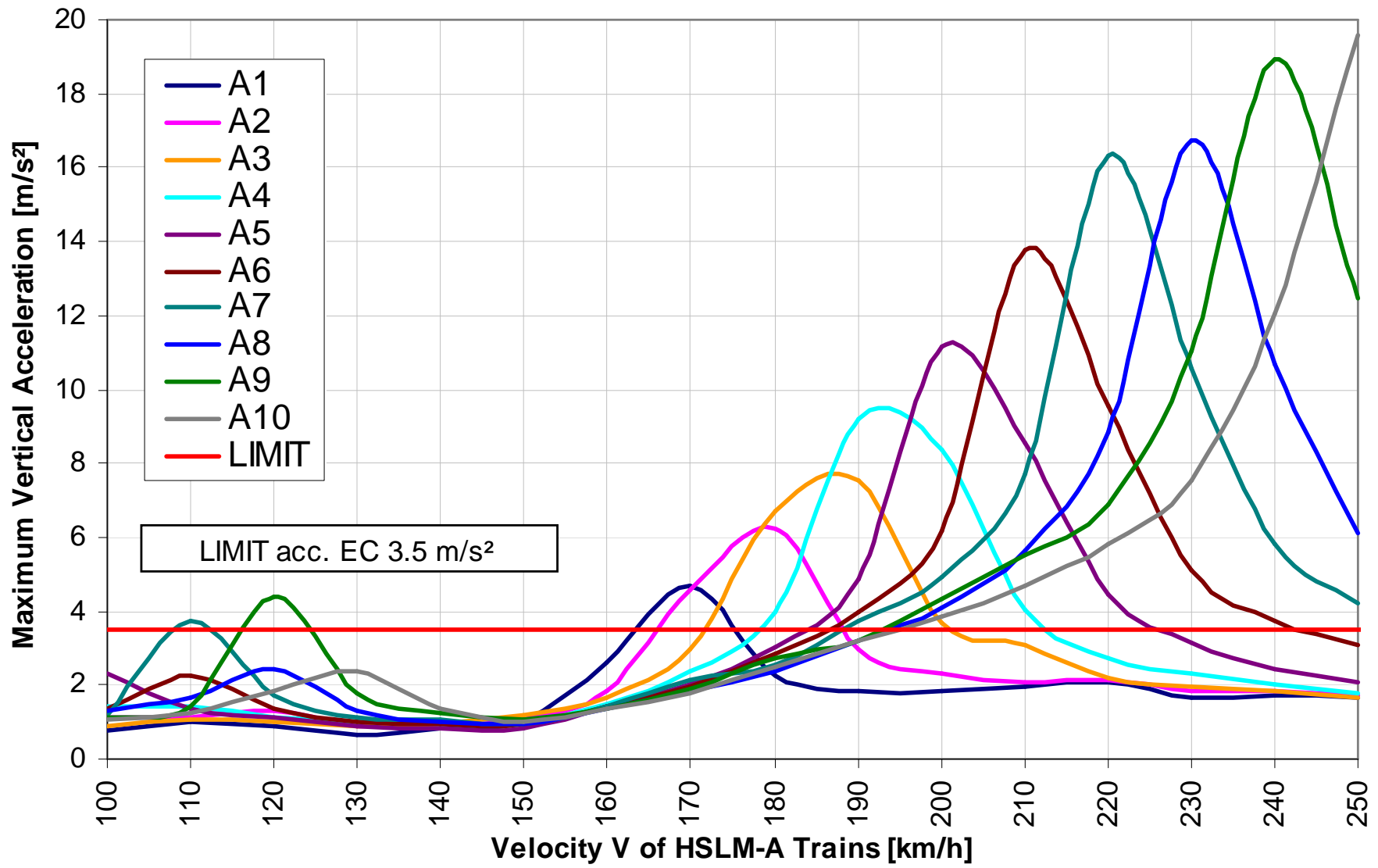
Advanced bridge design – Rolling Stock Analysis



Single result



ACCURATE RESULTS HSR



Example: High Speed Rail Taiwan

- Taiwan has 20.7 Million Inhabitants
- HSR from Taipei to Kaoshiung
- Total length of 354 km
→ 242 km Bridges
- Total Construction Costs
U\$ 13.1 Milliard
- Handing Over 2005



Advanced bridge design – Camber and erection control

With camber calculation functions implemented in RM2006 the user gets very easily all the information for the check on site in a compact excel sheet

Erection control can be used for design and later for checking or correcting the fabrication shapes in the erection sequence

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International projects Cable Stayed Bridges



The **Sutong Bridge** will be the **world's largest Cable-Stayed Bridge** with the main span of 1088m, overtaking the Stonecutters Bridge in Hong Kong.

Design by **HPDI, China**

RM2006 Erection Control
used for the project.



Professional Software Overview



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TDV Know-How in international projects

Segmental bridges

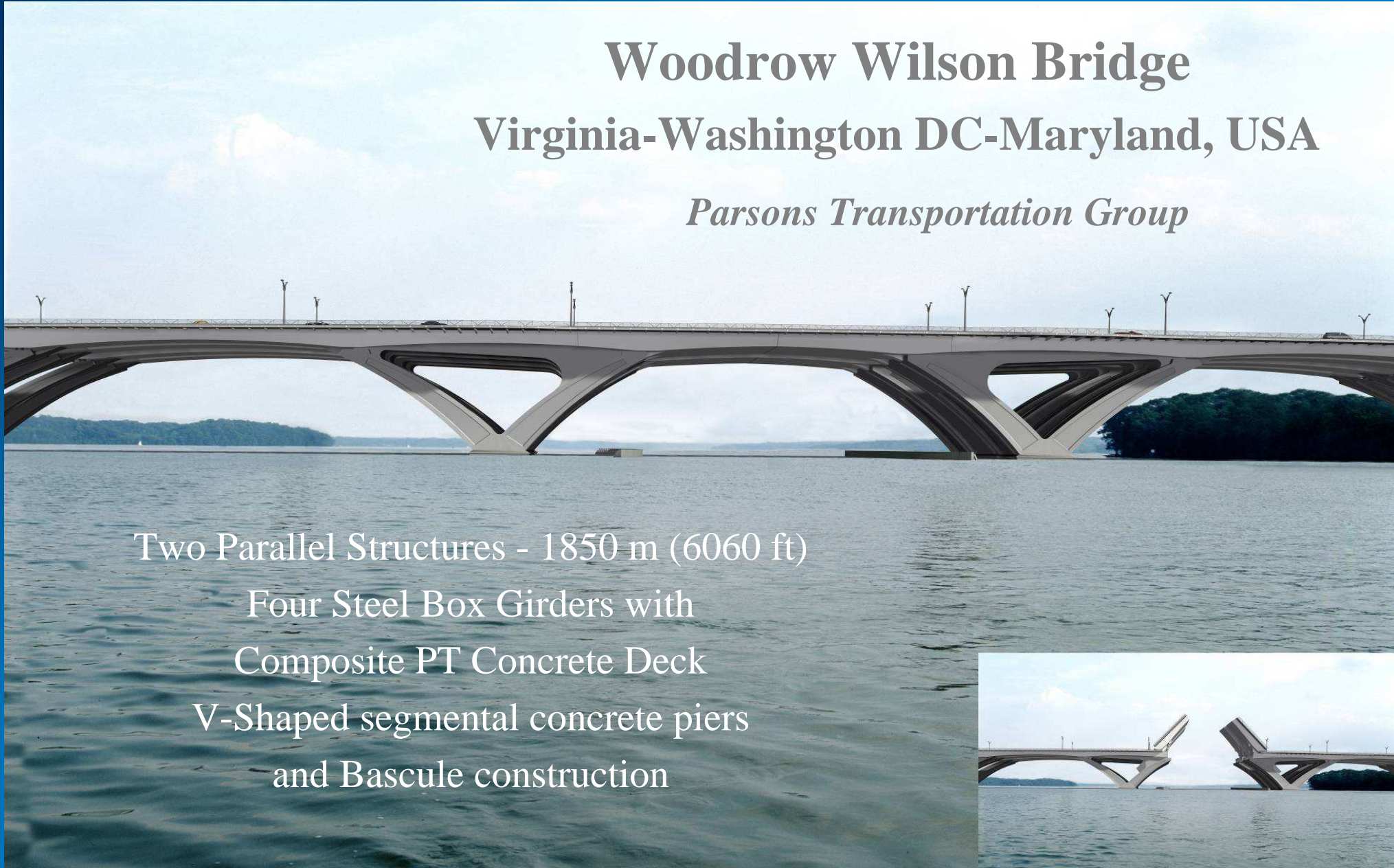


Professional Software Overview



Woodrow Wilson Bridge Virginia-Washington DC-Maryland, USA

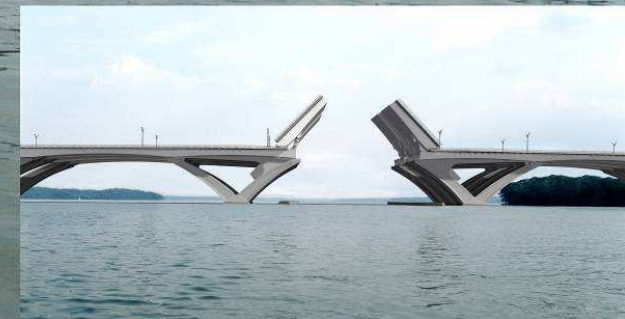
Parsons Transportation Group



Two Parallel Structures - 1850 m (6060 ft)

Four Steel Box Girders with
Composite PT Concrete Deck

V-Shaped segmental concrete piers
and Bascule construction



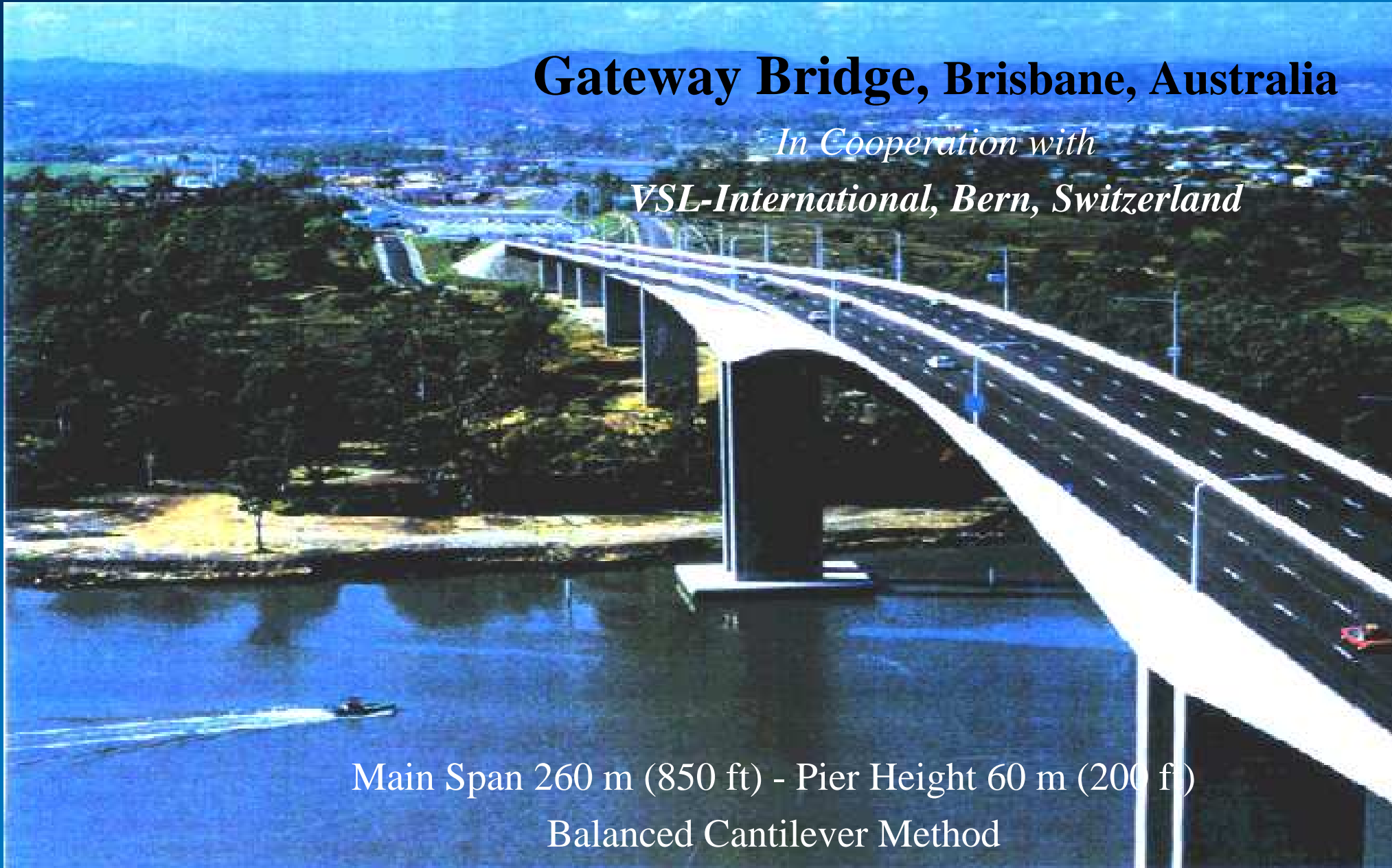
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TDV Know-How in international projects

Segmental bridges



Professional Software Overview



Gateway Bridge, Brisbane, Australia

In Cooperation with

VSL-International, Bern, Switzerland

Main Span 260 m (850 ft) - Pier Height 60 m (200 ft)

Balanced Cantilever Method

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TDV Know-How in international projects

Segmental bridges



Professional Software Overview



Las Vegas Monorail Project

Las Vegas, Nevada, USA

In Cooperation with Carter & Burgess, Denver

Span Length to 37 m (120 ft)
Straddle Bents to 34 m (110 ft)
Total Length 4.3 km (2.7 miles)

TDV

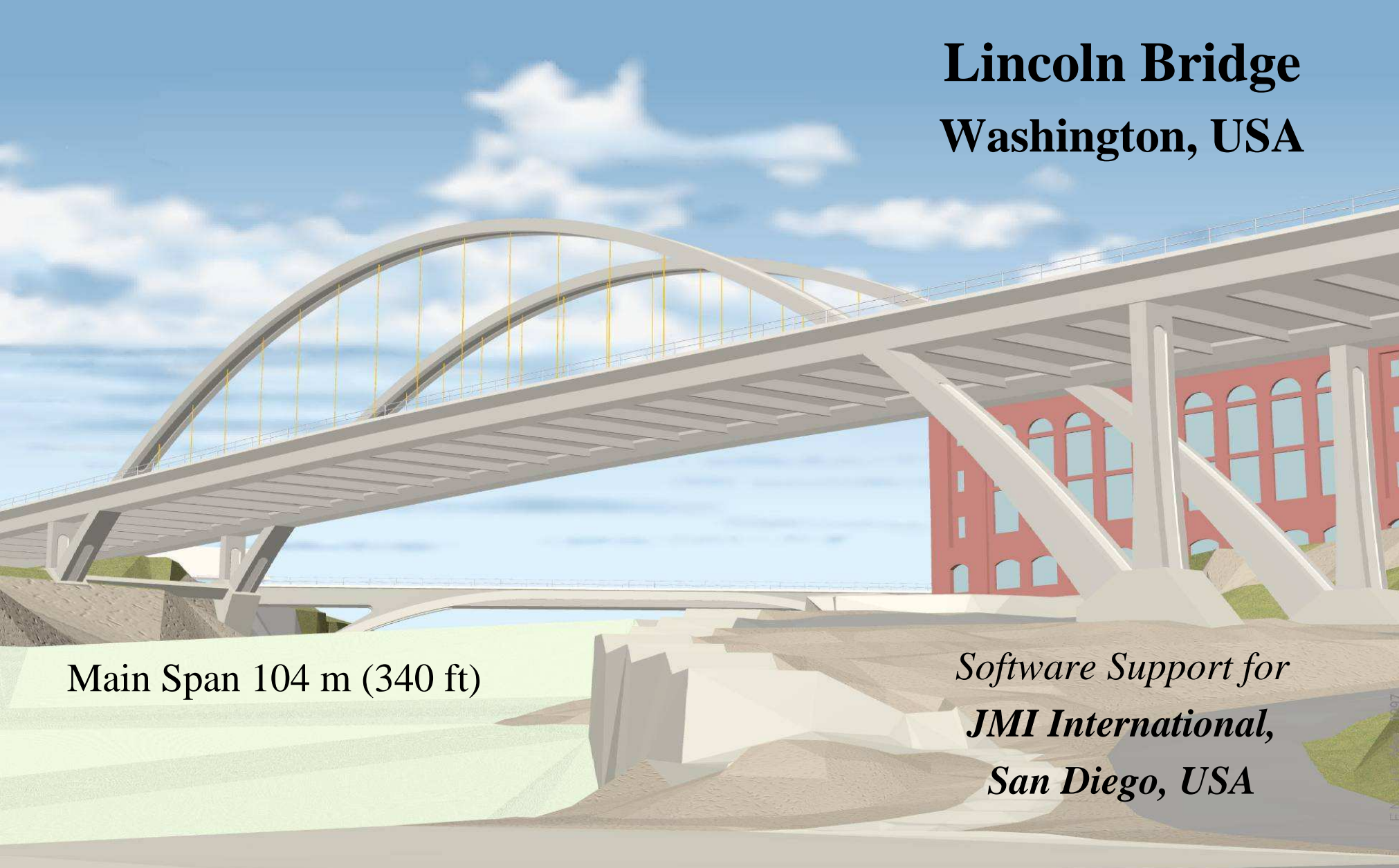
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TDV Know-How in international projects

Tied Arches



Professional Software Overview



Lincoln Bridge Washington, USA

Main Span 104 m (340 ft)

*Software Support for
JMI International,
San Diego, USA*

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TDV Know-How in international projects

Tied Arche-Cable Stayed

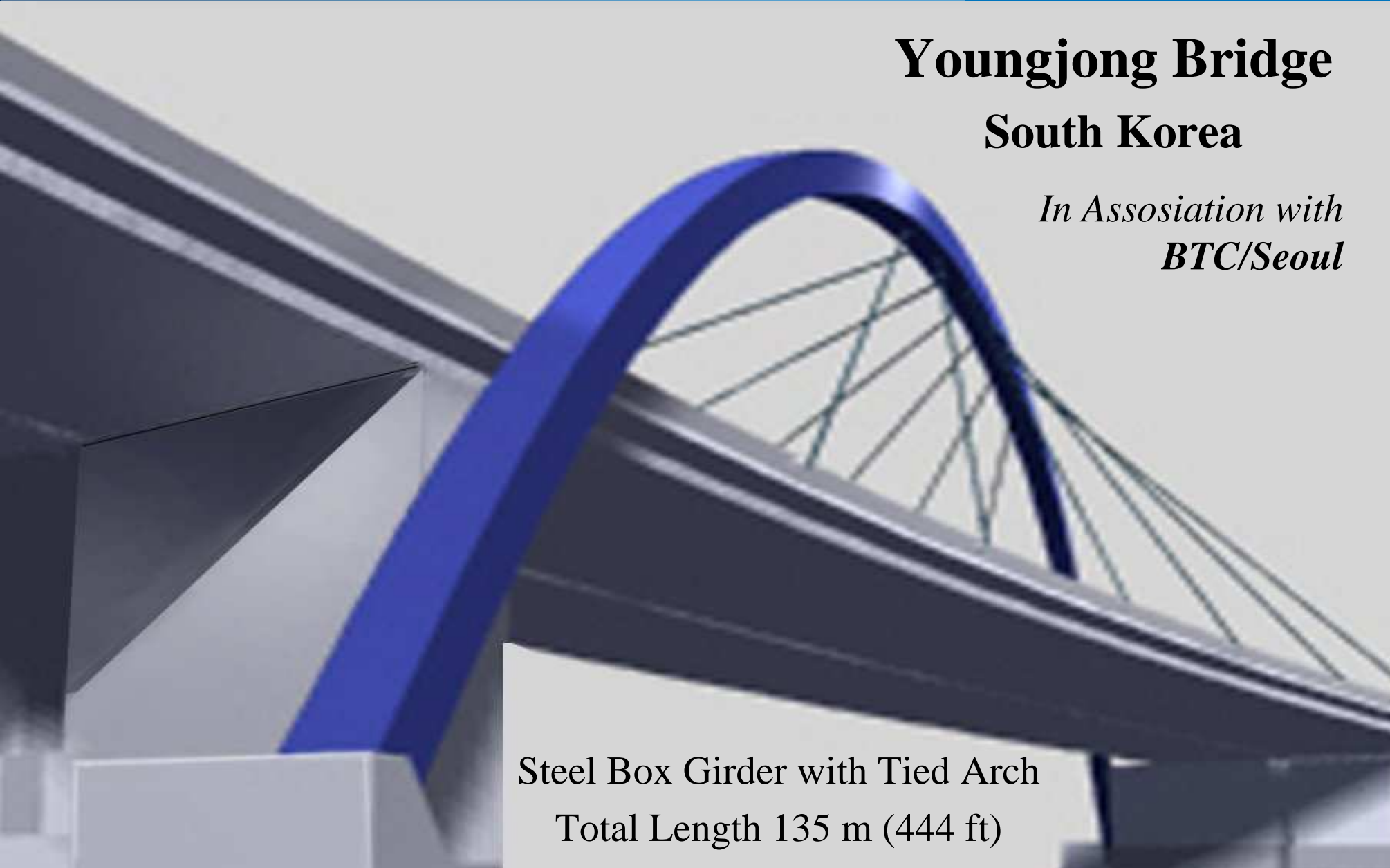


Professional Software Overview



Youngjong Bridge South Korea

*In Association with
BTC/Seoul*



Steel Box Girder with Tied Arch
Total Length 135 m (444 ft)

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TDV Know-How in international projects

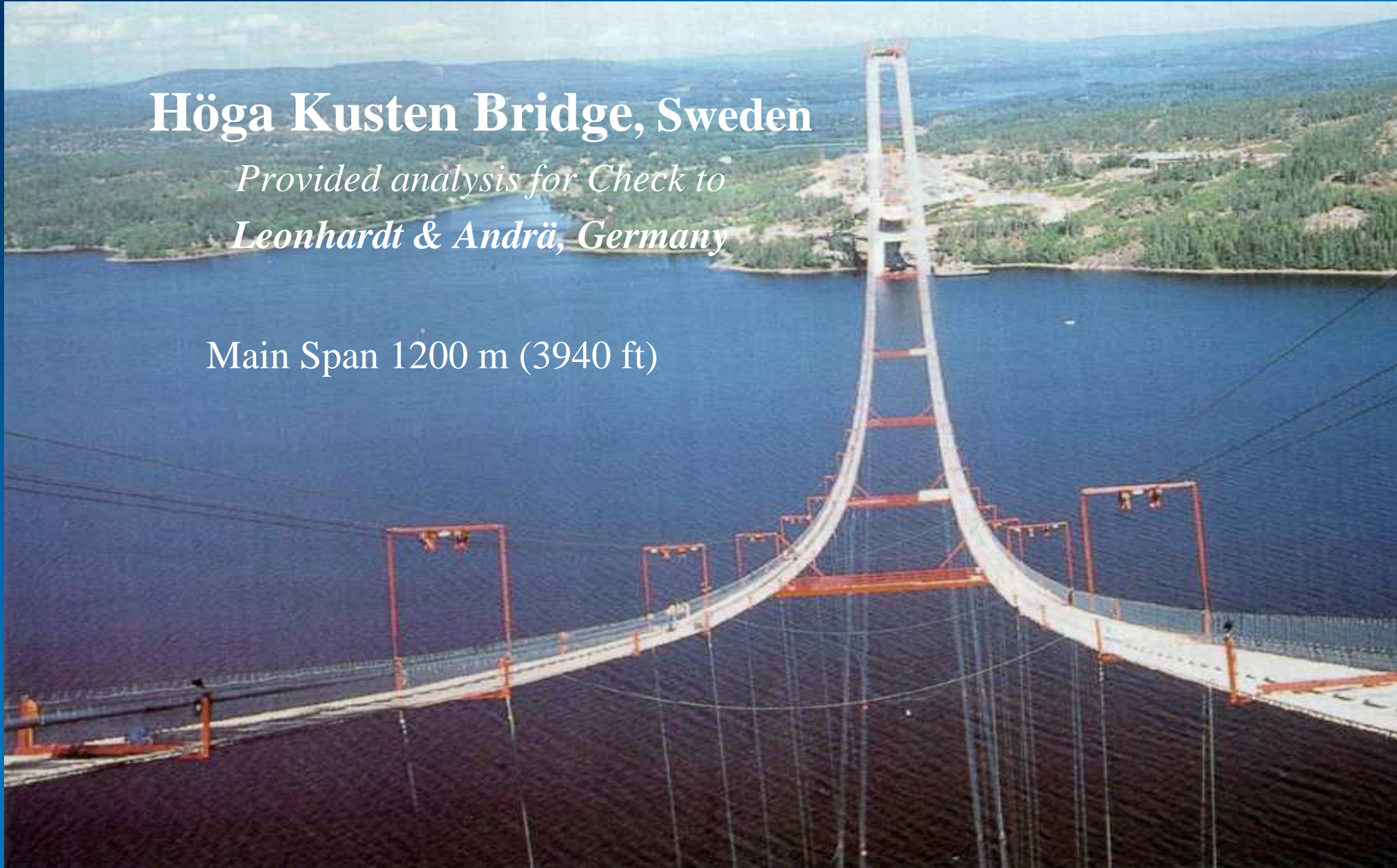
Suspension bridges



Höga Kusten Bridge, Sweden

*Provided analysis for Check to
Leonhardt & Andrä, Germany*

Main Span 1200 m (3940 ft)



Professional Software Overview





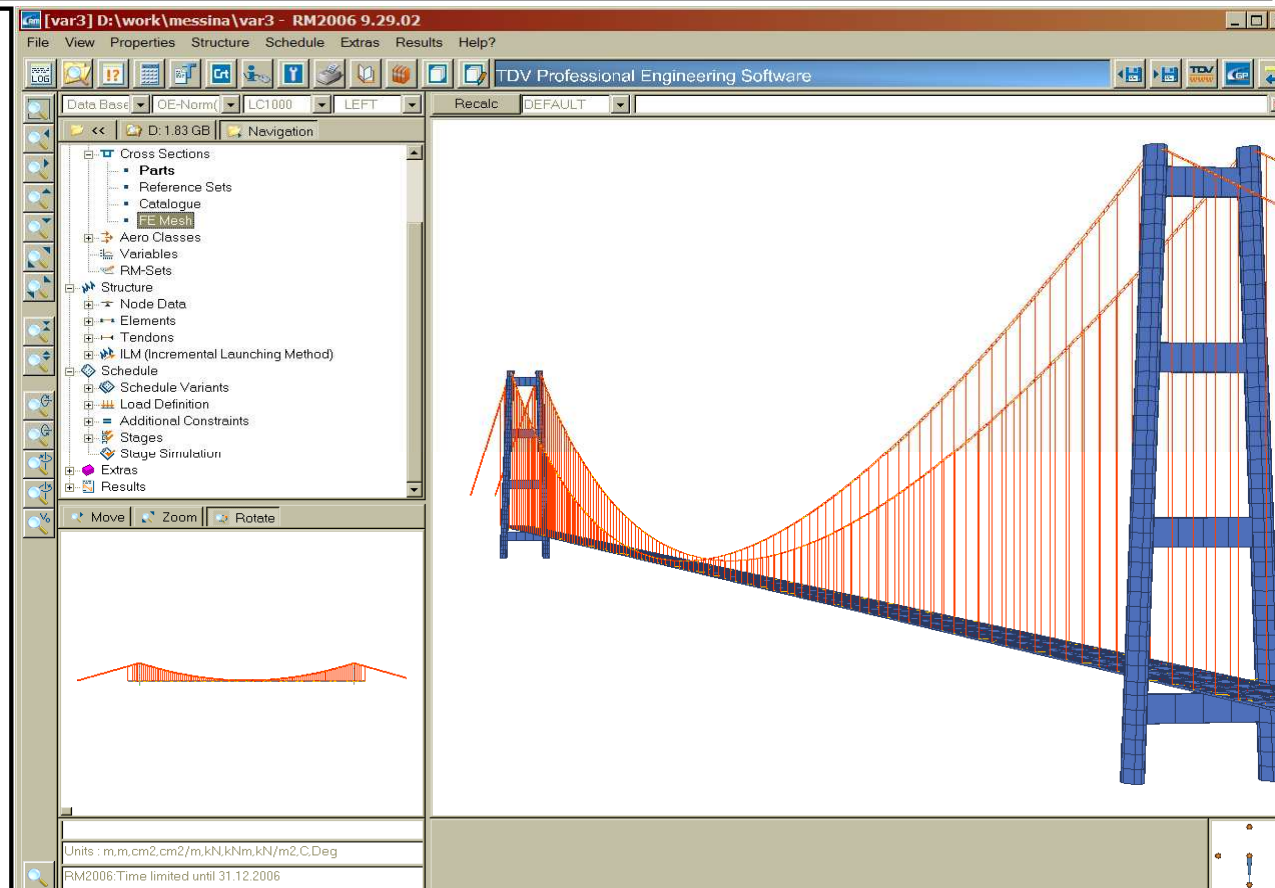
The Hardangerbridge

The Hardangerbridge will be the longest suspension bridge in Norway. The sailing height under the bridge will be 55 m.

Longest suspension bridge in Norway – 1310 m main span, total length 1380 m

TDV software in use:

- The bridge planning will be performed by the Norwegian public road administration department of bridges, with support from private bridge consultants.
- TDV software will be used for bridge planning
- TDV and TDA will give technical support in calculation work



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TDV Know-How in international projects

Suspension bridges



Professional Software Overview

San Francisco – Oakland – Bay Bridge, California

In Association with

SOHA, Anatech, PTG, T.Y.Lin

Proposal to Caltrans:

West span bike path planning and feasibility study over the existing San Francisco – Oakland – Bay Bridge
(length=3141m=10305ft)



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TDV Know-How in international projects

Suspension - Cable Stayed



Professional Software Overview

Brooklyn Bridge New York City, New York

*In Association with
Parsons Transportation Group*

Proposal to New York City DoT:

Check the seismic behavior of the mixed suspension and cable stay structure (length=1055m=3460ft).



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TDV Know-How in international projects

Cable Stayed Bridges



Professional Software Overview

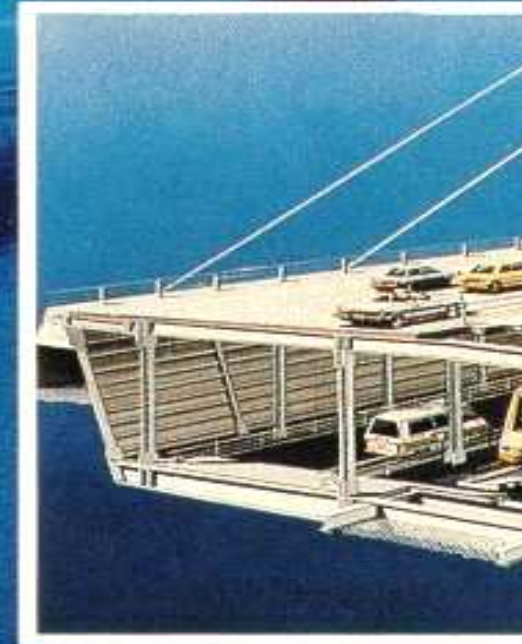
Kap Shui Mun, Hong Kong

*Software Support for
Leonhardt & Andrä, Germany
URS Greiner, Tampa, USA*



Live Load Analysis for Multi Deck
Top Vehicle / Bottom Vehicle and Train

Main Span 430 m (1410 ft)



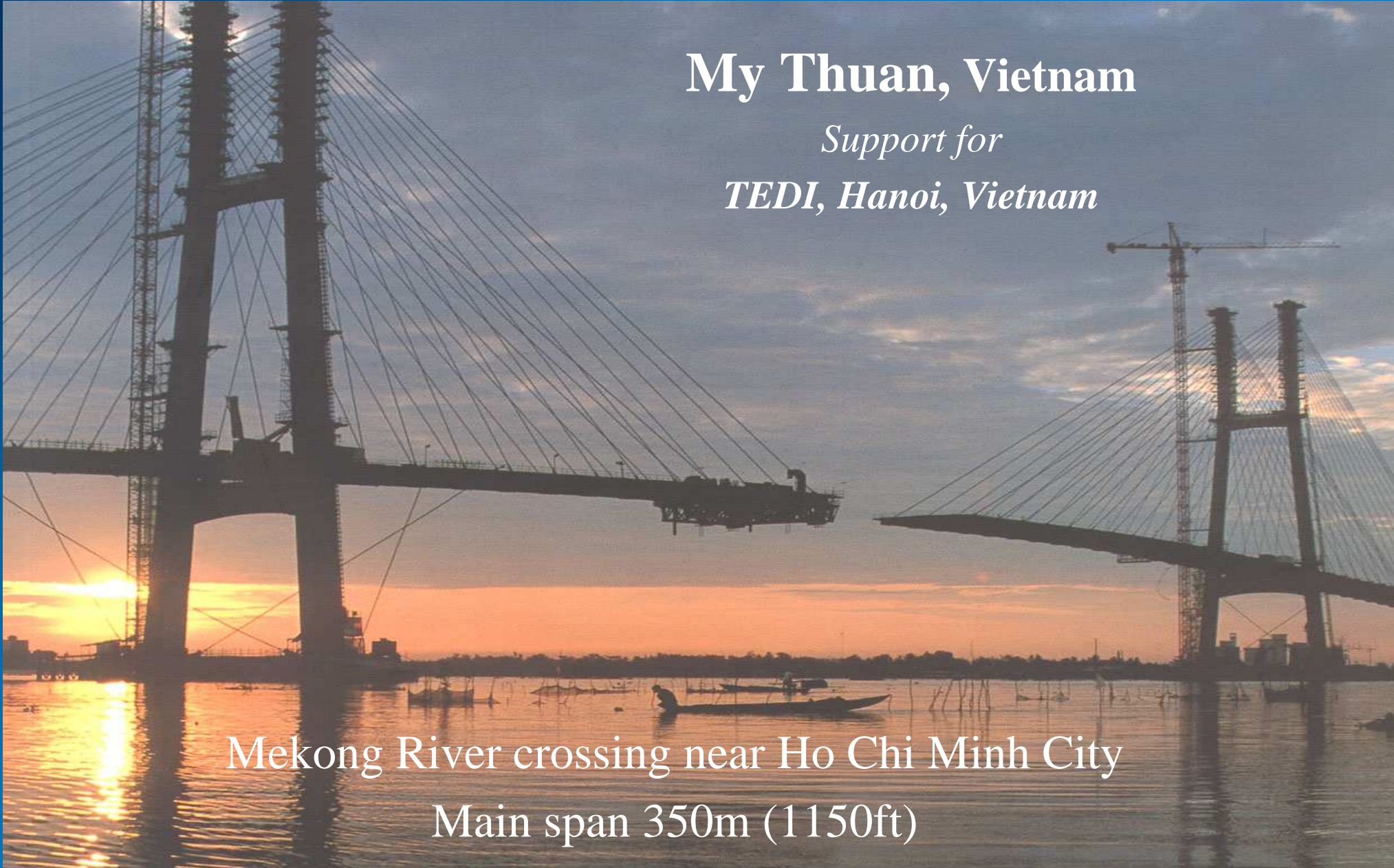
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TDV Know-How in international projects

Cable Stayed Bridges



Professional Software Overview



My Thuan, Vietnam

Support for

TEDI, Hanoi, Vietnam

Mekong River crossing near Ho Chi Minh City

Main span 350m (1150ft)

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TDV Know-How in international projects

Cable Stayed Bridges



Professional Software Overview

Kao Ping Hsi Bridge

Kaohsiung, Taiwan

Detail Design for

FFF 3F Engineering, UK



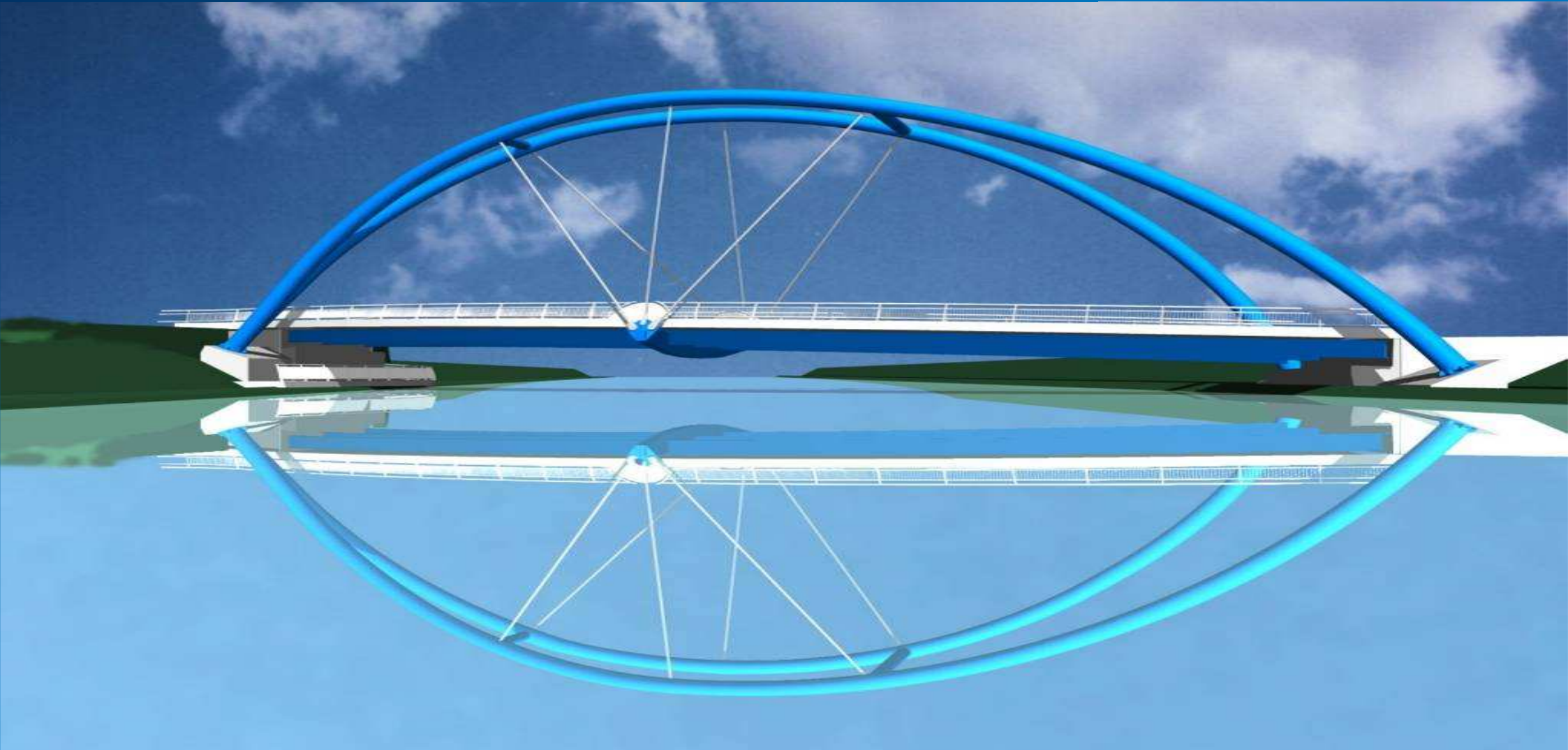
WHY CHOOSING RM2006?

- TDV was NEVER ONLY SOFTWARE development house!
- Professional bridge engineering software, developed BY Engineers FOR Engineers!
- Compensation of 37 years TECHNICAL KNOW-HOW!
- Technical solutions for all special problems in the world of bridges!
- Technical support and consulting for TDV users worldwide within 24 hours!
- Excellent hand in hand collaboration with users – projects and development.

WHICH BENEFITS BY CHOOSING RM2006?

- **TDV GUARANTEES** for high sophisticated technical level of Software and Support.
- **TDV GUARANTEES** for validity of results!
- **TDV QUALITY GUARANTEED** by THOUSANDS of successful bridge projects worldwide.
- **TDV QUALITY GUARANTEED** by the longest and the most complicated bridges in the world – already built and in the build process (Stone Cutter, Sutong, Bay Bridge)

ACKNOWLEDGEMENT



Thank you for your attention