Use of Steel in Refurbishment as an Environmentaly Friendly Activity

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At the Department of Steel Structures, Technical University of Budapest, Hungary a project had been carried out aimed to refurbishment of structures.

The main aims of the project was to:

- develop a new BSc curriculum for refurbishment steelwork engineering and
- to prepare new teaching materials.

In the framework of the project the following institutions took part in:

- Technical University of Budapest, Hungary (coordinator)
- University "Federico II", Naples, Italy
- University "Blaise Pascal", Clermont-Ferrand, France
- Technical University of Brandenburg, Cottbus, Germany,
- Heed, Structural Design Ltd., Budapest, Hungary

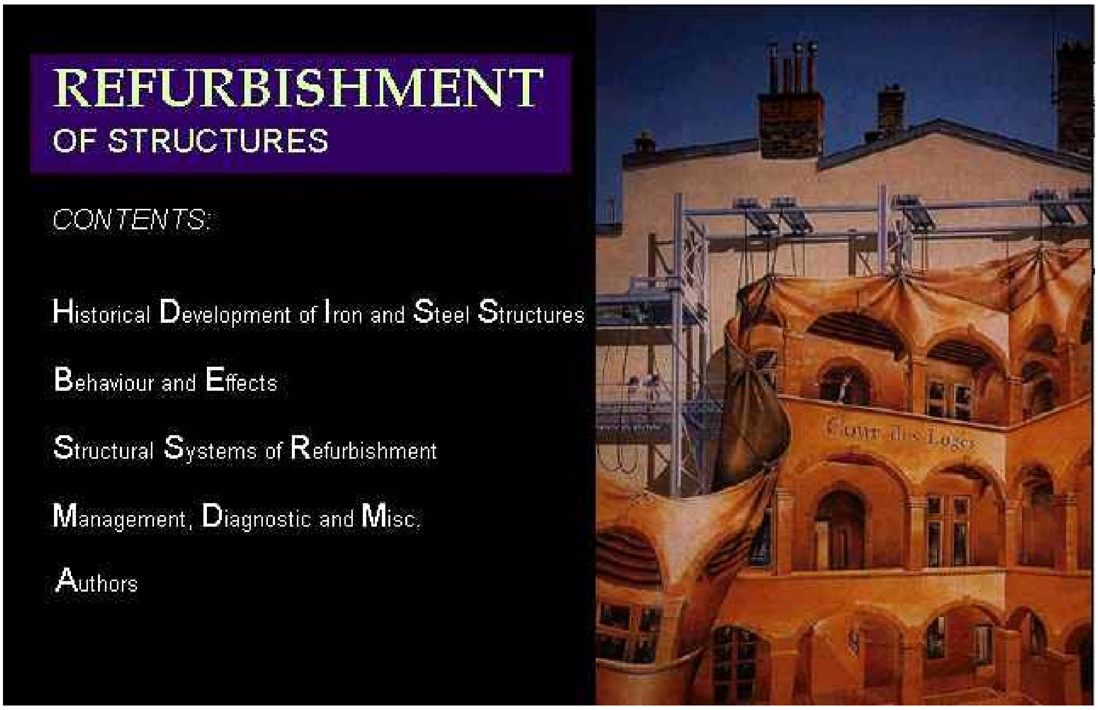
The project lasted for three years.

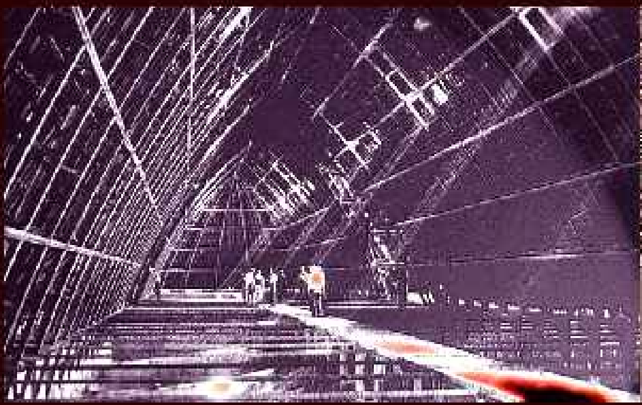
The main activities of the project were:

- mobility of students and staff members
- one seminar with invited participants from TU Bratislava, Slovakia and TU Timisoara, Romania
- two workshops

The main results of the project are summarized in two volumes of papers and in a CD ROM with the teaching material, which is based on ESDEP (European Steel Design Education Programme), literature and the project results.

The CD ROM includes four main parts.





BEHAVIOUR AND EFFECTS

The Use of Steel in Refurbishment

Strenghtening Options in Rehabilitation by Means of Steelworks

Some Aspects of Fires in Buildings

The Role of Earthquakes for the Structural Refurbishment

Fatigue of Metallic Structures

Corrosion and Corrosion Protection of Steel Structures

STRUCTURAL SYSTEMS OF REFURBISHMENT

Strengthening of structures

Transformation and repair

Re-use of buildings

Residual life assessment for bridges

Part III is the largest one. The details of the main four chapters are given below:

Strengthening of structures
- Introduction
- Levels of reconstruction
- Temporary works
- Systems for strengthening (repair and reinforcing)
  - Strengthening masonry structures
  - Strengthening masonry structures by lateral confinement
  - Timber structures
  - Concrete structures
  - Iron and steel structures
  - Comparison of different strengthening methods of masonry structures
  - Strengthening with IMS system
  - Beam-to-column connections in refurbishment
- Concluding summary
- References & additional reading

Transformation and repair
- Summary
- Introduction
- Modifying building structures
- General consideration of refurbishment
- Refurbishment in seismic areas
  - About some principles of buildings refurbishment in seismic areas
  - Seismic upgrading of churches by means of dissipative devices
- Case studies
  - The historical centre of Ancona, Italy
  - Van leer office building in Amstelveen, Netherlands
  - Office building, sea containers limited, London, Great Britain
  - Gymnasium in Cantu, Como, Italy
  - Rue de L'ourcq, Paris, France
  - Chemistry buildings of Technical University of Berlin, Germany
  - Alter Bahnhof exhibition hall, Rosenheim, Germany
  - Rue St. Jacques - a modern apartment above a late 19th century house
  - Abbey of Val Saint-Lambert Seraing, Belgium
  - Extension to the imperial war museum, London, Great Britain

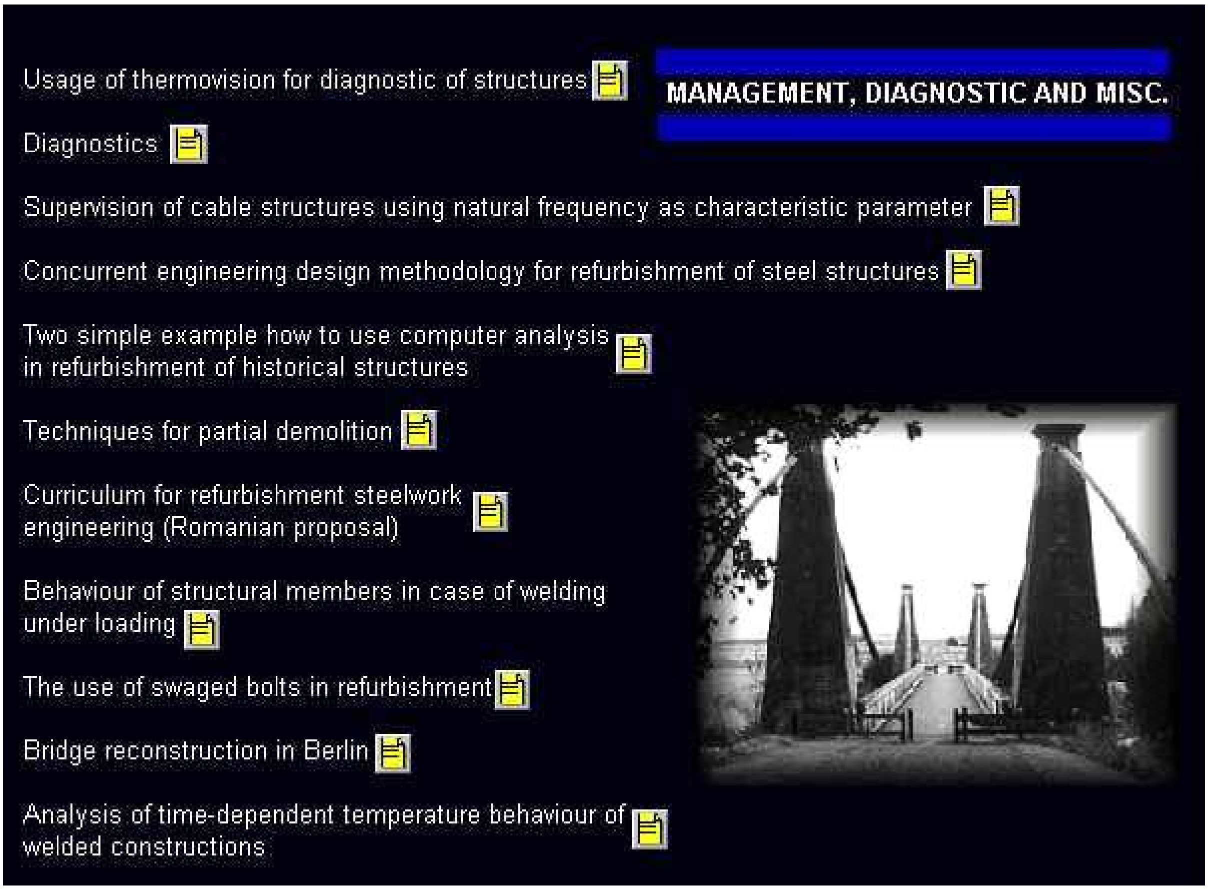
    - Repair techniques for the rehabilitation of fatigue cracked orthotropic steel bridges
    - Fatigue assessment of steel bridges of the bullet train system
- Orthotropic redecking of bridges
- Rehabilitation and strengthening of steel road bridges
- Steel plate bonding for concrete bridge strengthening

Case studies

- Angel Saligny Bridge
- Forth Bridge
- Rodenkirchen Bridge
- Eiseren Steges
- Tower Bridge
- Dismounting, transportation and rebuilding of a highway bridge
- Northumberland
- Refurbishment of Hungarian Danube Bridges
- Some examples of refurbishment in industrial steel structures and bridges
- The refurbishment of the West Railway Station
- Bearing replacement of the Petőfi bridge in Budapest
- Load test examinations on the Budapest Southern Railway bridge
- Strengthening of the deck of the Danube bridge in Ujpest

About the “Refurbishment of Hungarian Danube Bridges” during the Ariadne 11 workshop a presentation was given.

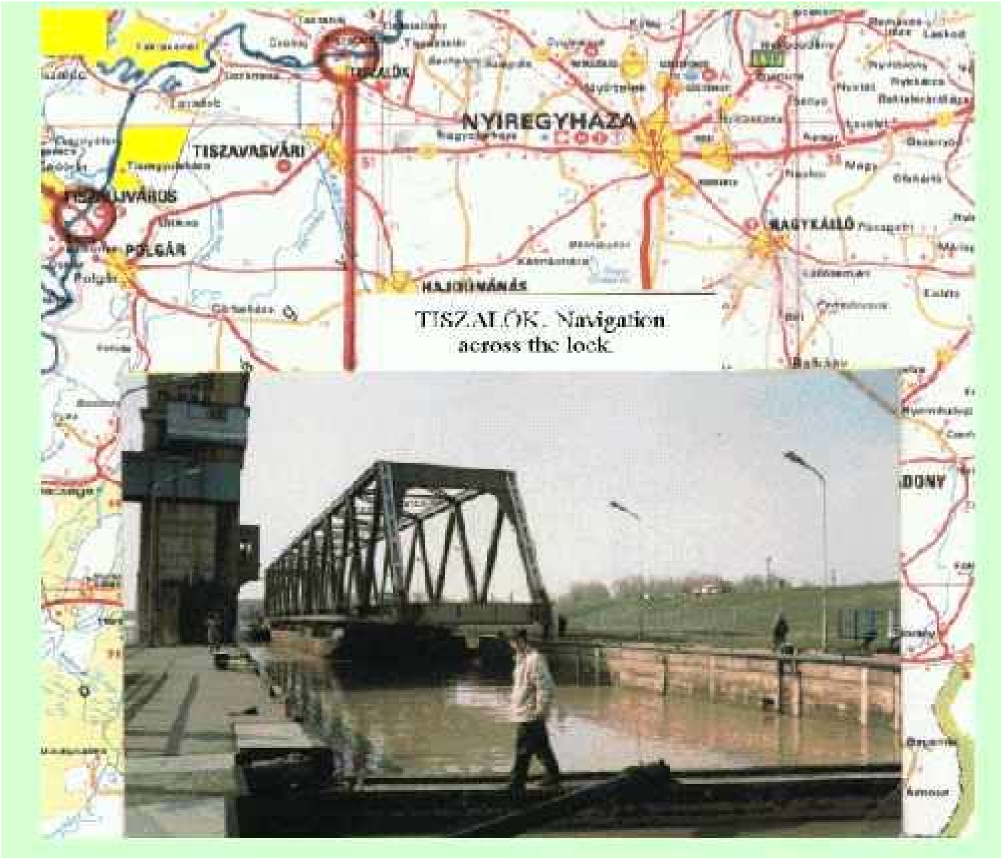
The topic of „Dismounting, transportation and rebuilding of a highway bridge” has a special interest. It is presented in details.

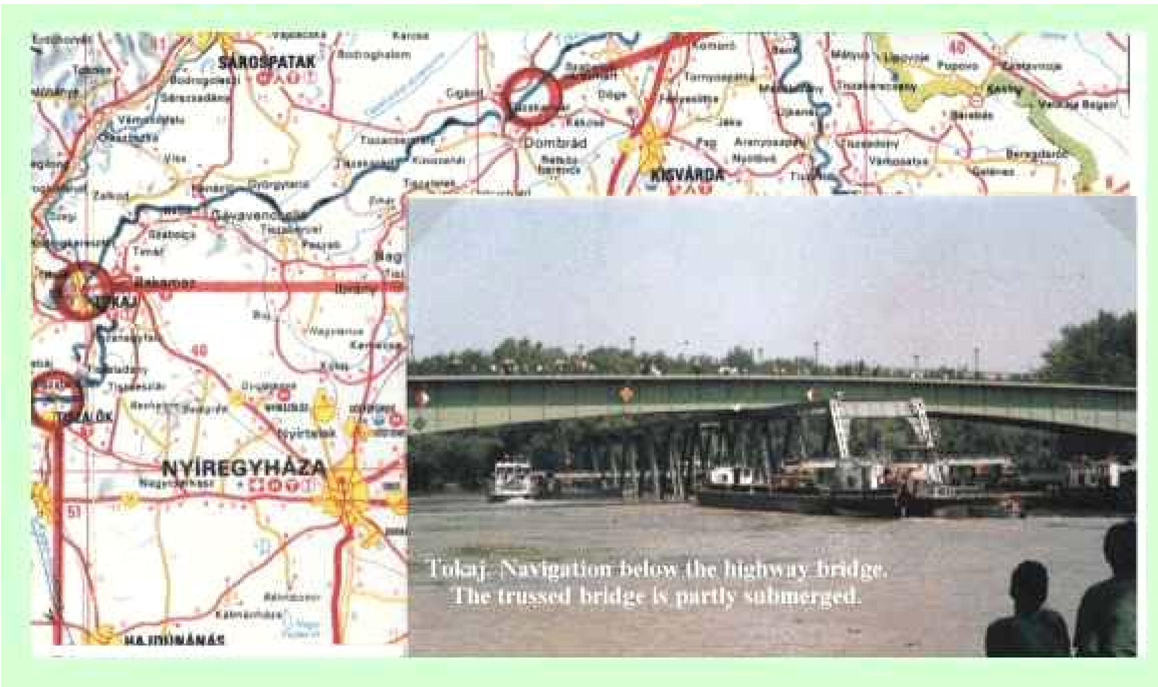


1. Dismounting, transportation and rebuilding of a highway bridge

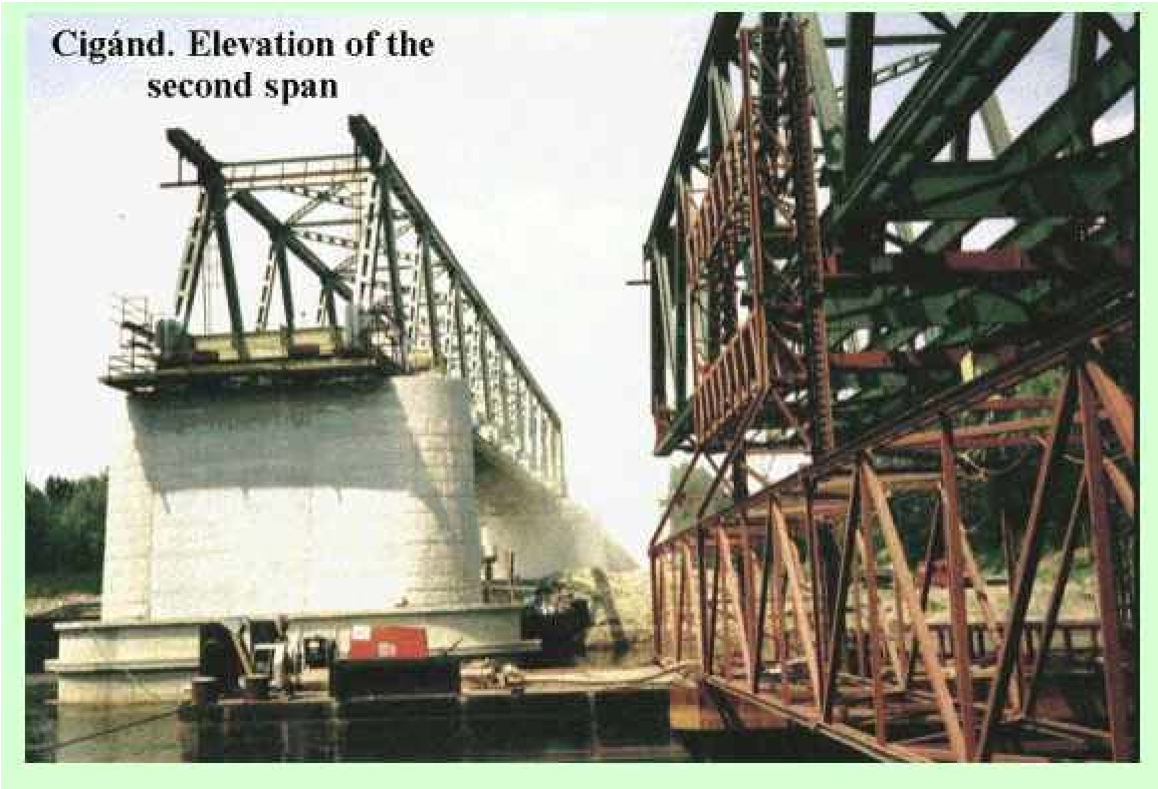
1.1 Introduction

In 1988 the Hungarian Highway Authorities decided that instead of the full reconstruction of the deck plate of a 2 x 106 m span riveted truss highway bridge built in 1942 across the Tisza river at Polgár, a new bridge had to be built, just beside the old one.





The new wider and higher load capacity bridge was opened to traffic in 1990 and the old one was closed, waiting for demolition. However, due to the good condition of the steel structure the idea arouse to dismount the structure and rebuild it above the same river upstream in 100 km in a place where the modest traffic requirements had already been satisfied by a floating bridge.



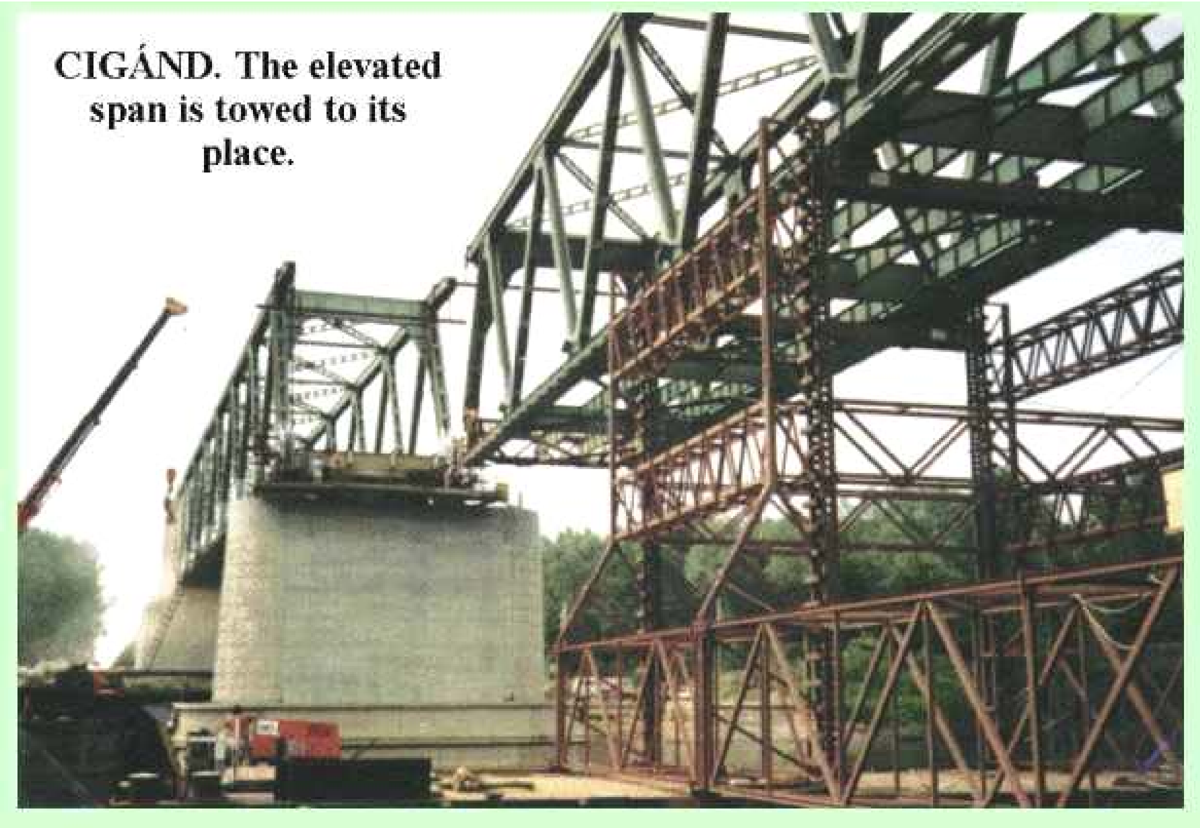
A permanent bridge would have meant here an achievement. The process of dismounting, transportation and rebuilding was developed and design by dr. István Szatmári, associated professor at the Department of Steel Structures, Technical University of Budapest, Hungary and the computerised supervision of the process was worked out by Miklós Kálló.

1.2 The project

According to the design, the two span continuous bridge was to be cut at the middle support, and the two parts (practically the two spans, 106 m long and of a mass of 430 tons each) were to be shipped on board of barges to their final place. Two barges had to be rigged specially so as to ensure the lifting, descending and horizontal movement of the spans. Four 15 m high columns were built to each barge with two cross beams between them. The beams were moveable (up and down) along the columns by hydraulic jacks and made possible the movement of the full load in 175 mm steps. The two lift barges were connected to each other by two 21.2 m long lattice girders to perform a statically stable structure. These barges were able to raise a span form the supports and let it down on the board of the transport barge at the original place and to perform the inverse operation at the final destination place.

A series of pictures illustrates some characteristic situation of the task, together with the difficulties which had to solve along the long voyage.

The whole process was finished at the end of July 1994 with full success. This delicate operation needed measurements and continuous supervision in some stages of the work. These can be detailed as follows.

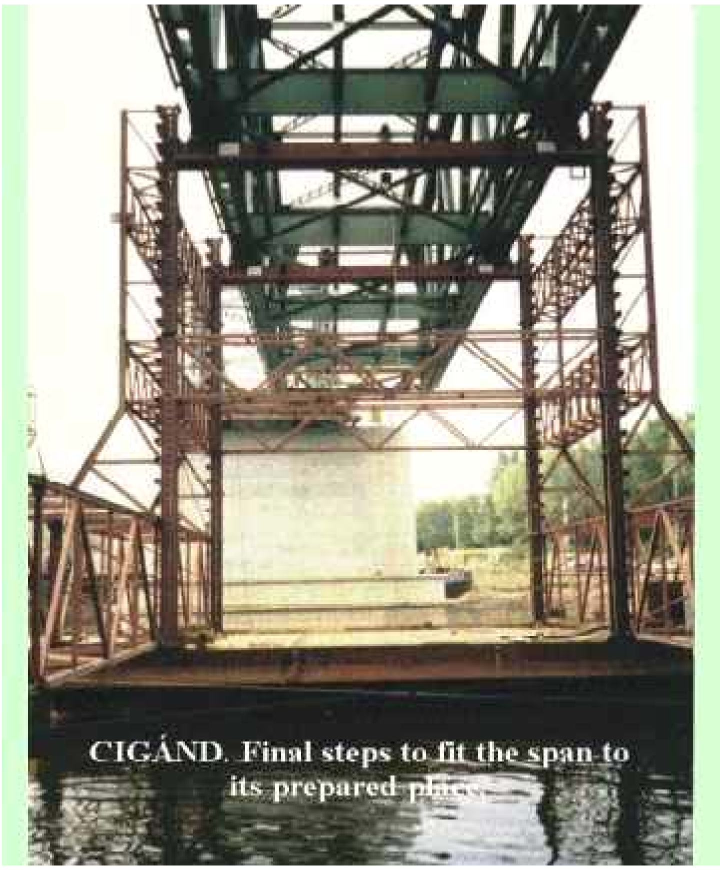


1.3 The process of hoisting

During the vertical movement of the spans the position of the four hydraulic jacks, working on the same barge and controlled by the same engineer, was measured by potentiometric transducers and displayed on screen. The display had three ranges for each transducers: a 200 mm range, which showed the actual position of the cylinder, a +/- 5 mm range, which always followed the actual position and signalled the vicinity of the marked positions, where the pins (fixing the raise beams, needed for the step-by-step motions) had to be changed. This way the engineers controlling the hydraulic systems were able to see the displacements, guess the velocity and sense the critical points of the four jacks, although these were hidden by structural parts. It proved to be extremely important due to the fact that the four reaction forces were far from being equal, therefore some interaction (e. g. to slow down the motion of one cylinder or quicken an other) was needed time to time based upon the display and pressure gage readings.

1.4 Supervision of the whole elevating gear

During both the vertical and the horizontal movements (latter carried on by sailors maneuvering the barges) a third computer gave a general survey of the state of operation. 36 strain gages were bonded to the chords of lattice beams between the two barges (four of them for drift control) for measurement of stresses in the critical places and two inductive transducers measured the inclination of the bridge in the longitudinal and transversal direction. The software calculated the horizontal and vertical bending moments, torsional moments, maximum stresses and the normal forces. The result could have been graphically represented on the display. As it later became clear, the display of the maximum stresses was always important, the vertical bending moment during the vertical movements and ballasting, the horizontal bending moment while the barges were moved together along the river. The normal forces – very likely due to the accurate setting of geometry – did not change too much. The inclinations showed correctly the actual position of the bridge, seldom was needed any correction.



CIGÁND. Final steps to fit the span to its prepared place.

1.5 Supervision of the elevated structure

The third main supervision) computer, when raising up the 2nd span at the final place, had to measure the stresses in one of the diagonals of the bridge. This very slender diagonal originally (when the span was supported at the ends) took tensile forces, while lifting the span up, the position of supports (raising beams) turned it in compression. Uprising the structure (at the first time only partly) the direction of the possible buckling became evident (as it was shown on the display), the diagonal in question was fixed by steel cable and remained so until the span was put onto its final supports.

1.6 Summary

It happens often, that a bridge built in an earlier time can not meet the requirements of the growing traffic in its original site, although its load carrying capacity did not decreased and in an other place, where the traffic is less intensive it would be suitable even for tens of years. The relocation of such structures depend mainly on the possibility of an economic realisation process. An economic process requires the application of method which ensure the movement of the possible largest units of structure (or the movement of the structure as a whole).

The case presented here shows such a relocation of a Tisza-bridge for a distance of about 100 km on the same river. The economic solution became possible by the application of up to date hydraulic tools and computerised on-line measurement supervision.