CASE STUDY

Arched Bridge of Tsakona

K.LIAROMATIS

STRUCTURAL STEELWORK


ΚΑΤΑΣΚΕΥΗ:

DESCRIPTION

The Arched Bridge of Paradisia-Tsakona was the last part to be delivered, on the motorway A7-Moreas (Tripoli-Kalamata), constructed by the Government with a total budget of €22,850,000 which at the present time is under the management of «Moreas» Consortium.

The construction of the arched bridge started in 2008 and was delivered to traffic in January of 2016. It was planned to pass over and therefore avoid a large landslide, which in 2003 disrupted completely the traffic in the highway. The landslide involved mobilization of both flysh colluviums and manmade deposits about 6.000.000m3.

Is the 2nd largest in Greece in terms of openness while among the 50 largest arches of bridges globally and it is an aesthetic landmark. A real engineering featuring, built over an active landslide in an intense area of seismicity presenting excellent complexity, both the foundations and superstructure.

The project includes a huge bow with a maximum height of 45m that has been set up on two podiums while the bridge hanging from it without been affected by the underneath landslided area. The bridge rests on three points: a mainstay on each side and a bracket located near to the top of the bridge podium, consisting of a giant prefabricated building ensuring the stability of the bridge.

TECHNICAL SPECIFICATIONS

The main span of 300m length, which passes over the landslide, consists of two vertical steel arches with rise of 45m and a steel-concrete composite deck, 22,80m wide, fully suspended by the arches with 2x20 vertical hangers. The approach to the main span of the bridge is achieved by a V-shaped prestressed concrete bridge 90m long and 20,40m wide.

The bridge consists of a steel arched body mounted to a composite deck with length of 260m, combined with an access section of prestressed concrete on the side of Tripoli's of 130m length. It has a total length of 390m and a max. Span of 300m. Deck has prestressed portion width of 20.40m and in arched 22.80m, while includes 4 lanes & restraining island with a width of 2m. Section of bow, which is an important novelty for Greece, consists of two parabolic arcs joined together by external wind bracings.

Totally on the project employeed over 600 Greek citizens such as: researchers, consultants, supervisors, engineers and inspectors, subcontractors, operators, foremen, technicians & workers.

PROJECT DETAILS

Commencement Date
2008

Contractor
Terna SA

Completion Date
28/01/2016

WorkTime
50 Months

Employeed
600 Persons

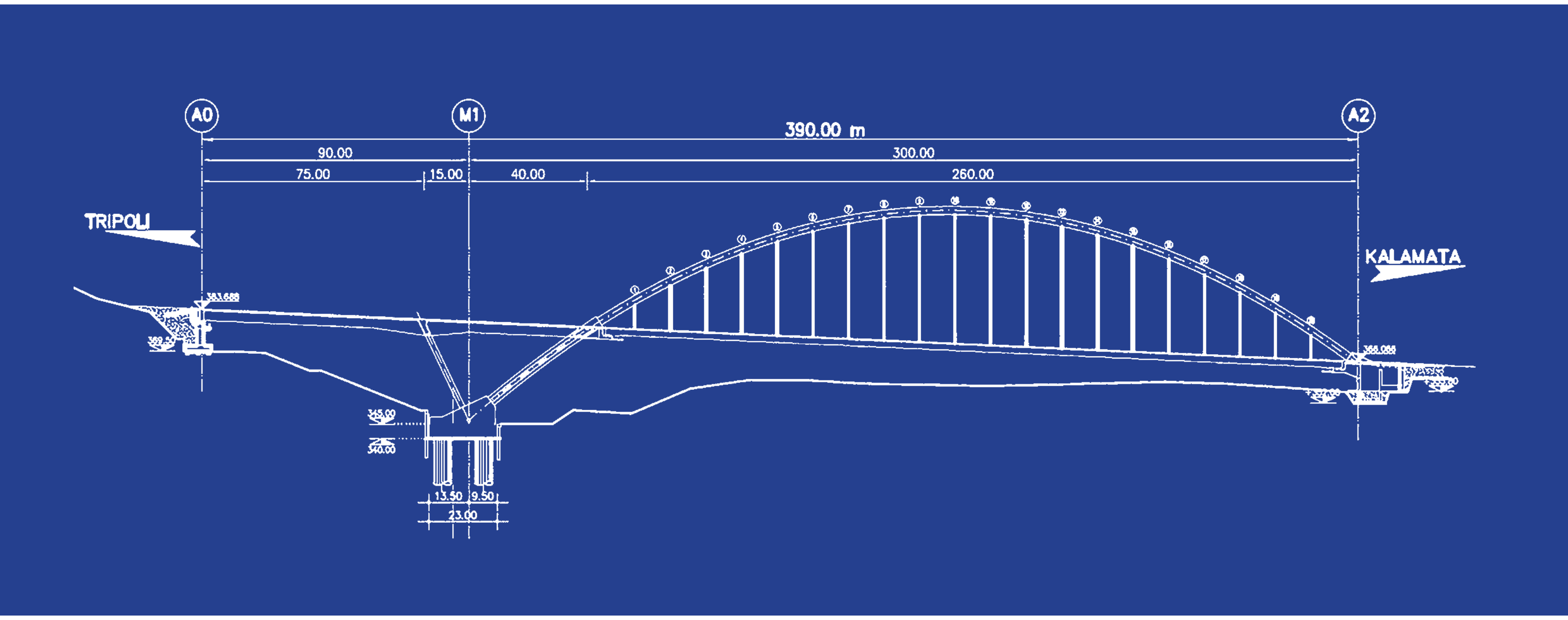
Estimated Materials:
- 22.500m³ concrete
- 3.290tn reinforcement & prestressing steel
- 3.720 steel for deck, arch & hangers

PROJECT DATA

- For the erection of the arches was chosen as more suitable the heavy lifting method using hydraulic jacks with support of built sections on temporary steel towers suitable acquired in landslide.
- Drafted the relevant structural design of temporary steel towers, foundations thereof & auxiliary structures as well as the entire building methodology.
- Special attention was given to achieve quality controls with an emphasis on weldings which were commissioned on Certified and specialized partners.

PROJECT REQUIREMENTS

Design was in accordance with German DIN Regulations although because of the manufacturing importance checked the compliance with Eurocodes requirements. Category of the bridge was 60/30 according to the DIN 1072 with dynamic charging factor of 1.00 to 1.40, while it has also tested for Standard Charging Class 1 according to EN1991 1-2.

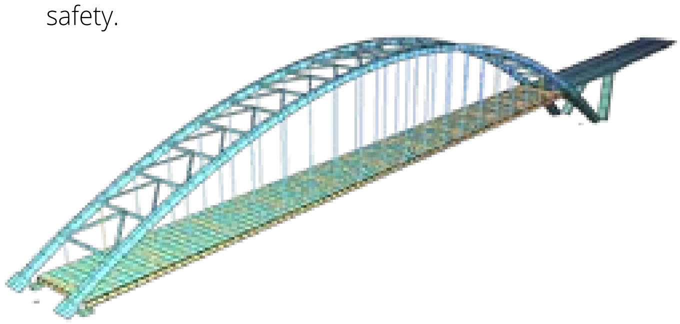


DESIGN AGAINST OPERATING ACTIVITIES

- **Viaducts Loads - DIN 1072**
- **Concrete structures - DIN 1045 - DIN 4227 - DIN 1075**
- **Steel Structures - DIN 18800 - DIN 18809 – VBT - Ri**

SPECIAL ISSUES & CONTROLS

Special issues, which the above German regulations do not adequately cover, were using Eurocodes in order of safety.



ANTISEISMIC PROOF DESIGN

- The Greek Instructions for designing bridges in earthquake zones (E39/99)
- The Greek Instructions to study bridges with seismic isolation (OAMG-2006)
- The Greek Anti-Seismic Regulation for the design of structures under seismic actions (EDC-1999/2003).

SIMULATION & ANALYSIS

- Detailed description of geometry and actions according to the phases of construction
- Linear and nonlinear analyses of 1st and 2nd class (check of arches camper)
- Fasma analyses (control of isolation).

MATERIAL SPECIFICATIONS

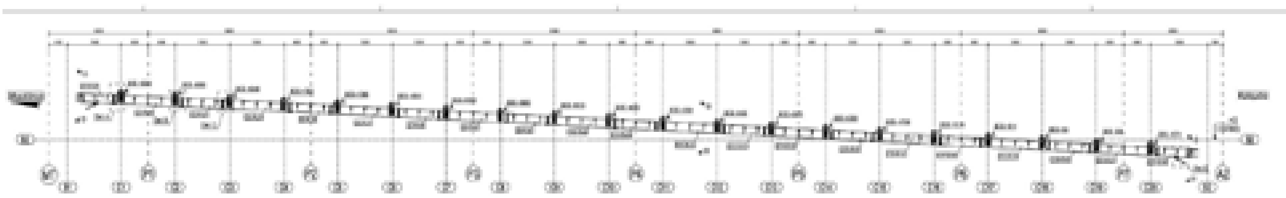
Special attention was given to the selection of steel for the supply of raw materials since the specifications of the study required high-strength steel, large thicknesses and guaranteed leak threshold.

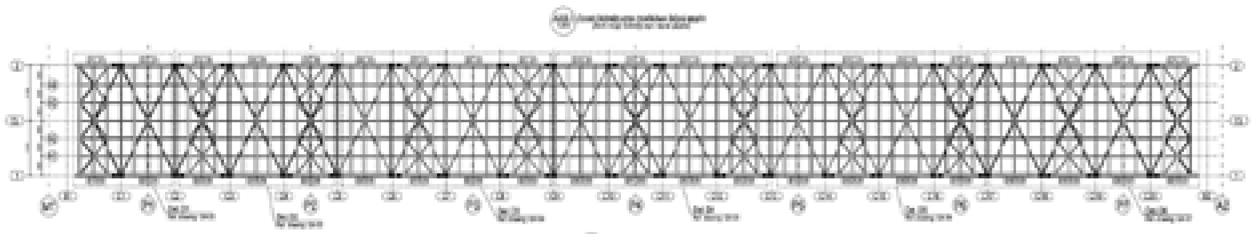
STRUCTURAL STEEL

- Bows (soles and logs) with a guaranteed yield strength fyk ≥ 355MPa for soles of arcs regardless of the thickness - J2 S355 + N
- Other main minerals (main beams, cross sections, arc, wind bracings, mounts etc) - J2 S355 + N
- Longitudinal trapezoidal sheets - J2C S355 + N
- Secondary minerals (wind bracings, spacers, couplings of composite deck etc) - S355 JR
- Cross section nails type Nelson F22/200 from S235-J2 + n + C450
- Main elements such galvanized bolts class-GV 10.9 m = 0.50
- Black bolts & subcomponents class-SL 8.8.

COMPOSITE DECK

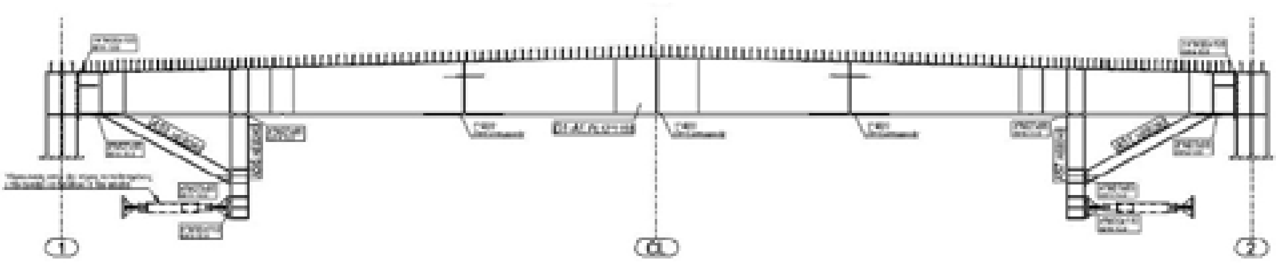
Composite steel deck consists of 2 steel main beams, 83 steel cross sections and reinforced concrete slab. Each main rafter beam has shaped cross-section I with fixed height 1.80m, and consists of plates dimensions 600 × 25mm for the upper tread, 1715 × 20mm for the trunk and 800 × 60mm for the bottom tread. The total length of 248.50m is divided into 21 sections, with lengths from 9m to 15m, which are connected between them with full strength connections that occur through double plate's trunk and feet with prestressed bolts.

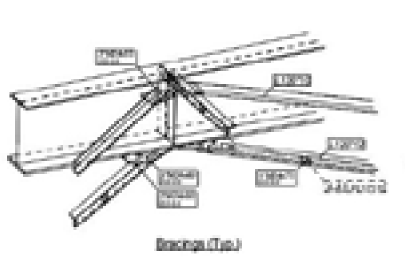


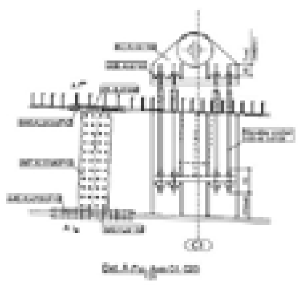


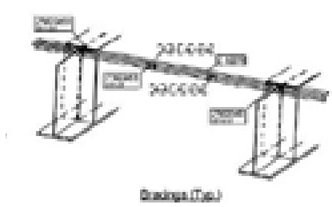
CROSS SECTIONS & SUB COMPONENTS

Cross sections have an opening 21.55m in length and are placed per 3.00m. They have variable cross-section height, from 870mm and supports up to 1210mm in aperture, and consist of sheets with dimensions 400 × 20mm for the upper foot, 12mm (Center section) or 15mm (extreme parts) for the trunk, and 500 × 35 (central part) or 500 × 25 (extreme parts) for the bottom tread. The wood is connected with the main beam through a frontal plate and prestressed bolts.









The steel body of the deck includes some subcomponents that provide sufficient durability and lateral stability against wind. These items are only active during steel body assembly and pour the slab. The reinforced slab concrete C30/37 is being over on galvanized steel deck 100/1.5 with a solid thickness of 25cm. The shear plate connection with main and crossbeams ensured through shear spot head F22/200.

QUALITY CONTROL OF WELDINGS

- Persons Certification carrying out non destructive tests (ISO 9712:2012).
- Persons Certification carrying out non destructive tests with industrial radiography (RT) – level I, II and III: castings and welds.
- Certification of persons interpreting industrial radiographs (RI) – level I and II: castings and welds.
- Persons Certification carrying out non destructive tests with ultrasound (UT)

  - level I, II and III: castings and welds.

  - level I and II: inspection and thickness measurement of plating.

- Persons Certification carrying out non destructive tests with ultrasound (UT) using transceivers of phased array (phased array transducers) – level I and II .
- Persons Certification carrying out non destructive tests with ultrasound (UT) using the technique of time delay ultrasonic beam on existing defects (Time of Flight Diffraction (ToFD). – Level I and II : soldering .
- Persons Certification carrying out non destructive tests with Visual testing (VT) – level I, II and III: General construction products .
- Persons Certification carrying out non destructive tests with magnetic particles (MT) – level I, II and III: General construction products .
- Persons Certification carrying out non destructive tests with liquid penetrants (PT) – level I, II and III: General construction products.

Quality Controls

An integral part of the larger process of industrialization is a quality control that closely monitors all stages aiming to achieve correct implementation of strict requirements in EN ISO 9001 and EN 1090.

STEEL BRIDGES

Paint System

Steel surfaces are protected with a paint system of minimum 15 years lifetime, suitable for ambient conditions Category C2.

Cutting

Based on the detailed three-dimensional design of the project, the cutting sheets were produced, which were processed by a state-of-the-art CNC pantograph, giving high precision and quality.

Cutting, Drilling & Marking

Featuring modern and fully automated CNC cutting equipment, are creating, material management and branding have too high machining speeds and accuracy greatly increasing our production capacity and fulfilling demanding and strict delivery times.

Built-Up Welded Beams

The connection of the trunk and the top of Built-Up beams were made to ultra-modern automatic welding machine to submerged arc procedure with bilateral appropriate receiving constant thickness in 100% of shear flow.

SandBlast

Sandblast at closed tunnel according
to Swedish standards: Sa 2 ½.

Assembling

The sheets rigidity (longitudinal and transverse) of the main beams was placed with stitching welds of appropriate thickness.

Modular Deck Links

The deck is connected to the arc through modular connections with vertical ropes per 12,00m and is secured with dowels.

Paint Coatings

Base coat primer 80 μm.
Intermediate layer epoxy base 100 μm
Final layer coat of polyurethane 60 μm.
Total thickness: 240mm.

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