Corinthos Canal Bridge

Lifting for Bearings Replacement

HiSCS reports

July 2026

PARTICIPANTS

Contractor

APION KLEOS JV

Concessionaire/Operator

OLYMPIA ODOS

Designer

DENCO Structural Engineering Consulting Office

Subcontractor

ELEMKA

in cooperation with HiSCS

A Construction Delay of Almost 2500 Years

The Isthmus (a relatively narrow strip of land that separates two coasts and in turn connects two areas of land) of Corinthos was known in the ancient world as the landmark that separated the Peloponnese from the rest of mainland Greece.

This land strip of 6 Km (3.7 miles) in length with sheer rock walls that rise nearly 80 m from the waterline excavated saving mariners on a journey of hundreds of nautical miles around the Peloponnese peninsula. Its navigation width is about 25 m (82 ft) and has a max depth of 8 m (26 ft).

Tugboats Guide Vessel through Canal

Map of the Area

It took the name Corinthos Canal from the nearby city of Corinthos, due to its geographical location emerging from antiquity as a major naval, commercial and cultural center.

The difficulty in transporting goods by land prompted the Tyrant of Corinthos, Periandros, being the first to think, around end of 6th century BC, to construct the famous Diolkos, a paved walkway, on which the ships of the time smeared with grease, slid to cross the Isthmus from one coast to the other.

HiSCS engineering experts

THE ICONIC SHORTCUT BETWEEN AEGEAN AND IONION SEAS

Bridge View from Water Level

The Very First Attemps

6th Centrury BC to 17th Centrury

It appears that Periandros was the first to think of opening the Isthmus, however, he quickly abandoned his plan, fearing that he would incur the wrath of the God Poseidon, to whom the area was dedicated.

It is said that the main reason that forced him to abandon this idea was not the divine wrath per se, but the enormous technical difficulties of carrying out the project plus the economic interests of Corinthos, which wished to maintain its privileged position as the "key" of the Mediterranean transit trade through Diolkos.

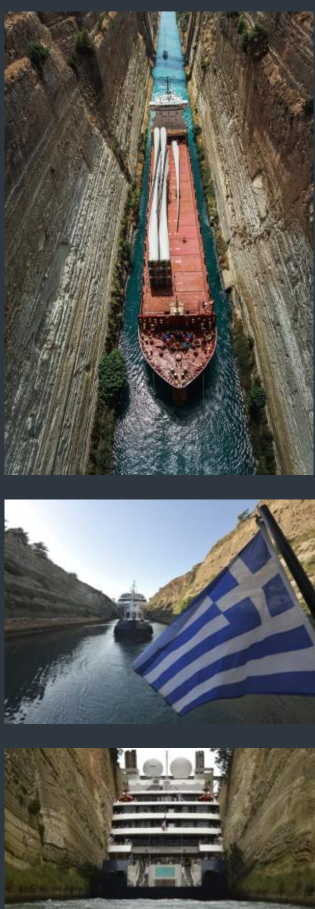
Diolkos-Ship Transport Illustrations

Three centuries after, Demetrius the Besieger attempted to implement the same plan for opening the Isthmus, but abandoned the idea when the Egyptian engineers, whom he brought for this purpose, assured him that the difference in the sea-level of the Corinthian Gulf from the Aegean Sea was such that, with the opening of the Isthmus, the waters of the Corinthian Gulf coming from one side to the other would flood resulting in the submergence of the neighboring coasts and islands.

During the Roman Era, after 2.5 centuries, Emperors Julius Caesar and Caligula made plans for opening the Isthmus, which were, however, abandoned for political and military reasons.

Later, Emperor Nero based himself on these plans when he decided to carry out the project. The work was started by the emperor himself, giving the first blow to the land of the Isthmus with a golden pickaxe. The excavation work stopped after about 3,3 Km (2 miles) when Nero was forced to return to Rome; his death canceled the project definitively.

Attempts by Heroides the Atticus and the Venetians after centuries, encountered great difficulties which led to the cessation of work almost immediately.



Marine Traffic through Canal

Isthmus Photo during Construction

The 40 million gold francs that were foreseen in the budget, which was deemed necessary for the execution of the project, could not be found by the first Governor of modern Greece I. Kapodistrias (circa 1830), thus the effort was again abandoned.

Finally, the work began in 1882, when the concession for 99 years was awarded by General Ettienne Türr who transferred all rights to “Société Int’l du Canale Maritime de Corinthe”. The work suspended due to bankruptcy after 7 years, forcing the establishment of a new Greek company taking over the project till the handover in 1893.

It is interesting to note that initial design specified Canal width 43m (141 ft) and a depth 6.5 m (21 ft). At that time Suez Canal had width of 22 m (72 ft) and 8 m (26 ft) depth, therefore, the opinion of Ferdinand de Lesseps (designer of Suez Canal) was sought who recommended 22 m (72 ft) width and 8 m (26 ft) depth instead.

The Canal section was finally designed by the Hungarian Civil Engineer B. Gerster, being also the site manager.

Construction Delay = an extension or interruption in a project schedule that prevents work from being completed on time

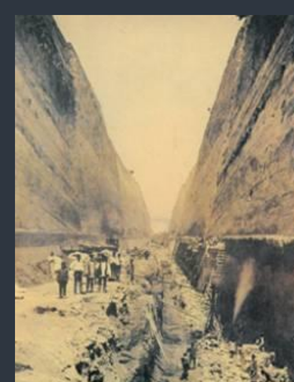
People usually complain about construction delays, but even the most sluggish modern infrastructure project has nothing compared to Corinth Canal. Inauguration ceremony took place in 1893, almost 2500 years since the time of the first attempt of Tyrant of Corinthos, Periandros.

Photo of Construction Works

EYE ON IT

Around 2,000 to 2,500 people worked on the main construction of the 19th century Corinth Canal in Greece.

This workforce was mobilized to excavate about 12 million m^3 of earth and rock between 1882 and 1893.



Isthmus Photo during Construction

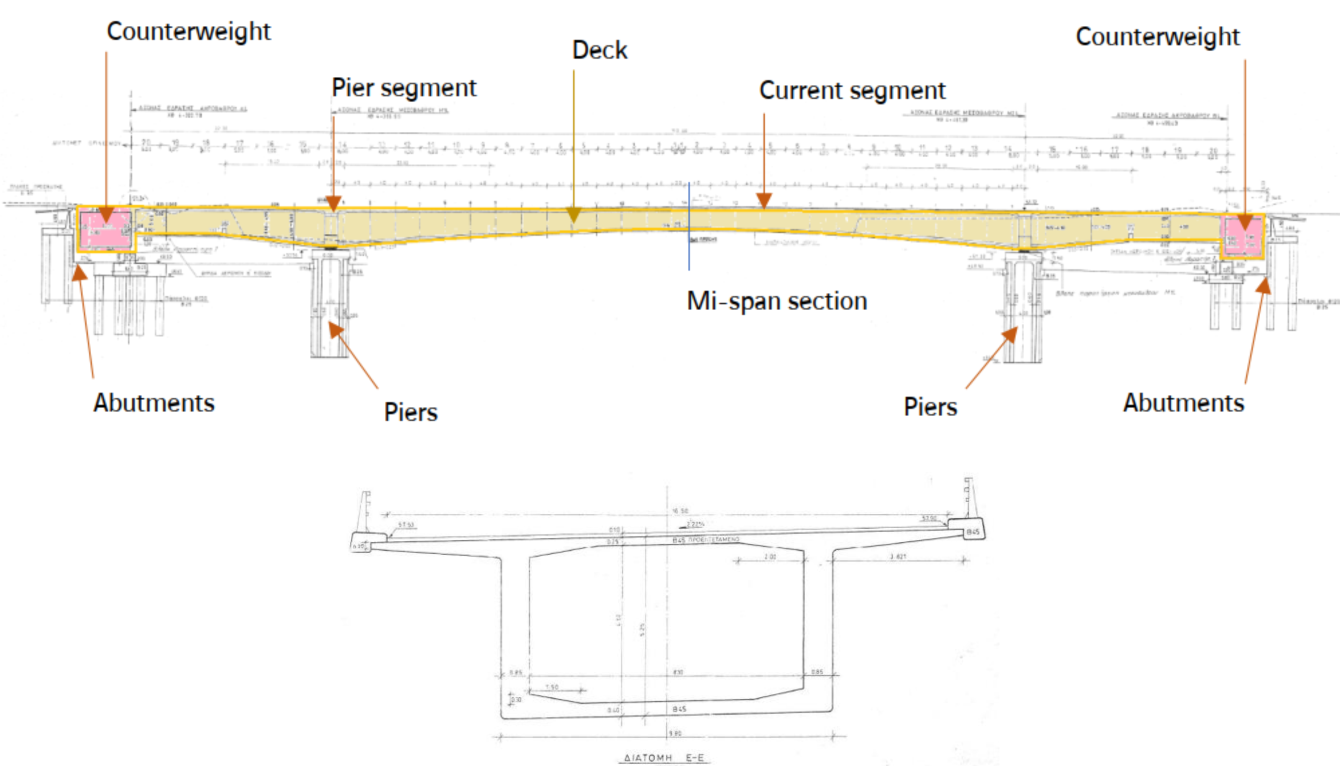
ICONIC

Describes something widely recognized, classic, and deeply symbolic of a particular era, place, or concept.

The Structure: An Iconic Cantilevered Vehicular Bridge

- Year of Construction: 1996.
- Method of erection: Balanced cantilever method.
- Total length: 190m, Branches: 2, Spans: 3 (max span 110m).
- Section: Prestressed concrete box girder
- Width: 16.7-18.7m, Height: 4.5-6.0m
- Concrete: C35/45 – deck & C30/37 – piers & abutments
- Boxes: filled with ballast beyond abutments to counterbalance the large cantilevers of main span during construction.
- Piers: with circular shape dia 6m. Piers are located fully inside cylindrical shafts.
- Bearings at abutments: 6 pcs x 4 abutments - High Damping Rubber Bearings (HDRB) 700x800x315(210[#1])mm (allowable deformation ±400 mm).
- Bearings at piers: 1 pcs x 4 piers - Free sliding pot 55000 (82000[#2]) KN/±400mm/±400mm (vertical load KN/allowable sliding in longitudinal direction/allowable sliding in transversal direction). Basic dimensions: 2020x2020x219mm, weighing about 4.5 tons.

Notes: #1-Figure in parenthesis total rubber thickness, #2-Figure in parenthesis ULS vertical load



Abstracts from Existing Design Drawings (Side View & Cross Section at Piers)

EYE ON IT

Pot Bearing – Free Sliding

Specialized structural bearing to safely transfer high vertical loads while accommodating the structure's rotations and displacements.

The bearing relies on a simple fluid-dynamics principle: confined elastomer behavior and consists of:

The Pot: A shallow, solid steel cylinder forming the bottom base.

The Pad: A completely encased rubber pad placed inside the pot.

The Piston: A close-fitting steel piston plate sits directly on top of the rubber pad, sealing it inside the cylinder.

Existing Pot Bearing

Structure Upgrading:

The Necessity of Changing the Existing Bearings at Piers

The existing free sliding pot bearings at the piers use a sliding material which is not covered by modern standards. According to previous monitoring studies, bearings are likely to not slide at all. The behavior of bearings of this type cannot be reliably predicted in the future if a prolonged period of inactivity has occurred. According to the relevant studies it is possible that a value of the coefficient of friction to the order of 15% may appear, which exceeds the maximum value for which the bridge has been designed (11%).

Sliding Material of Pot Bearings

Recent geotechnical studies have shown that the slopes of the Corinth Canal have reduced resistance, partly due to the excavation of the nearby railway bridge. Based on the geotechnical deterioration of the Canal slopes it is concluded that failure due to excessive bridge displacements occurs when the horizontal force at the top of the piers corresponds to a friction coefficient equal to 8.6% or a horizontal force of 3.8 MN.

The new seismic isolation design proposes the use of new sliding bearings having a curved sliding surface (commonly known as Friction Pendulum Systems – FPS) which will replace the existing free sliding pot bearings at the piers. The existing High Damping Rubber Bearings (HDRB) at the abutments will not be replaced.

The new seismic isolation system is designed in accordance with the current modern standards (EN 1998-2/Eurocode 8-Design of structures for earthquake resistance) in combination with the relevant standard (EN-15129/Anti-seismic Devices) in full compliance with the European legislation. The study was performed by DENCO Structural Engineering Consulting Office, with non-linear dynamic time-history analysis which is the most modern and at the same time safe calculation method for structures under seismic excitation. The analyses show the adequacy of the solution in terms of a) the available displacement capacity of the seismic isolation bearings and b) the maximum forces that can be tolerated to be transferred to the piers and their foundation according to the latest geotechnical assessments.

The management of works performed by Contractor APION KLEOS JV in cooperation with the Operator OLYMPIA ODOS. Lifting and replacement works by Subcontractor ELEMKA in cooperation with HiSCS.

New Antiseismic Devices - FPS

Curved Surface Sliders consist of a concave slider (top plate) whose radius of curvature imposes the period of oscillation and accommodates the horizontal displacement and the lower plate with a secondary concave sliding surface that permits rotation.

By reducing the curvature of the sliding surface, the oscillation period of the structure can be extended, reducing the acceleration of the structure during earthquakes.

The friction induced on the sliding surfaces provides energy dissipation and helps to minimize the impact of seismic forces on the structure.

The bearing behaves like a pendulum because of the re-centering mechanisms that keep the superstructure almost centered after an earthquake.

The new friction bearings at the piers have a controlled coefficient of friction which has been certified by tests. This is important because due to inevitable variations in bearing loads and friction coefficients it is expected that one of the two new friction bearings at the piers will also remain stationary in the future.

Properties of the New Bearings

- Nominal value of the equivalent radius of curvature: R = 9.9 m (32 ft)~ 10.1 m (33 ft)
- Average nominal value of the equivalent friction coefficient: 0.0375
- Variation of the average value of the equivalent friction coefficient: +/- 25%

The equivalent radius of curvature of approximately 10 m (32.8 ft) was chosen among other reasons for:

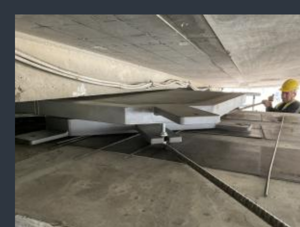
- The mild radius of curvature creates a small uplift of the superstructure in the position of the piers when the bearings are moved. For the max displacement capacity of the bearings the uplift corresponds to 8 mm (0.3 in). This uplift is tolerated by the deck which is designed for a 10 mm (0.39 in) uplift when the bearings are replaced.
- The re-centering capability of the system is ensured in addition to the action of the curved sliding surface also by the elastic action of the high-damping elastomeric bearings at the abutments.

EYE ON IT

Among the Biggest Bearings in the World

70000KN maximum vertical load and sliding capacity in both directions ±400mm.

Basic dimensions: 1890x1890x220mm, with weight about 3.2 tons.



EYE ON IT

Jacks Characteristics

- Base diameter – 553 mm (21.7 in)
- Total height with closed piston – 306 mm (12 in)
- Lifting capacity – 50 mm (1.97 in)
- Spherical heads capable of bearing a horizontal load 2-4% of the vertical with a tilt angle of ±2%
- Max working pressure – 630 bar
- Oil capacity – 8 lit
- Weight – 465 Kg (1025 lbs)

Hudraulic Jacks with Load Distribution Plates

The Endeavor of Jacking & Lifting

Lifting capacity of 1000 tons per jack

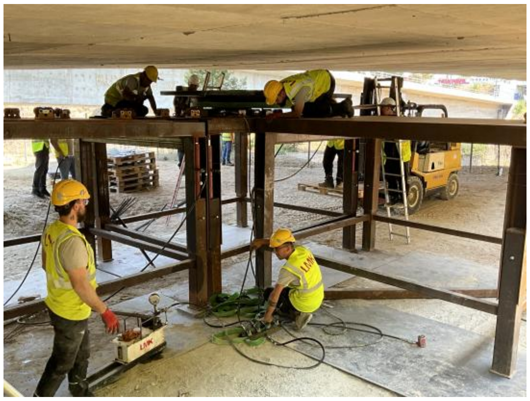
The jacking & lifting design foresees the use of 3+3 hydraulic jacks each with capacity of 1000 tons located left and right of the bearing.

Maximum uplift to the order of 10 mm (0.39 in).

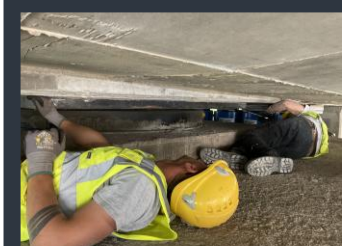
Location of jacks on both sides of the bearing along the deck crossbeam above each pier.

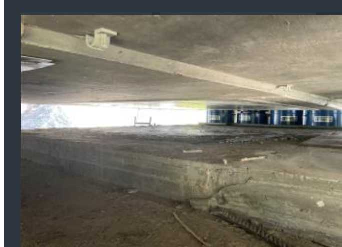
The replacement of the bearings had to be utilized in a corridor aligned with the longitudinal axis of the bridge of maximum width 2.1 m (6.89 ft).

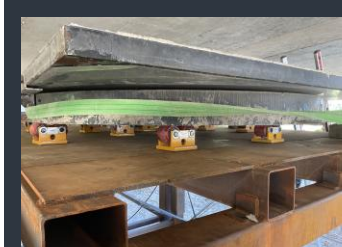
For the shake of safety 4+4 jacks' of 1000 tons each with locking rings were used considering that the bridge will always remain open to traffic < 26 tons vehicles without the use of temporary support (lack of space).



Basic Stages of Execution







- Topographic survey for accurate recording of lifting areas at piers.
- Preliminary casting works to create a horizontal and level path for bearing extraction and insertion.
- Preparation of jacking surfaces on the pier cap (horizontality and leveling).
- Installation of main vertical and secondary side jacks, load distribution plates and parts of hydraulic equipment (distribution valves, high pressure hoses, quick coupling, gauges, hydraulic pumps, teflon sheets to accommodate small service movements, laser measuring devices etc.), working platforms, seam plates along the shaft perimeter etc.
- Clamping of upper and lower anchoring plates of existing bearings.
- Removal of lower mechanical anchoring bolts.
- Lifting of the superstructure and bearing's base plate detachment from bearing plinth.
- Placement of rollers beneath base plate.
- Partial re-settlement of superstructure and temporary support on rollers.
- Removal of upper mechanical anchoring bolts.
- Rolling of existing bearing and placement onto steel frame.
- Re-settlement of superstructure in its initial elevation and activation of jacks locking rings.
- Repair of bearing' contact surfaces (bearing plinth and superstructure using a high strength mortar.
- Installation of new bearing on the steel frame.
- Rolling of new bearing on the steel frames.
- Lifting of superstructure and slide of new bearing to the bearing plinth using rollers beneath bearing's base plate.
- Alignment of lower mechanical anchor bolts with the existing bars embedded in substructure, and partial screwing.
- Slight lifting of bearing using small jacks and removal of rollers beneath base plate.
- Screwing of lower bolts
- Removal of clamps and alignment of upper plate mechanical anchor bolts with the existing bars embedded in superstructure, and partial screwing.
- Full re-settlement of superstructure till full support on the new bearing.
- Check of elevations, bearing and neighboring areas.
- Tightening of upper and lower bolts with the appropriate torque.
- Final checks, mobilization to the new location by repeating the above procedure.

The average time per jacking location was about 10-15 working days.

Jacking and lifting works took place from May the 8th 2026 up to June the 19th 2026 with traffic closed for vehicles > 26 tons.

It is noted that side jacks were placed between the shear keys during lifting and re-settlement to secure the superstructure from any side movement. Side jacks were removed during full support of superstructure on main jacks to simulate the free sliding behavior of existing pot bearings.

Thinking Outiside the Box

All bearings of modern design/manufacture can be replaced. Replaceability is now a contractual term. However, replacement (especially of large bearings in size and weight) in a confined space and with access limitation, requires significant skills.

The use of equipment (hydraulic and E/M) and devices that cannot be transported-installed by hand requires a special approach to work in narrow spaces, use of modified tools and devices to overcome these difficulties, given the iconic and strategic importance of this bridge.

Special steel frames with adjustable height using hydraulic pistons to match the elevation of the pier caps were used to facilitate the removal of the old bearings and the installation of the new ones.

Thick steel plates were placed beneath these frames to secure a smooth and solid ground contact surface.

Rollers of several types were used to slide the heavy bearings from bearing plinth to the frames and vice versa.

Finally, the new bearings mechanical anchoring system was designed to match the axis arrangements of the existing anchor bars embedded both to substructure and superstructure.

Conclusions

It is well known that the lifting and jacking of any bridge requires a unique approach and inventiveness with on-the-spot decisions and concepts affecting significantly the completion of work. Considering the existing pot and new anti-seismic surface sliders among the biggest and heaviest bearings in the world as well as the strategic importance of this bridge, we faced challenges beyond any previous experience.

The quote “Impossible is Nothing” once again justifies its importance among engineers.

Impossible is not an engineering fact, nor a specification. It's just a weak opinion. It is said that the word engineer comes from the word genius = an exceptional talent or skill, something above and beyond the Norms.

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