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Foundation of a Reinforced Concrete Arch Bridge

Fondations d'un pont en arc, en béton armé

Fundation einer Stahlbeton-Bogenbrücke

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FOUNDATION OF THE REINFORCED CONCRETE ARCH THE SPAN OF 390 M

The bridge connecting the Yugoslav Coast with the Island of Krk, in the Adriatic Sea, consists of two reinforced concrete arches over which a prestressed concrete superstructure is to be installed.The appearance of the bridge is shown in Fig.1.

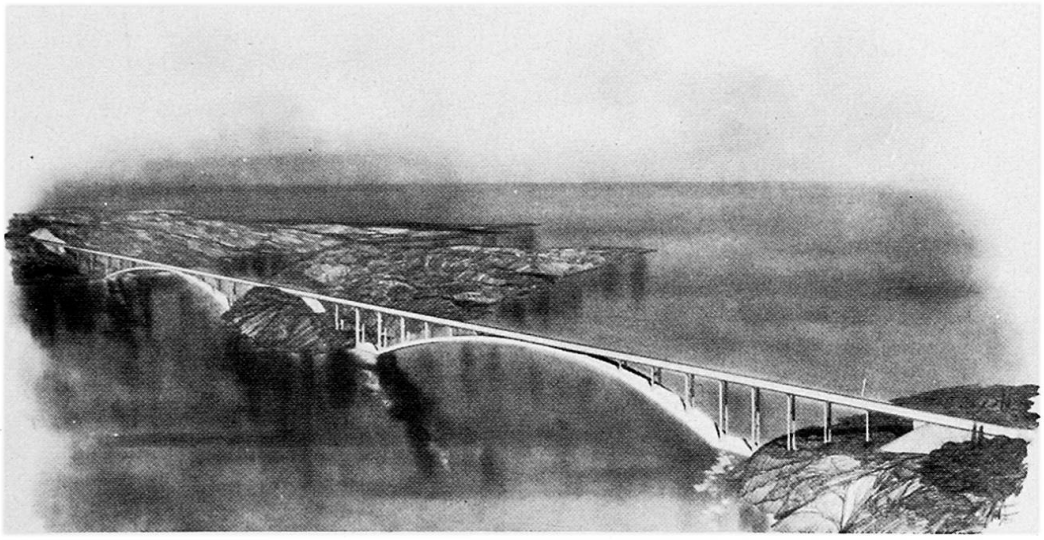

FIG. 1

The reinforced concrete arch over the smaller opening has the span of 244 m, and the arch over the larger one, has 390 m between two supports.As the distance between two shores in this opening is much longer, over 460 m, two arch supports shall be partially founded in the sea,in order of reducing a span,as shown in Fig.2 .

The arch reaction (of approximately 14.000 t) has been distributed to the filled oblique pier founded in the sea (transferring 9.000 t to the rock),and to the nearly horizontal box structure above the sea level that transfers to the coast rock mass the other component of the arch reaction (6.000 t),and the arch bending moment originated from the bridge loading.

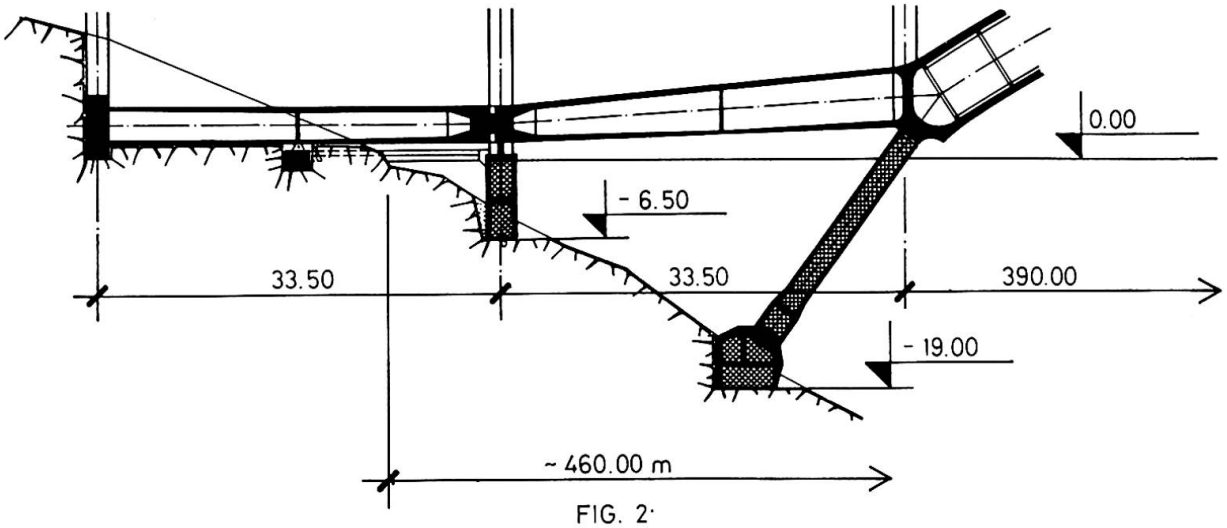

FIG. 2·

The bridge construction works are being performed by "The Civil Engineering Enterprise Mostogradnja " from Beograd, Yugoslavia,according to its design.

The process of foundation works shall be revealed through the construction stages.

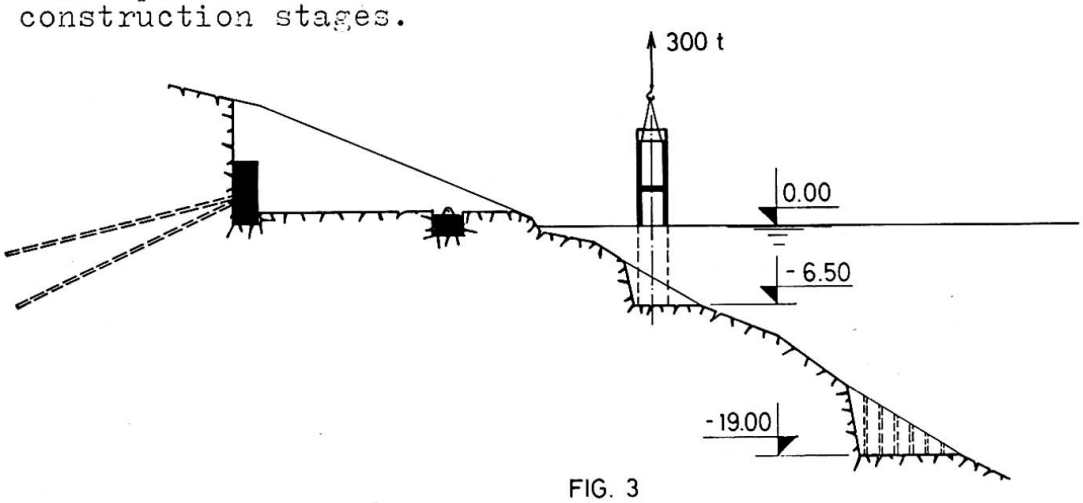

FIG. 3

To mine and excavate the limestone at the places of the arch foundation,was the first step to be executed (see Fig. 3.). The sea boreholes have been prepared operating from a floating device and the explosive installed by the divers. The excavation of material has been executed by the excavators. Finally, a team of divers has accomplished the leveling and clearing operation of the foundation bottom at the level of -6,5o, i.e. -19,oo m under the sea surface, performing corrective mining where it was necessary.

Upon completion of excavation on the shore the anchors shall be fixed into the rock, in the lenght of 2o,oo m. The cables consisting of 24 steel wire cords, ⌀ 7 mm,shall be installed in the bores,diameter of 1o5 mm. The entire anchor force of 3800 t shall be then applied to concreted lateral footing.

Simultaneously to the excavation,affixing the anchors into the rock and cocreting of the foundation onthe shore,there shall be prepared a hollow pier structure devided into the appropriate compartements,with a caisson chamber in the bottom part. Concreting is to be executed at the site auxiliary quay where it shall be transferred from,to the sea,by a floating crane, the bearing capacity of 36O t, and installed in the bottom.

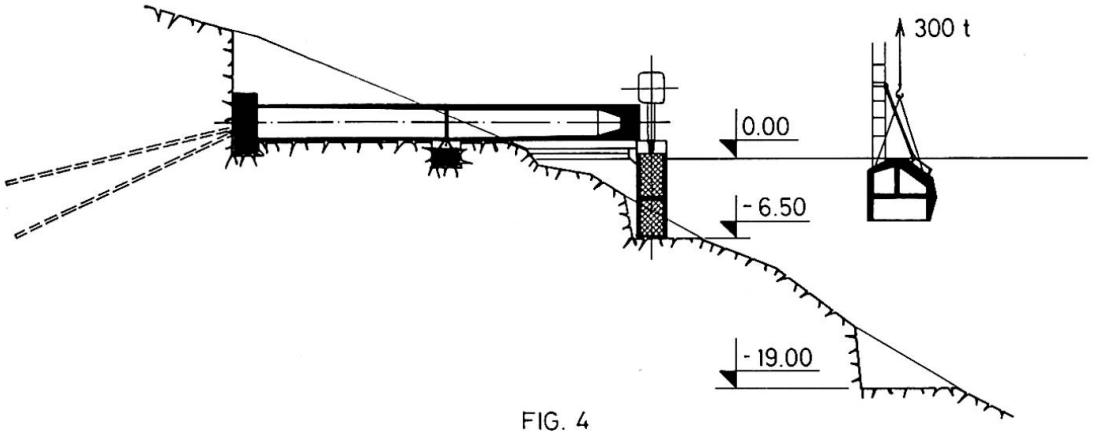

FIG. 4

When placing in its position, the pier shall be connected to the foundation on the shore by a couple of prefabricated concrete ties,thus determining its precise position. Having the protection of compressed air the level of the pier has been regulated by four hydraulic jacks installed in the corners of the caisson chamber.

Concreting of the hollow pier compartments has been planned to be performed upon completion of clearing the soil in the caisson bell (see Fig. 4.).Providing the protection of compressed air,the first step was to concrete in a caisson bell and subsequently the upper part of the pier,performing the concreting operation in waterless space having the water previously exhausted.

Concreting of the horizontal box structure, extending from the pier to the foundation block on the shore, shall be accomplished simultaneously to the above described.This structure shall be prepared, by prestressing,to accept and transfer to the anchors,which are fixed in the rock, the tensile stress occuring in it, prior to assembling of the reinforced cocrete arch.

Together with these works the caisson bells for the arch oblique pier foundation shall be concreted.This shall be performed on a floating platform provided with self-sinking and floating mechanism. The bells should be lowered until the entire body is immersed as their original weight of 300 t, shall then be considerably reduced (up to 140 t, due to existing air in the upper compartments),thus facilitating their transfer and placement by the crane to the previously prepared ground at the level of -19,oo m from the sea surface.

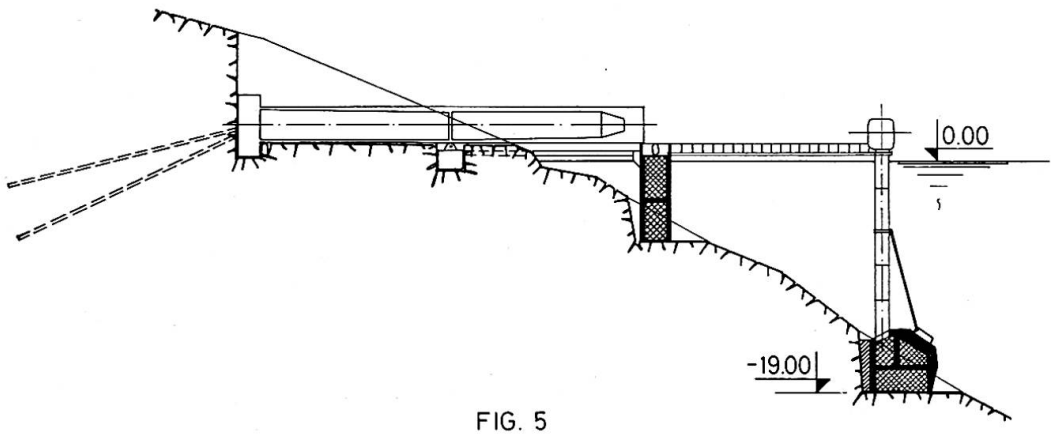

FIG. 5

The caisson bell should be placed on the bottom along with a pair of caisson tubes (see Fig. 5.). These tubes are coupled transversely and their longitudinal position affixed by the obliquely arranged steel bars and by the steel structure of the approaching bridges, thus affixing the position of the caisson bell itself. The foundation level is controlled by the hydraulic jacks installed in the corners of the caisson chamber.

Completion of excavation intended to level and clear the terrain underneath the caisson bell should be followed by concreting of the foundation cavity. The chamber is to be filled with concrete under the protection of compressed air and the upper compartments through the caisson tubes as the water has been previously pumped out from those and the hardening of the concrete in the lower chamber has progressed sufficiently.

The hollowed area next to the caisson, toward the rock mass, should be filled with concrete by the application of the contraction method, for the purpose of confronting with the horizontal component of reaction originated from the arch oblique pier.

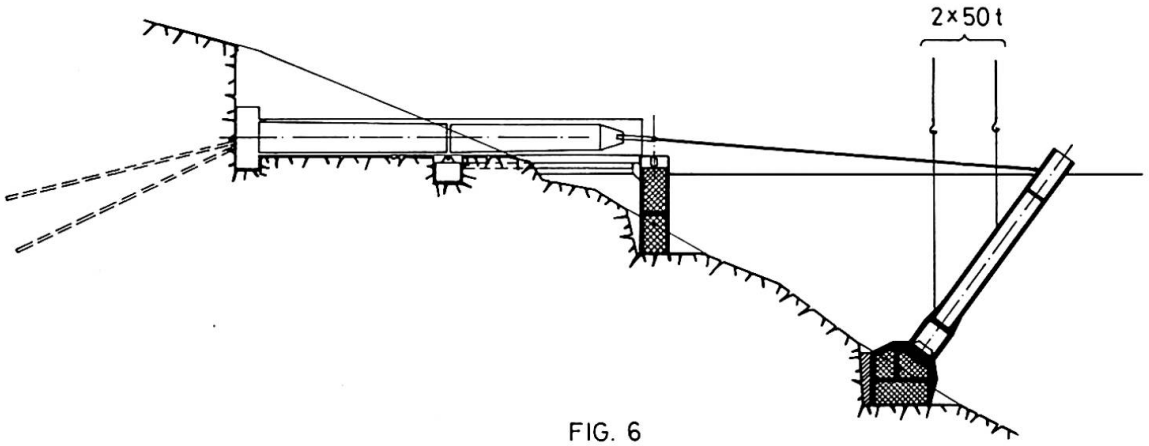

FIG. 6

At the same time the excavation in the caisson bell is being performed, followed by the pouring of concrete into the oblique pier foundation cavity, the oblique pier box structures should be as well concreted, on the same floating platform upon its floating out to the surface. By sinking the platform the oblique piers should be transferred by the floating crane to their determined positions (see Fig. 6.). The cavities in the pier penetrated by air are designed in a manner to reduce its weight, after being immersed, to the rate suitable for the installation operation. Affixing of the oblique pier into,by the design predicted position, should be accomplished attaching the temporary steel ties equiped with the device for the adjustmeht of their length.

Upon sealing the joint of the pier bottom and foundation by the application of the epoxy resin,concreting of the pier hollow body should be commenced in waterless conditions. The chamber next to the foundation is the first to be filled with concrete, and then, one by one, the other compartments after the water has been pumped out.

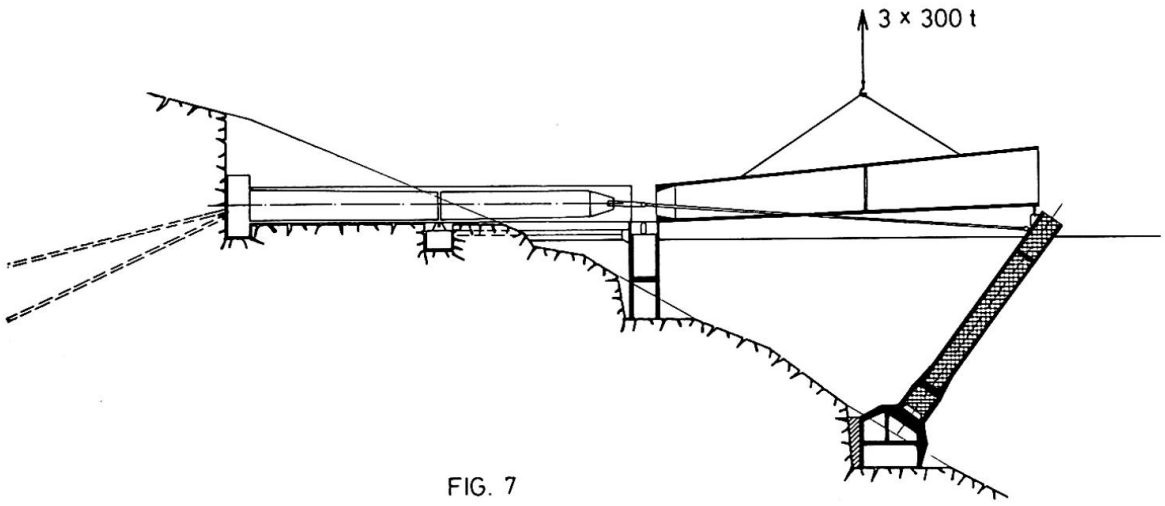

FIG. 7

After that the box structure,prefabricated on the shores in three segments (300 t each), has to be assembled above the arch oblique pier by the floating cranes (see Fig. 7.).Upon completion of assemblage, their transversal and longitudinal joints should be concreted too.

The supporting blocks are the last to be concreted, that is to say the concreting shall be performed above the pier,as well as the joint of the oblique pier and horizontal box structure at the place where the reinforced concrete arch is leaning (see Fig. 8.).

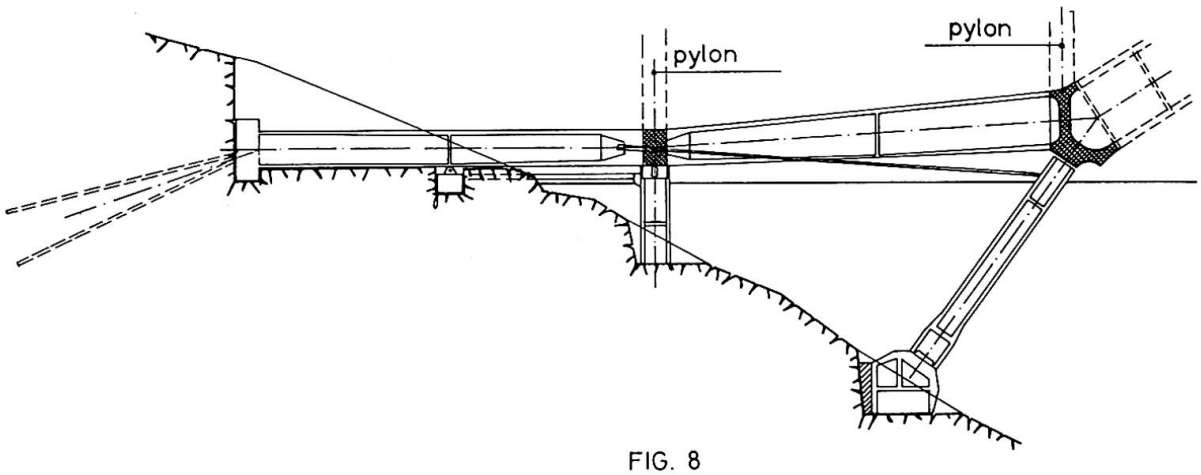

FIG. 8

Further,construction of the object should be continued upon estabilishment of this structure designed for the purpose of transfer of the arch reaction to the ground. Applying a sliding shuttering,the piers determined to sustain the superstructure in the final stage, are to be concreted as the first.In the arch construction they shall serve for suspension of the auxiliary steel ties, which, on the other hand, carry the suspendingly installed arch consisting of prefabricated reinforced concrete elements.

The installation of the arch has been predicted to begin in the early 1977.

SUMMARY

The foundation of a reinforced concrete arch bridge is described. The arch's reaction is transmitted to the ground through a horizontal box structure and an oblique pier, founded 19,00 m below the sea surface. The greatest part of this foundation structure will be composed of prefabricated reinforced concrete elements, which will be placed into the final position by a floating crane of great bearing capacity.

RESUME

Les fondations d'un pont en arc, en béton armé sont décrites. La réaction de l'arc est transmise au sol par l'entremise d'une structure en caisson horizontale et d'une pile oblique fondée à 19 m au dessous du niveau de la mer. La plus grande partie de la structure de fondation est composée d'éléments préfabriqués en béton armé, qui sont mis en place à l'aide d'une grue flottante de grande capacité.

ZUSAMMENFASSUNG

Die Fundation einer Stahlbeton-Bogenbrücke wird beschrieben. Die Bogenreaktion wird durch ein horizontales Kastentragwerk und einen Schrägpfeiler in den Baugrund geleitet. Die Fundamentkonstruktion liegt 19 m unter Meereshöhe. Der grösste Teil der Konstruktion besteht aus vorfabrizierten Stahlbetonelementen, welche mittels eines Schwimmkrans an Ort und Stelle versetzt werden.