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Concept: Arc-in-tension Bridge

A method for elevating and building arc bridges in a single movement, based on the idea of applying tension at the same time to all the individual sections of the arc.

not to be patented

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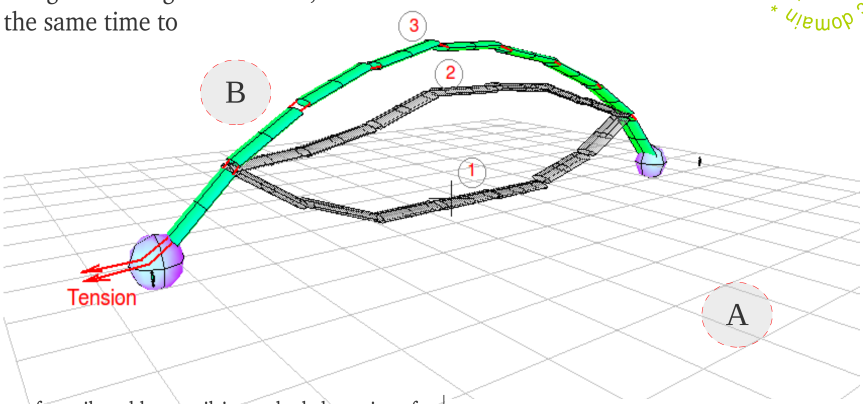

1. Introduction

When an arc of a big bridge is being built, everyone is impressed by the extraordinary amount of mass being elevated against gravity in that process. There are several methods for achieving this in practice, but most of them rely on a continuous process of measuring and compensating the torque induced in the structure at each phase, in order that the net result will always be null, at any instant of time. Arc bridges can be loaded in basically two ways: into *compression*, or into *tension*, as next figures suggest. This characterizes the way the *bridge's deck* is to be suspended from the ground. In the first case the weight of the deck (and its traffic) is transferred into the arc by means of a compression process, while in the second case it is done by means of a process of tension.

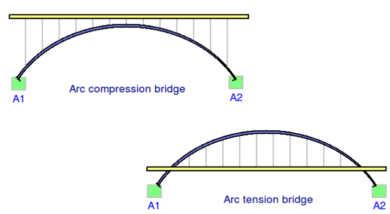

Fig 1. Compression and tension arc bridges

During construction, however, in both cases the elevation of the arc is the primary objective and this is usually the biggest challenge in the construction itself.

The emblematic *Arrábida bridge* (Porto, Portugal, 1963), was for me the first inspiring bridge on the elevation and construction of a *béton* arc between two places distanced by around 600 meters, across the *Douro* river. As is represented in the next figure, after the elevation of the first two lateral sections of the mould of the arc by means of the usual process of construction, a third and central section of this arc (also a mould), previously installed on boats at the centre of the river, was elevated directly from the river by means of tensile cables, until it reached the point of being able to be joined to the lateral sections. These cables were obviously capable of supporting the weight of the central structure.

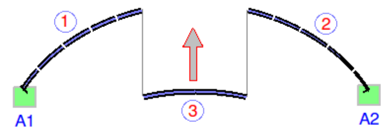

Fig 2. Process of building the mould of the arc of the *Arrábida bridge*, Porto, Portugal, 1963.

Once this operation was finished, *béton* was finally be injected into the structure and the final arc built.

2. Arc-in-tension, the new proposal

The proposal presented herein, which I have named the "arc-in-tension" method, gets its basic principle from the fact that the resistance of a structure, like in the molecular world, comes from an internal mechanical tension, and from how such a tension is distributed throughout the structure. It is therefore an idea that stems from the microscopic world and is being extrapolated to the world of civil engineering. And it makes possible the elevation of the whole arc of a bridge as a single and complete structure, at the same time.

The first aspect to have in mind is that the arc must be divided into a reasonable number of unit sections previously interconnected to each other, perfectly aligned by means of at least two cables, as the next figure suggests. These little unit sections, once aligned, will naturally build up the structure of the mould of the arc, where later the *béton* will be injected. This structure may first of all be mounted at the ground level, between the two sides of the bridge. Its elevation will be made by means of a slow application of an increasing tension between its sections. I wonder if *Arrábida bridge* could not have been built by means of this method...

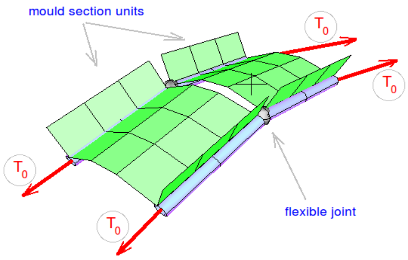

Fig 3. An example of the connection of two mould section units by means of tension (T_0).

This tension can be applied to the cables by several methods, but the simplest way is to use a mobile support at one end of the bridge, while the second support is maintained fixed. This obviously implies some extra space available perpendicular to the bridge, but this space is only needed during the process of construction, as shown in the next figure.

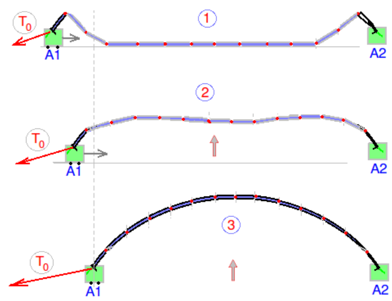

Fig 4. Three distinct phases in the process of elevating the mould structure of the arc, by moving the support A1.

The mobile support (A1) could be a giant block of *béton* that would slowly be made to move along rails, thereby tensing the cables step by step till the moment that the arc becomes completely elevated to its proper position. After that, the mobile support will be made fixed and the *béton* injected into the structure of the arc.

By J. Manuel Feliz-Teixeira

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