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Cable Mounted Bridges: a New Approach in Construction of Long Bridges

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Summary

Design and construction of bridges across deep valleys have always been a challenge for engineers. Construction process of these structures usually requires interference and access to the valley, incurring large cost and causing potential damage to the environmentally delicate regions. In this paper a technique is proposed to keep the valley's underneath unobstructed and to reduce the cost of the bridge. In this method, each prefabricated longitudinal segment of the bridge would be consecutively mounted on a system of cable-set across the valley and it will be placed on its final position by a wrench mechanism. Construction cables in this approach are arranged to be used later as the main pre-stressing tendons for the bridge. The cost of the structure in this method is reduced not only because of the cost effective constructional procedure but due to the effective use of structural materials in the bridge system.

1. Main concept

In cable mounted bridges, a system of cables across the valley is used to support the construction process from the above. This cable-set is mainly composed of two or more horizontal (or inclined) parallel cables, stretched from one side of the valley to the other. The deck of the bridge consists of longitudinal prefabricated segments. Each of these them, mounted on a special cart, will be pulled along the cable-set by a simple wrench mechanism located on the opposite side of the valley. When all segments are in their final position, the anchorage of supporting cables from the valley will be transferred to the deck of the bridge and pre-stresses all the segments together. In the construction procedure there could be some other supporting cables to stabilize the process of construction but they are considered as temporary and minor components of the system. Fig.1 illustrates the process of construction while Fig.2 shows a panoramic view of a completed bridge.

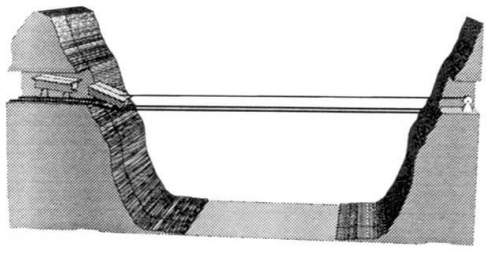


Fig. 1 - Construction process

2. Construction procedure

Construction begins by installing a set of tightly stretched cables across the valley. The tilt and height of every pre-fabricated longitudinal segment of the bridge must be set accordingly (based on a preliminary calculation regarding the final position of each segment and deformation of cable-set at that position). When the last segment of the bridge enters onto the cable system, all the segments are positioned consecutively with a small apparent misalignment with respect to each other. In order to construct the deck of the bridge, an accurate alignment of all the bridge's segments in a horizontal line is required. Since pre-

setting of tilt and height of the carts can not guarantee an accurate alignment between bridge's segments, the adjustment mechanism implemented in each cart system must be used to reposition each segment and to reach to a precise alignment between all segments of the bridge. Figure 3. Shows one example of an adjustable cart. In such a simple mechanism, a person walking on top of the deck will be able to easily adjust the height and tilt of each segment of the bridge.

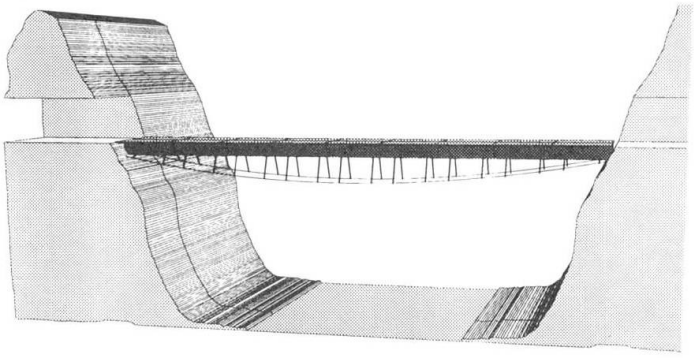
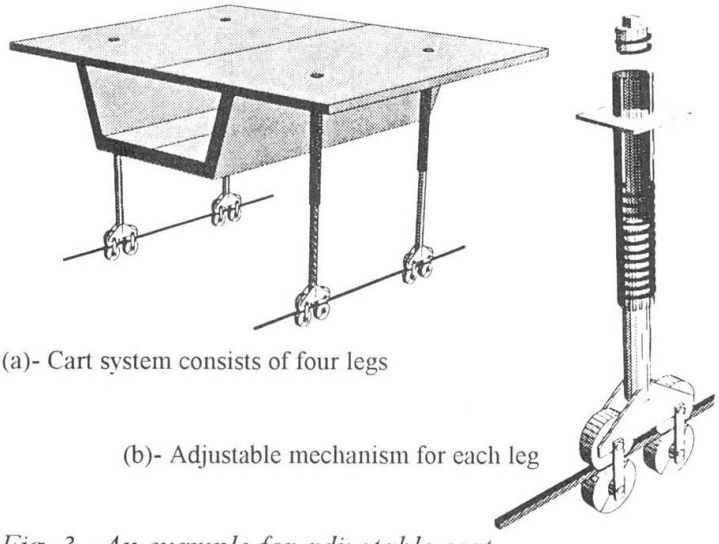


Fig. 2 - An artistic view of a completed bridge.

To establish connectivity between all segments of the deck system a few pre-stressing tendons is required. These tendons passes through all segments of the bridge and provides a small pre-stressing force on the deck and connects all the segments together. At this phase, if by a sophisticated mechanism and/or procedure, the anchorage of cables to the valley transfers to the deck of the bridge, there would be a large axial force on the deck which effectively pre-stresses all the segments together. Having a large axial force on the bridge provides enough bending moment capacity to the deck to resist the effects of live loads. The bridge system at this point is considered as a classic example of a post-tensioned bridges.

3. Advantages

In this approach there is no need for heavy equipment in the construction process. The construction procedure is also faster than other techniques because of the use of prefabricated segments and the routine process of installation of each segment on the cable-set. Another important feature in this approach is the fact that, most of the construction components of the bridge system can be used as permanent parts of the bridge. The cable-set will be used directly as the main post tensioning tendons for the bridge and components of the cart system can be used as permanent parts of the bridge system. This technique can also be applied to multi-span bridges without any major modifications.



(a)- Cart system consists of four legs

(b)- Adjustable mechanism for each leg

Fig. 3 - An example for adjustable cart

Cable mounted approach although is considered predominately as a cost saving construction method, but it also offers some structural benefits. In this approach there will not be any dead load bending moment in the deck of the bridge and all the dead loads in the system is carried by tension in cable-set and compression on the deck of the bridge (i.e., in the most efficient way, truss action).

3. Technical notes

In the process of construction any unbalanced load in the cable set (also on the deck of the bridge) may cause unprecedented forces, not sustainable by the bridge system. Therefore tensile force in the cable system must be carefully monitored and continually adjusted during the construction procedure. The anchorage of cable-set to the valley during construction is another major concern in this technique. It is obvious that the magnitude of tensile force in cables is enormous and transferring this force to the valley needs careful preperation.