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Characteristics of Technology Development in the Akashi-Kaikyo Bridge Project and Proposal for Cost Reduction in Future Projects

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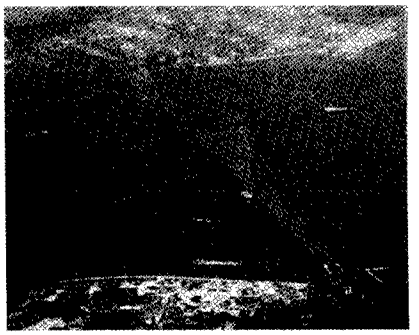
1. Objective

According to the ENR (1), the Akashi-Kaikyo Bridge project costs about four times as much as the Great Belt Link East Bridge project in Denmark (2). Even though we understand that construction costs reflect differences of load conditions like earthquakes, it is very difficult to explain the magnitude of these project costs without explicitly considering additional aspects, such as regulations, existing technology levels, availability of resources, and other local conditions. In our research, we select eleven long-span bridge projects around the world and identify key technology developments in each project and their impact upon construction cost and duration. In this paper, we introduce results briefly related to the Akashi-Kaikyo Bridge project.



Source: http://www.hsba.go.jp/bridge/e-akasi.htm

Fig. 1 Akashi-Kaikyo Bridge

2. Key Technology Development for the Akashi-Kaikyo Bridge

Based on a wide range of papers and interviews with many engineers on the project, we identify following three key technology developments for the Akashi-Kaikyo Bridge project:

- Desegregating Underwater Concrete (3) for building foundations in the deep water more than 50m;
- Self-Compacting Concrete (4) to shorten the construction schedule of anchorage;
- High Strength Wire (1,800 MPa) for main cables (5) to sustain girders.

3. Characteristics of Technology Development in the Akashi-Kaikyo Bridge Project

a) Design

Design of the Akashi-Kaikyo Bridge and others in the Honshu-Shikoku Bridge project are based on a traditional US design, such as the Verrazano-Narrow Bridge in the US completed in 1964, with steel pylons, steel truss-girders, and expansion joints at the pylons and anchors. The decision to use this traditional design was influenced by the experience and capabilities accumulated by the Honshu Shikoku Bridge Authority (HSBA). The HSBA had initiated a set of projects for relatively short-span bridges at the end of 1970's, and then committed itself to building the world's longest suspension bridge. During this period, some innovative technologies, such as a box-girder design, were developed. However, the HSBA did not adopt these new designs or technologies for the Akashi-Kaikyo Bridge project because first, many of these innovations did not meet the specified criteria in their test results, and second, the HSBA engineers had no experience with innovations.

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b) Wide Rage of Collaboration

The strength of Japanese technology development system can generally be described as close collaboration among the Owner, contractors, material suppliers, and universities. One good example is the development process of the Self-Compacting Concrete. Its prototype was developed by Professor Okamura et al., and matured by a project team composed of various firms under the direction of the HSBA.

c) Field of Strength

As shown above, the key technology developments for the Akashi-Kaikyo Bridge are mainly related to new materials. To enhance productivity and cost reduction, development of complimentary capabilities in design and method are desired.

d) Others

In contrast to the close collaboration among Japanese firms, no foreign firms participated in the beginning stage of Akashi-Kaikyo Bridge project, i.e., during the design and technology development process.

4. Recommendation for Cost Reduction

a) Loosen Regulatory Constraints

In many cases, there are detailed regulations that strictly define construction procedure in the Japanese construction system. In a long-span bridge project like the Akashi-Kaikyo Bridge, there still remain rooms for improvement. To encourage all participants to propose their expertise for cost reduction, flexible management for selecting methods and equipment are essential. To prevent troubles, careful selection of participants and strict quality management by the Engineer are indispensable at the same time.

b) International Collaboration

Collaboration with foreign experts during the conceptual and early design stage is highly recommended. For example, two long-span suspension bridges, the Great Belt Link East Bridge in Denmark (1998) and the Tsing Ma Bridge (6) in Hong Kong (1997) have unique characteristics, such as box-girders, a hydraulic buffer at anchorage, a multiple girder erection method, and others design and technology innovations. The design and construction teams for these bridges have particular strength in the field of design and method, and it can be highly advantageous to exchange knowledge and design approaches within the international professional community.

c) New Designs, Methods, and Materials

In the Akashi-Kaikyo Bridge project, the HSBA tried to overcome all kind of difficulties by adopting new materials. This strategy worked extremely well to accomplish the primary objectives, but also resulted in a high overall project cost, in large part due to the higher costs associated with the production and use new materials. For future projects, we believe that substantial cost reduction is possible by improving the design process, effectively using standard materials, and developing cost effective methods for new materials and designs.

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