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Anti-Washout Concrete and Highly Workable Concrete

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Summary

The foundations of the Akashi Kaikyo Bridge are enormous concrete structures, and the natural conditions under which they had to be constructed were without precedent. A special anti-washout concrete and highly-workable concrete were developed and used, respectively, for the main tower foundations constructed in the Akashi Strait and the anchorages on either shore.

1. Development and Use of Anti-washout Concrete

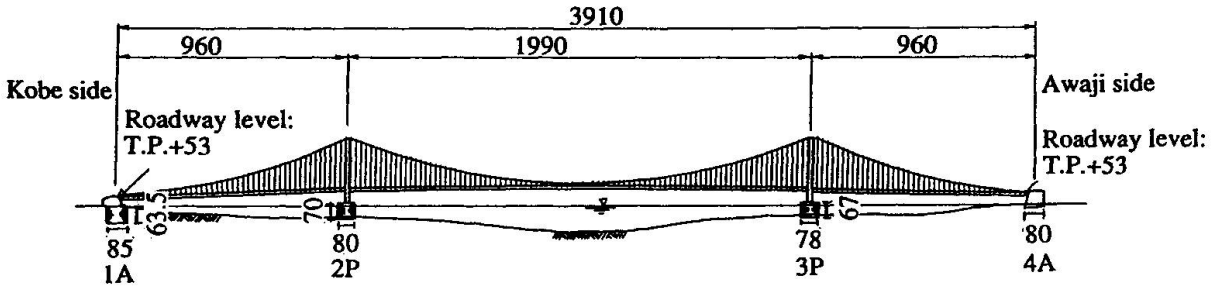
The two main-tower foundations were constructed in currents of up to 4 m/sec. by the laying-down caisson method. Anti-washout concrete was cast into the caissons. This type of concrete was first introduced into Japan between 1975 and 1984, and is made by adding an underwater anti-washout admixture and a superplasticizer to ordinary concrete. This provides it with excellent anti-washout properties as well as self-leveling characteristics. With a total of 264,000 m^3 of concrete needing to be cast in 30 operations, or about 9,000 m^3 per casting, for the main-tower foundations (2P and 3P), it was necessary to develop a new method of casting such massive amounts of concrete at speeds far in excess of conventional capabilities. Regarding the quality of the concrete, the challenges faced were (i) to minimize strength loss while retaining an adequate anti-washout property and flowability for many hours even after flowing through a long placing system; (ii) to look into reducing cement content, using low-heat cement, and using a precooling facility to prevent thermal cracking; and (iii) to calculate the lateral pressure that would act on the steel caissons (which functioned as forms) and study methods of controlling the pressure. After overcoming these challenges, concrete casting for the 2P and 3P foundations was successfully completed in October and December, 1990, respectively.

2. Development and Use of Highly-Workable Concrete

The arrangement of steel reinforcement, structural steel, and anchor frames securing the main suspension bridge cables is extremely complex, and difficulties were anticipated in casting good-quality concrete into the two anchorages, 1A and 4A. To achieve adequate quality control in pouring large quantities of concrete into sections with dense arrangements of steel, the authority developed a highly-workable concrete using low-heat generating cement. This low-heat generating concrete is highly flowable and has desegregation and good filling properties.

There are various methods that can be used to make concrete more flowable. In this case, because a special plant was to be built for the purpose and as a result of economic considerations, it was decided to secure flowability and the desegregation property by adding an AE water reducing agent while at the same time replacing some of the aggregate with a fine limestone powder to increase the powder content.

The introduction of this highly-workable concrete made it possible to cast 140,000 m^3 of concrete into anchorage 1A (on the Kobe side) in just 18 months and 240,000 m^3 into anchorage 4A (on the Awaji side) in 31 months. Use of this concrete achieved a labor-saving of about 30-40% in the casting work. This effort demonstrates that highly-workable concrete using low-heat cement can effectively reduce construction periods, offer manpower savings, and ensure good quality.



T.P.: Mean sea level of Tokyo Bay

Fig. 1 Elevation of Akashi Kaikyo Bridge

Table 1 Concrete volume (unit: m^3)

	1A	2P	3P	4A
Underwater anti-washout concrete	-	260,000	240,000	-
Highly-workable concrete	140,000	-	-	240,000
Others	380,000*1	90,000*2	80,000*2	-

*1 Concrete for RCC and earth-retaining wall

*2 Non-underwater concrete