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Outline of Minami-Bisan-Seto Bridge

Weight	(Truss)	39,260ton
	(Cable)	23,840
	(Tower)	18,990
	Total	82,090

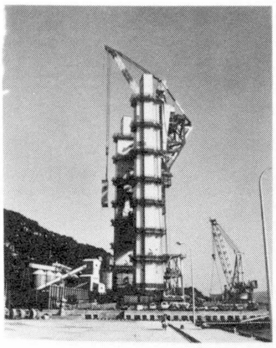
CONSTRUCTION OF SUSPENSION BRIDGE

Honshu-Shikoku Bridge Authority

Erection of tower

Compressive force of tower shaft is designed to be transmitted by friction bolt and direct metal contacts by 50% each.

To assure this designe policy, end surface of three blocks of tower shaft was finished by facing machine. At the erection site the ratio of metal contacts was inspected using gap gauge, and the ratio was confirmed at inspected points.



Erection of tower

Erection of cable

To control the accuracy of main cable of suspension bridge, it is important to adjust the length of each strand.

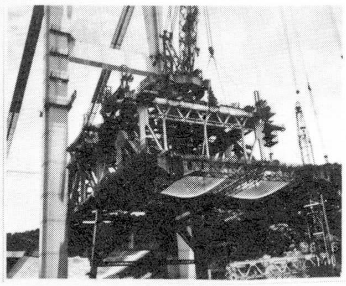
In fabrication, the length of each strand is determined by the gauge wire which was measured correctly. At the site, the hight of 1st strand was measured careflly and adjusted to the right position.

The hight of other strands were adjusted to this standard strand. These adjustment should be done at around midnight when the temperature of each strand were uniform. The void ratio of main cables, which indicates how the wires were compacted, are within 20% as specified.

Erection of cable

Erection of suspended structure

To erect the stiffening truss, the panel members which is assembled at the shop are connected tightly each other so as to keep stiffness of erected truss. When the stiffening truss is connected to the suspended ropes, oil jacks are set at three panel points for each side of truss in order to distribute the tensile force of suspended ropes. At several steps during erection, the hight, torsional deflection, and others will be measured to confirm the accuracy comparing measurement and calculation.



Erection of stiffening truss

Construction of Suspension Bridge in Honshu-Shikoku Bridges Project

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1. Introduction

There are eleven suspension bridges to be constructed in the three routes of the Honshu-Shikoku Bridges project. Of these, the Akashi-Kaikyo Bridge of the Kobe-Naruto route and the six suspension bridges of the Imabari-Onomichi route are for highway use only, while the other suspension bridges are for combined highway and railway use. The Ohnaruto Bridge is designed to allow the passage of Shinkansen trains in the future. The three suspension bridges of the Kojima-Sakaide route are also designed to allow the passage of Shinkansen and ordinary type trains. However, only ordinary type trains are scheduled to be constructed at the present stage.

2. Construction of Superstructures of Suspension Bridges

(1) Tower Construction

1) Tower fabrication

All towers for the suspension bridges of the Honshu-Shikoku Bridges Project are made of steel. The towers are divided into blocks of about 10m length, each block being constructed of three cells. At the tower joints friction bolts are used, and the design is such that 50 % of the axial force is transmitted by direct contact with the end faces of the members. To secure this design prerequisite each cell fabricated at the plant was temporarily assembled and finished using an end facing machine.

2) Erection of tower

Prior to the erection of the tower shaft, the surface of the top of the pier was polished using a concrete grinder, to ensure the perpendicularity of the tower when completed.

The erection of each block of the tower and the installation of the various members, such as diagonal members, horizontal members, etc. was performed using a creeper crane which was mounted on a guide rail attached to the tower column already installed. As each block was erected the metal contact ratio was inspected and confirmed for the required quality. Also the perpendicularity was measured and when necessary a correction was made when erecting the next block to offset the previous error.

(2) Construction of cables

1) Wires for cable

For all cables of the suspension bridges parallel wires of about 5 mm in diameter were used. The quality required of this wire is specified in the Honshu-Shikoku Bridge Standards. In strength of wire testing methods for each item and criteria for judgement, etc. are provided. The breaking strength is required to be in the range of 160 kg/mm^2 -180 kg/mm^2. Each wire is galvanized to keep it from corrosion. The diameters of the wires vary depending on the bridge, which is in the range of 5.10 mm to 5.37 mm. In the PWS method, strands consisting of 127 wires are fabricated in the shop. The length of the strand is controlled using a gage wire prefabricated to the required length which is marked and placed at one corner of a regular hexagon. Colored wires are placed on the other corners facilitating inspection of twists in the strand at the site.

2) Installation of cables

There are two methods of constructing cables for a suspension bridge. One is the aerial spinning method (AS method) and the other the prefabricated parallel wire strand method (PWS method). Five of the six suspension bridges constructed to date in the Honshu-Shikoku Bridges Project were constructed using the latter method. The only example of using the AS method was the installation of cables for the Shimotsui-Seto Bridge, in which case the tunnel anchor method was used. If the cable has the same number of wires the area for connection can be made more compact, which was the reson that the AS method was used.

It is important that the cables for suspension bridges be installed at the required height, as this governs the configuration of the bridge when it is completed. However, the height of the cables cannot be adjusted after all the strands are installed, therefore surveys and adjustments were made during the installation of the strands to insure the accuracy of the bridge height when completed. To make sure the first strand was installed at the required height a survey was conducted and necessary adjustment was made, which was performed by sliding the strand at the saddle of the tower or the anchorage. Using this first strand as a basis, the height of the second and subsequent strands was adjusted. When about 1/3 and 2/3 of the strands were installed the heights of the cables were surveyed, confirming their accuracy.

The adjustment performed as mentioned above also contributed to the alignment of the strands in the cable, helping to meet the required void ratio for the cable after clamping.

The maximum void ratio of the cable is specified at about 20%. The larger the ratio, the more wires are crossed, suggesting that there may be a possibility that the strength at the crossing will become lower.

(3) Construction of girder

1) Structure of stiffening girder

The stiffening girders of the suspension bridges of the Honshu-Shikoku Bridges consist of steel trusses, except for one case where a steel box girder is used. This is mainly to increase the stability against wind. In this regard the sectional configurations of the stiffening girders were determined after wind tunnel tests had been performed.

2) Erection of stiffening girder

There are two methods of installing stiffening girders for suspension bridges. One is the method in which the stiffening girder, assembled to a designated length, is directly lifted at the installation location using a lifting device attached to the cables, i.e. the block erection method. The other is the method in which individual members are installed in sequence by overhanging from the towers to the right and left. In general, the former is considered advantageous, however, in the light of the situation that the straits across which the Honshu-Shikoku Bridges are to be constructed are congested navigation routes and the use of sea surface below the girder is limited, most of the bridges of the Honshu-Shikoku Bridges Project use the latter method.

The controlling of the configuration of the stiffening girder is accomplished by test assembling it in the shop and confirming the accuracy of the dimensions of each members. At the site various surveys (displacement, torsion, stress conditions, etc.) are performed at several steps during erection and confirmation of the installation accuracy is made. Under normal conditions, however, no adjustment would be required at the site as no significant errors can occur during the erection.

(4) Conclusion

The quality control in the construction of suspension bridges can be classified roughly into three items, as follows:

o Quality control of materials used---strengths of steel materials, thickness and flatness of steel plates, quality of point, etc.

o Quality control in shop fabrication ---accuracy of dimensions of members, inspection of welding, working conditions and thickness control of painting, etc.

o Quality control at the construction site--- measurement of configuration when installed, etc.

To ensure the quality of an overall bridge it is important to confirm that at all these stages the required standards as provided for in the HBS are met. This importance must be emphasized in the light of the fact that once the work proceeds to the next stage there are many items that can no longer be corrected.