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Adaptability of Precast Block System in Prestressed Concrete Bridges

Faculté d'adaptation d'éléments préfabriqués dans la construction de ponts en béton précontraint

Anwendbarkeit vorfabrizierter Teile in Spannbetonbrücken

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The adaptabilities of construction methods using precast blocks are discussed based on performances in construction of prestressed concrete railroad bridges.

Yoneshirogawa Bridge — This bridge, as shown in Fig. 1(a), is a single-track railroad bridge consisting of two box-section, three-span continuous girders with each span 56.3 m in length. As the main girders were erected during the low-water wintertime, stagings were provided for the entire length with blocks of 5 ~ 2.6 m arranged on the stagings and joint mortar packed between the blocks followed by transfer of prestress. This construction method can be adopted only in cases of rivers at which it is possible to build stagings.

Nadachigawa Bridge — This is a 4-track railroad bridge of two box-section, simple beams of 31.2-m spans as indicated in Fig. 1(b). Precast blocks 1.85 ~ 1.3 m in length were joined with epoxy resin near the bridge site after which prestress was transferred to form single girders and these were drawn out with a gantry crane travelling on rails. This system is practicable only when there exists a suitable open space near the bridge site for joining of blocks. Also, it is not applicable except for cases of relatively short spans.

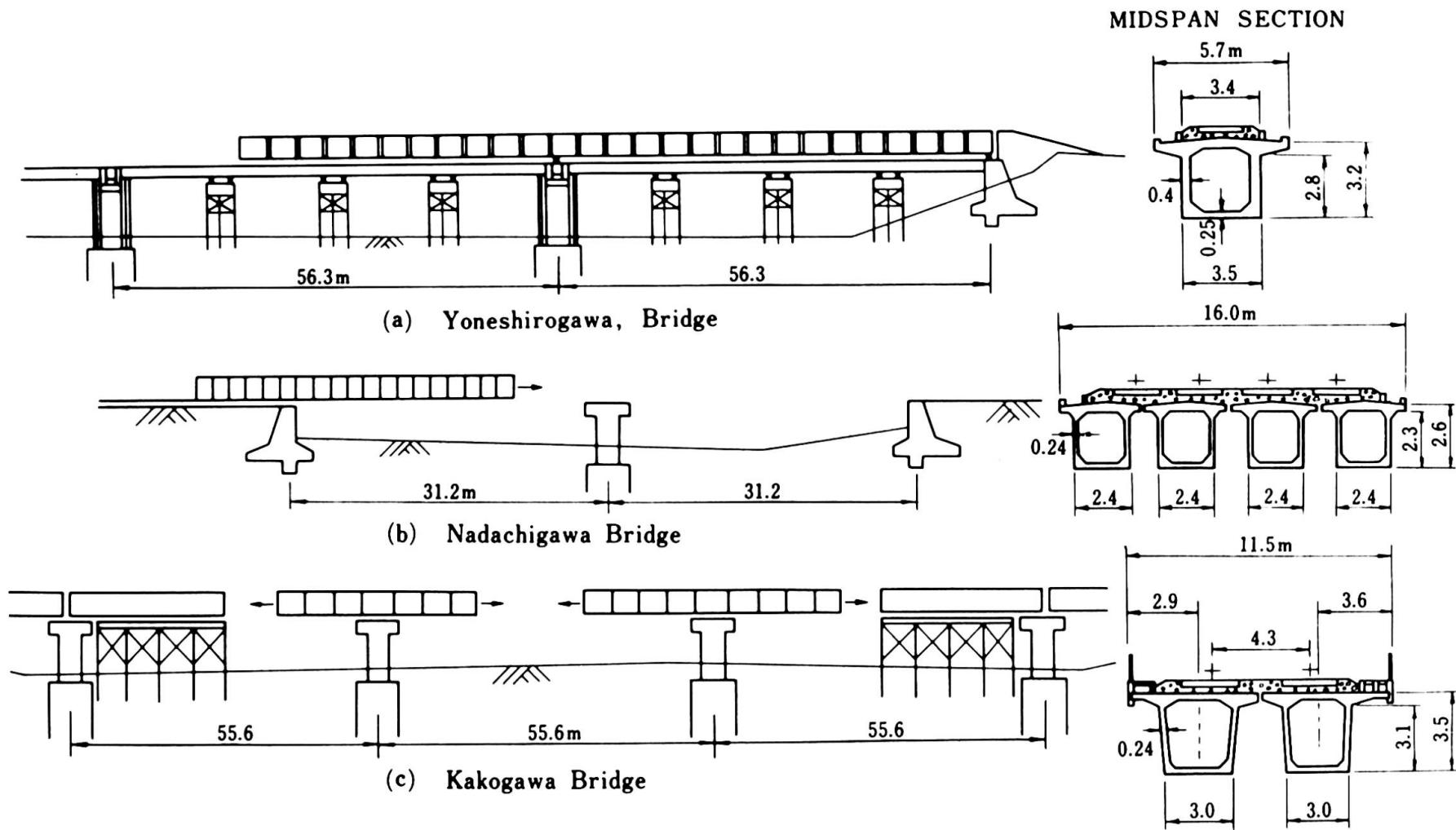


Fig. 1 — Erection methods of main girders in 3 types of railroad bridges and transverse sections at midspans

Kakogawa Bridge — As shown in Fig. 1(c), this is a double-track railroad bridge consisting of three box-section, three-span continuous girders with each span 55.6 m in length constructed for the New Sanyo Line between Osaka and Okayama. As stagings could be provided for one-half of each of the side spans, these parts were constructed with cast-in-place concrete, but the remainder was of precast blocks 4 ~ 3 m in length joined in sequence by cantilever erection. Cantilevering is the only method of bridge erection with precast block adaptable for cases of long spans.

When building a prestressed concrete bridge, whether it would be advisable to adopt a system of cast-in-place concrete or a system using precast blocks, and in the case of precast blocks, which of the erection systems would be best are matters for careful decision taking into consideration the various conditions, and it is impossible to indicate the superiority of any one system in a general way.

Based on the performances in construction of the 3 bridges described above, the comparisons of construction periods and pure construction costs of superstructures of prestressed concrete bridges assumed to have been built by the respective methods at the Kakogawa Bridge site are shown in Table 1. To elaborate, considering only pure construction cost, it would be most economical to provide stagings over the entire length for cast-in-place concrete, but since the provision of stagings would be limited to the low-water season of the river, this method would require the longest construction period. The system in which precast blocks are erected by cantilevering is high in construction cost, but the construction period is shortest. However, it is clear that the longer the bridge the more the construction cost is decreased through the use of precast members.

Railroad Bridge Piers Comprised of Precast Members — There has been a case when a double-track elevated railroad bridge in a district of soft ground in the vicinity of Tokyo was made a prestressed concrete, simple girder type with each span 16 m in length using artificial lightweight aggregate over 13 spans. The piers supporting these simple girders were made portal rigid frames using artificial lightweight aggregates of which piers for 6 spans were constructed with cast-in-place concrete while those for 7 spans in order to shorten the construction period were made into portal rigid frames by erecting precast columns on cast-in-place footings on which precast beams were placed and joining by prestress (see Fig. 2). In comparison of the two methods based on construction period per one pier, 72 days were required for the cast-in-place system from start of driving of precast concrete piles to completion of pier whereas for the precast block system only 46 days were required and a great difference was seen. As for the construction cost per pier, this was \$24,000 for cast-in-place concrete and \$25,300 for precast block.

Conclusion

As is clear from the performances stated above, the greatest merit of using precast members lies in the extreme shortening of the construction period. In trunk-line railroad projects and express highway construction which are of long lengths, shortening of construction periods make possible early starts of operation, and the ensuing benefits being extremely great, the increases in construction cost are more than compensated. It is for the purpose of taking advantage of these merits that precast block construction methods are presently being studied in earnest in Japan.

Reference

Takahashi, K., "Study for Weight Reduction and Rapid Constructing Process in Concrete Bridge for Railway Construction," Railway Technical Research Report No. 804, Railway Technical Research Institute, Japanese National Railways, Mar. 1972.

Table 1. Example of Comparisons of Construction Periods and Pure Construction Costs of Prestressed Concrete Railroad Bridge Superstructures.

System	Construction Period	Pure Construction Cost
System providing stagings over entire length with cast-in-place concrete on top	18 mos.	\$1,760,000
System providing stagings over entire length with precast blocks arranged on top (system indicated in Fig. 1(a))	16 mos.	\$2,030,000
System with no staging provided and precast blocks cantilevered out in sequence (system corresponding to Fig. 1(c))	10 mos.	\$2,010,000
System with no staging and cast-in-place concrete cantilevered out	13 mos.	\$1,990,000

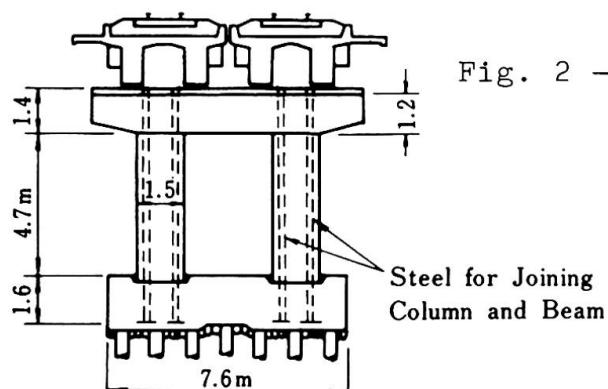


Fig. 2 — Portal rigid frame pier

SUMMARY

The contribution compares prestressed concrete bridges erected by different methods and shows use of precast block to be extremely effective in shortening construction periods and in certain cases also economical.

RESUME

Comparant des ponts en béton précontraint montés selon différentes méthodes, l'auteur montre que l'emploi d'éléments préfabriqués permet de raccourcir efficacement le temps de montage, tout en étant, dans certains cas, économique.

ZUSAMMENFASSUNG

Vergleiche von Spannbetonbrücken mit verschiedenen Bauverfahren zeigen, dass die Verwendung vorfabrizierter Elemente die Bauzeit stark verkürzt und in bestimmten Fällen die Baukosten senkt.

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