Repair of scoured substructure (Japan)

Autor(en): **Morinaga, Norio**

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2. Repair of Scoured Substructure (Japan)

From the topographic features of Japanese rivers that often have strong current from its gradient, river beds around substructures are often scoured. For this reason, there is a necessity for repair and reinforcement of substructures. Due to limited duration of work possible, that is mostly during winter when the water level is low, and the limited clearance available below the bridge, the methods for repair that can be taken are limited. Following are two cases:

Case 1 Reinforcement with piles; Iwaide Bridge, Wakayama

Owner: *Ministry of Construction*
Contractor: *Koike Gumi, Asakawa Gumi*
Work's duration: *6 months*
Date of repair: *1979 – 1980*

The Iwaide bridge, completed in 1955, has 385 m bridge length and 7.5 m road width (Fig. 1). The substructure consists of a 13 span cantilever girder. The substructure is a wall type reinforced concrete pier and an elliptical open caisson foundation of a length from 10.0 m to 12.5 m.

The substructure has been scoured to a depth of 4 m average up to 6 m maximum from the effects of dredged riverbed and embankment located upstream. In the worst case, the depth of embedment was reduced to 5 m from the original 11 m. To prevent a further decrease, measures were taken in 1970 by temporarily placing protection blocks. Then in 1979 the caissons were checked again for its stability. To completely solve the problem, the substructure was reinforced by underpinning and constructing a new slab connected with the existing caisson. The repair job was performed on 7 heavily scoured substructures among a total number of 12.

For reinforcement of caisson with reduced depth of embedment, a cast in place pile method was chosen for underpinning, under consideration of geologic condition, clearance below girder during work an economy.

With the cast in place piles, four Benoto piles of 1.5 m diameter and 11.5 m length were placed at four sides of the caisson. The caisson and piles were connected by placing a 2 m thick slab on top to make a new footing (Fig. 2 and 3). To determine the dimension of slab and piles, the structure was analysed to resist working forces together with the existing bridge. The caisson and slab was connected by having the upper and lower steel reinforcements from the slab of 29 mm diameter and 3.5 m length embedded 30 cm deep with resin into the sides of the caisson.

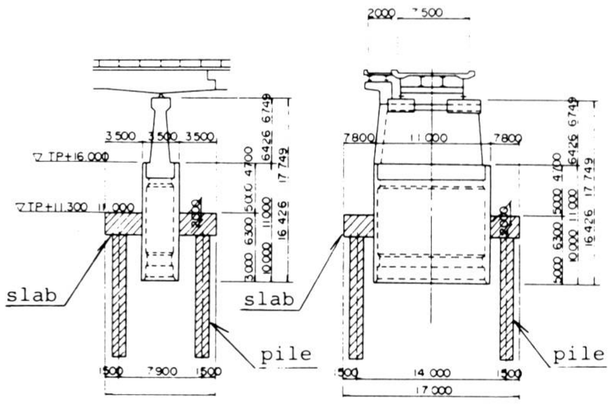

Fig. 2 Repair method (Iwaide Bridge)

Fig. 3 After repair (Iwaide Bridge)

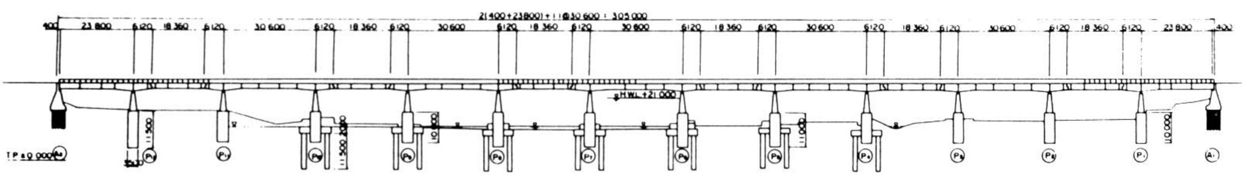

Fig. 1 Elevation (Iwaide Bridge)

Case 2 Repair by reinforced concrete lining; Natori Bridge, Miyagi

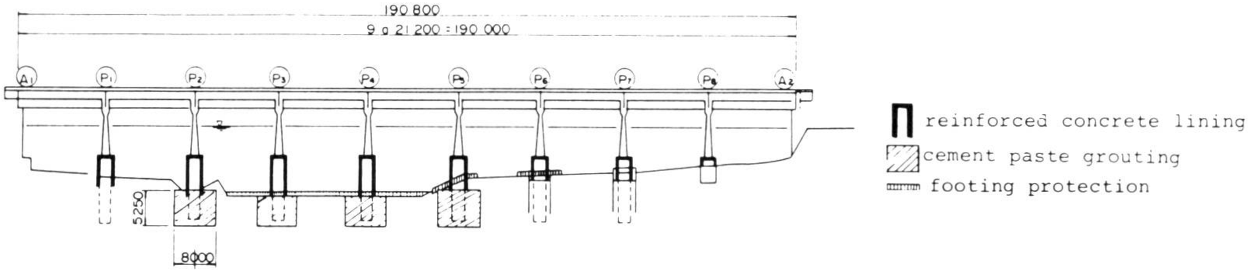

Fig. 4 Location of repair (Natori Bridge)

Owner:	*Ministry of Construction*
Contractor:	*Endo Construction*
Work's duration:	*phase 1: 5 months,* *phase 2: 2 years and 1 month*
Date of repair:	*phase 1: 1974 – 1975* *phase 2: 1981 – 1983*

The Natori bridge, completed in 1932, has 190.8 m bridge length and 7.5 m road width (Fig. 4). The superstructure is a 9 span steel plate simple girder. The substructure consists of a rigid frame reinforced concrete pier and caisson.

The substructure on this bridge was repaired due to the following problems:

1) Exposed steel reinforcements at top of the caisson.
2) Bridge pier endangered of toppling due to scouring at the caisson causing differential settlement and loss of strength in the surrounding foundation.
3) The connection between caisson and pier has been deteriorated from shear force.
4) Furthermore, due to its old design, its ability to resist today's load has been questioned.

The repair job was carried out in two phases. Phase 1 was the repair job on severely damaged piers and phase 2 was for the remaining piers.

The repair job was carried out by following four methods (Fig. 5, 6 and 7):

1) The bridge pier structure was repaired with a reinforced concrete lining added as a seismic protection wall.
2) The caisson was reinforced by connecting the top of the caisson with a connecting beam and adding a reinforced concrete lining to its exterior.
3) Cement paste grouting of foundations surrounding the caisson.
4) To protect the pier from scouring, piers located on the minor footing protections were placed and for piers located on the major bed, sheet piles were placed.

This repair job was carried out under limited clearance below bridge girder and had to be done during the dry season. In view of these conditions, the methods described above were considered to be effective in this repair job. The reinforced concrete lining was economical and the required duration of work was short. The cement paste grout has greatly increased the bearing capacity of the foundation and was also found to be effective in the river bed.

(Norio Morinaga)

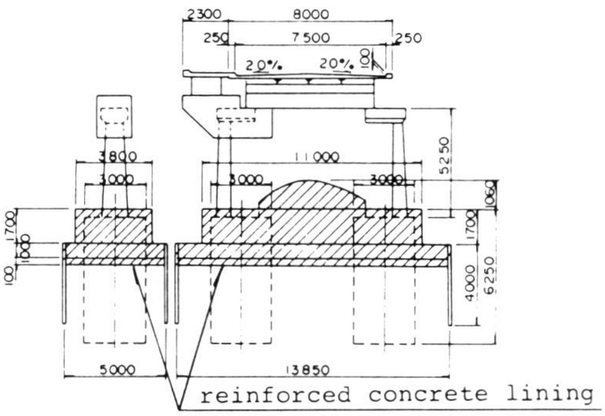

Fig. 5 Repair method (Natori Bridge)

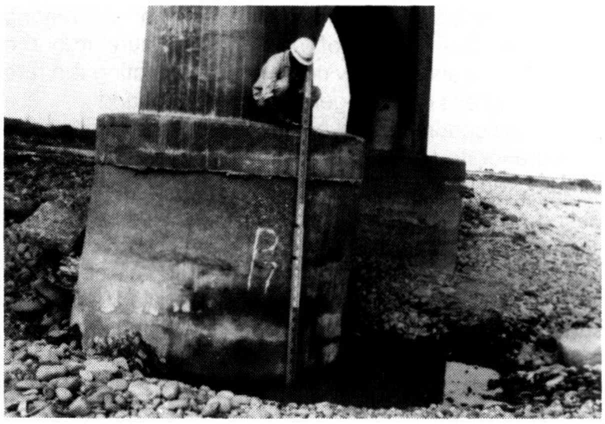

Fig. 6 Before repair (Natori Bridge)

Fig. 7 After repair (Natori Bridge)