Technical assistance upon bridge erosion damage in Hokkaido due to heavy rain by Typhoon No. 10

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1. Introduction

In Hokkaido, three Typhoons (Nos. 7, 11, and 9) made landfalls in a week from August 17 to 23, a passage of a front hit the region from August 29, and Typhoon No.10 approached successively, causing the flooding of rivers and landslides centered in eastern Hokkaido. Roads were also damaged and cut off in many places. Since a quick recovery of the road functions is of utmost importance to the restoration and reconstruction of the affected region, the authors made an onsite study of damage caused by the bridge corrosion and the like together with the bridges and river specialists from the Civil Engineering Research Institute for Cold Region (CERI) and provided advice on technical matters, etc., for restoration.

2. Technical support provided upon on-site study and temporary restoration

In a bridge over a river, the flow of water may scoop out the earth and sand around the bridge piers and abutment foundations (scouring and river bank erosion), making the foundations unstable and causing inclination and settling, resulting in falling of many bridges in the past due to this phenomenon. Such a phenomenon becomes prominent in locations where water flow concentrates and the flow velocity becomes high. In the bridge erosion investigation, deformation of bridges, such as inclination or settling, and whether the river channel has been blocked due to driftwood or the like caught on the bridge, etc., were checked. Then, the structures of bridges, in particular the depth and form of footing of the foundation, bridge installation location, and the main flow position and its transition, were checked in order to study the cause of the disaster and measures toward restoration.

As for the structural condition of a foundation, a direct foundation with shallow embedment tends to make a structure unstable when subjected to scouring and is liable to incline and settle compared to a foundation embedded deep into the ground such as a pile foundation. As for the installation position of bridge piers and abutments, if they are positioned in a water-colliding front where a river meanders and the like and the water flow gets stronger, they are under conditions more liable to scouring and riverbank erosion than when they are located in a straight region. If only the pier or abutment located in a certain position has undergone deformation, the position of the main flow is important in figuring out the cause. The investigation was conducted paying attention to the difference between the normal time and the time of the flood and the possible impact from changes in the state upstream and downstream of a bridge.

Five bridges investigated on-site this time included piers or abutment foundations that became positioned in the main flow area because of the flood and were inclined or sank due to scouring. Notably, there were also multiple cases in which the main flow moved behind the abutment because of the flood eroding riverbanks both upstream and downstream of the bridge. With respect to the bridges where such situations were affirmed, advice was given regarding the position to build a provisional bridge as a temporary restoration, which includes the following: 1) the provisional bridge should be built in a location least affected by riverbank erosion should there be another flood during its service, 2) countermeasures should be implemented to prevent erosion of riverbanks near the abutments, and 3) the abutment position should be moved toward outside the river than the existing bridge based on the expanded river channel due to the flood.

Photo 1: On-site study being conducted at Chiroro Bridge (National Route 274)

3. Toward a full restoration

As for planning of a full restoration, guidance was provided such that the recurrence of a similar disaster is prevented in coordination with the river administrator, considering the possibility that the river improvement project plan may be changed going forward, in particular for rivers under bank erosion, and with awareness that a short span bridge may cause the cross-sectional area of a river to be limited.