Development of technologies to minimize the effect of ground deformation on bridges

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1. Introduction

In the Kumamoto earthquakes, there are reports of cases in which important parts of bridges to support the function of bridges, such as main girders, are damaged because of the effects of earthquake motion, as well as the collapse of slopes and ground deformation. The earthquake resistance of road bridges is basically designed to provide enough resistance against the effects of vibrations to withstand the largest level of earthquake on record. Meanwhile, it is important to design bridges from the perspective of reducing the effects of uncertain risks, such as ground deformation. Therefore, the authors are developing design technologies to improve the certainty of generating fracture morphology with small effects on the restoration of bridge functions when a major change occurs to the lower structure of a bridge in case of ground deformation, such as the collapse of slopes and ground deformation. This paper introduces the concept of designs to control the fracture morphology that occurs to a bridge focusing on supporting parts based on actual damage to bridges in the Kumamoto earthquakes.

2. Damage to the supporting section of bridges in the Kumamoto earthquakes

In the Kumamoto earthquakes, ground deformation caused large shifts in both the upper and lower structures, and large relative displacement occurred between the upper and lower structures. Therefore, damage occurred to the main girders near the supporting sections between the upper and lower structures. Figure 1 shows the characteristics of the damage indicating that areas of damage varied among bridges.

Figure 1: Examples of damage to bridge supporting sections in the Kumamoto earthquakes

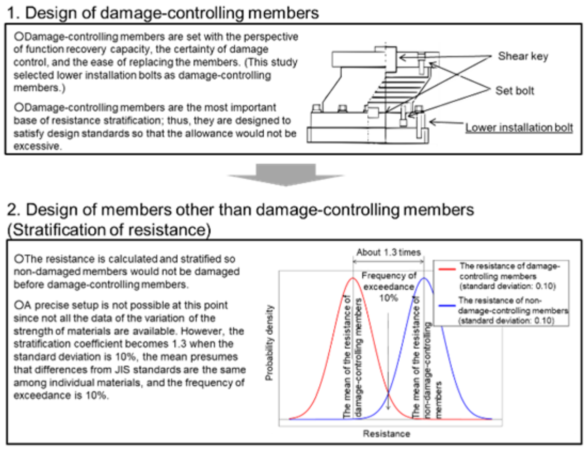

Figure 2: Concept of damage-control-type support (proposal)

3. The organization of the concept of damage-control-type support

Supporting sections consist of various types of members, which are individually designed based on bridge design standards. The authors examined the support design method to first satisfy the standards and then to control the parts that are to be damaged in the end so that the effects on the recovery of bridge functions would be minimized. Figure 2 shows the idea of the damage-control-type support design. Members that are damaged in the end (damage-control members) are set with the perspective of providing function restoration capacity, such as reducing differences in levels, as well as to increase the certainty of damage control and the ease of replacing the members. This study set the lower set bolt as the damage control member based on these perspectives. The idea is to control damage by designing a bridge by providing a significant difference in resistance between the lower set bolt and other members (the stratification of resistance).

4. In the end

The authors are planning to create pilot versions based on the concept of the damage control support design discussed above and conduct experiments with them. The authors are going to continue necessary examinations to apply damage-control-type support on actual bridges.