Subcommittee on the Study on Shear Design Method of Concrete Structures
(Subcommittee 343)

1. About the committee

The subject of shear force in concrete has been studied for quite a long time. The Concrete Committee of JSCE became actively involved in research on that subject about 40 years ago with the transition to limit state design method, and it has made several revisions over the years, including the current version of the design method. At present, under the concept of performance design, it is necessary to examine the method from new angles, including the questions of whether existing design methods form a system that can ensure adequate performance in diverse types of concrete structures, and whether this is a system that can be extended to deteriorated structures.

In this committee, researchers and persons engaged in practical design work have shared their knowledge, experience, and problems while engaging in activities for survey research that will contribute to the elucidation of loading capacity and rupture mechanisms related to shear force in concrete structures as well as rationalization of the shear design method.

2. Committee structure and activities

The study committee established the following four working groups, under the leadership of Chairman Dr. Yasuhiko Sato of Hokkaido University and Secretary-General Dr. Toshiya Tadokoro of the Railway Technical Research Institute. The activities of each working group are described below.

Design standards working group

The results of many years of research have made it possible to assess the shear loading capacity of general members with a high level of accuracy. However, actual structures have many forms, dimensions, and boundary conditions that are beyond the scope of applicability of such assessment. Therefore, sophisticated decisions based on very highly advanced knowledge and experience are needed when applying existing design methods. This working group has studied the background and characteristics of the shear design methods used in domestic Japanese design codes, along with differences from the Standard Specifications for Concrete Structures of JSCE; and we have performed calculations based on each code with regard to experimental data under a variety of conditions and compared the results of such calculations. This resulted in confirmation that there was a certain level of accuracy with regard to the experimental data.

Working group on surveying foreign standards

When confirming the applicability of the existing design method and considering future design methods for Japan, it is important to utilize foreign standards by understanding the backgrounds and characteristics of them, which have been developed in different ways than those of Japan. This working group has studied the background and characteristics of the shear design methods used in the foreign standards of Eurocode 2, ACI 318, fib Model Code, and the AASHTO LRFD Bridge Design Specifications, along with their differences from the Standard Specifications for Concrete Structures of JSCE. In particular, we used parametric calculations and other methods to perform a detailed comparison of Eurocode 2 and the Standard Specifications for Concrete Structures of JSCE. In addition, we performed calculations with each code for characteristic experimental data and compared the results, as was also done for Japanese codes.

Research survey working group

In order to consider future shear design methods, it is necessary to confirm the applicability of the formulas used to assess shear failure mechanism and shear loading capacity as determined up to the present time, and to identify the problems that need to be resolved. This working group has surveyed the latest foreign and domestic research on the shear loading capacity of concrete structures, based on key concepts considered to have an important influence in survey findings.

Structure verification working group

In the design of concrete structures, in many cases, the dimensions of members are determined on the basis of verification with regard to shear force. Therefore, in order to design more rational structures, it is necessary to improve the sophistication of the verification process by reviewing the procedures at each stage of verification.

This working group has examined the design drawings of reinforced concrete structures that are currently in use to find out whether there is variation in acts of design among engineers and to identify the issues at each stage of verification.

Verification involves modeling of the structures and loads for applying the design formula to the calculation of response values and determination of the cross sections for verification. Therefore, study is also needed concerning modeling and verification cross sections for use when applying a shear loading capacity formula.

The working group has indicated issues and methods for verification with regard to shear force in Y bridge piers and reinforced concrete slabs. After identifying the issues, we performed FEM analysis on Y bridge piers and reinforced concrete slabs as well as simply-supported reinforced concrete beams subject to the formula used in verification, and studied methods for applying the shear loading capacity formula by comparing their destruction properties and stress flow (**Figure**). For example, with Y bridge piers, the support conditions vary depending on the direction of loading, as in direct support or indirect support. In the case of direct support, pressure struts clearly appear in the overhang portion, so we used FEM analysis to characterize reinforced concrete simple beams showing a similar stress distribution, and were then able to use the results to determine the effective height and shear span for modeling as a simple beam. The calculated values showed similar yield strength to the results of FEM analysis, indicating the validity of the modeling method. Meanwhile, some problems were also identified, including the difficulty of assessment using a shear loading capacity formula in the case of indirect support.