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Artikel: A draft design code for steel-concrete composite girder in Japan

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A Draft Design Code for Steel-Concrete Composite Girder in Japan

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Summary

In Japan, a new draft design code for steel-concrete composite girder bridges was elaborated by the committee on composite structures(Chairman:Prof. H. Nakai) in JSCE. The code is mainly for the civil engineering structures such as composite girders in highway bridges and it was written by the format based on a limit state design method.

1. Introduction

The first composite girder bridge(CGB) in Japan was Kanzaki Bridge(Osaka city) of simple span length of 12m. The design was based on German experience and our own experiments. From the practice, The Codes for Design and Construction of Composite Girders on Highway Bridges was published in 1957. Then, the construction method was changed from "propped" to "unpropped" to build more easily. Also, many continuous CGB were constructed. From the late 1960th, non-prestressed continuous CGB had taken the place from difficulties in prestressing at the intermediate support and this type of continuous composite girders was specified in the Japanese Specifications for Design of Highway Bridges(JSHB), 1973. New Kanzaki Bridge is the longest non-prestressed continuous CGB of the span length of 88m. Since 1980th, the construction fever of CGB has decreased remarkably due to deterioration of concrete slabs in composite bridges. Shrinkage of concrete and running of heavy vehicles are the main causes. Recently, by using precast prestressed concrete slabs, the defects can be recovered and CGB are coming to life again.

Under these circumstances, the committee on ultimate strength of composite structures was organized in JSCE in order to prepare a design code for composite structures based on a limit state design method and a draft design code for CGB was elaborated. The paper describes the outline of the code.

2. Application Range and Fundamentals

The draft codes are available to simple composite girders, prestressed or non-prestressed continuous composite girders and composite girders with in-site RC slabs, precast RC slabs and composite decks.

3. Classification of Composite Girders

The composite girders are classified into compact ones and non-compact(slender) ones in relation to the rotation capacity of the cross section. In the compact girder, the composite cross sections can form a full plastic hinge and the ultimate strength of the section can be calculated by the plastic analysis. In the non-compact sections, the ultimate should be limited up to the own when the extreme tension-side fiber stress of steel girder reaches its yielding strength.

The compact section can be determined whether the following equation Eq. (1) is satisfied as well as Eurocode 4 and BS5400,

$$b/t \leqq 9\varepsilon \quad (1)$$

$$d/w \leqq 33\varepsilon/\alpha \quad (2)$$

where, α : ratio of compression zone of web to the web height,
$\varepsilon = \sqrt{(235 / f_y)}$.

The composite action between slab and girder can be expected with ordinary stud arrangement designated in JSHB.

4. Strengths for Materials and Members

Structural steel and concrete should be selected according to the Draft Codes for Steel Structures and the Standard Specification of Concrete of JSCE, respectively.
Headed studs are common for shear connectors. Alternative connectors can be used on pertinent approvals of experiments or research data.

5. Verification for Limit States

Safety for each limit state should be verified with the following fundamental equation Eq. (2) :

$$S_d/R_d \leqq 1.0 \quad (2)$$

where, $R_d = \phi \cdot R(f_d)$, $S_d = S(\gamma \cdot F_d)$.

Here, the loading effects F_d and safety factors γ for loads may be adopted of ones designated in the Draft Code for Steel Structures.
The bending moments at internal supports in continuous composite girder may be redistributed by only their 15% from internal supports towards the midspan.

6. Verification for fatigue of studs

The safety for fatigue of studs should be verified with Eq. (3) and (4) [1].

$$\Delta\tau_d/\Delta\tau_R \leqq 1.0 \quad (3)$$

where, $\Delta\tau_d$: the maximum design shearing stress range (Mp),
$\Delta\tau_R$: shearing stress range (Mp),

$$\log \Delta\tau_R = 2.74 - 0.117 \log N \quad (4)$$

7. Structural details

When the slabs are constructed by in-situ concrete, haunch should be provided at the girder place. The effective breadth of concrete flanges should be determined in accordance with JSHB. When precast slabs are used, a careful attention is necessary for stud arrangement. In the case, group arrangement of plural studs in a position is required and their strength.

Reference

[1] Maeda, Y., Matsui, S. and Hiragi, H. : Effect of Concrete-Placing Direction on Static and Fatigue Strength of Stud Shear Connectors, Tech. Rept. of the Osaka Univ., Vol. 33, No. 1733, pp. 397-406, 1983