LOAD-CARRYING CAPACITY OF SBHS700 STEEL PLATES WITH CRUCIFORM JOINT

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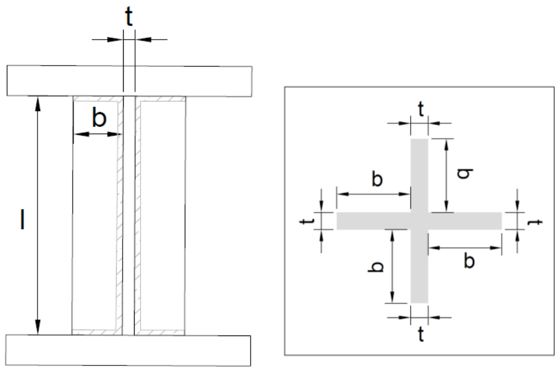
1. INTRODUCTION

In recent years, the use of SBHS (Higher Yield Strength Steel Plates for Bridges) was introduced for its remarkable performance on bridge structures, and it was standardized by JIS in the code JIS G3140[1]. Comparing with conventional steels such as SM490, SM570 and HT780, SBHS at a similar strength accordingly reaches higher and more constant yield strength that is independent of the plate thickness. Moreover, advantages such as high toughness and weldability allow applications on various structures with a lower cost. SBHS is categorized according to the yield strength grade, namely to be SBHS400, SBHS500 and SBHS700. Although previous studies have indicated certain design guidelines for SBHS, details are still remained for investigation. In this experiment, load carrying capacity of steel plates with cruciform joints made of SBHS700 was examined by compression, from which its compatibility with the current design standard was confirmed.

2. TEST SPECIMENS

The test specimens were made into cruciform joints, which have three sides welded and one side free for each plate, as shown in Fig.1. Experimental data were collected from the strain gages and the displacement meters. The compressive loading was applied at a rate of 0.005 mm/s by universal testing machine with a capacity of 5000 kN. The dimensions of all test specimens as well as the yield stress σ_y obtained from the tensile test are shown in Table 1. The width-to-thickness ratio parameter R_R is defined by Equation (1).

$$R_R = \frac{b}{t}\sqrt{\frac{\sigma_y}{E}\cdot\frac{12(1-\nu^2)}{\pi^2 k_R}} \qquad (1)$$



(a) Front view (b) Cross-section

Fig. 1 Design of the test specimens

Table 1 Properties of the test specimens

Name of the test specimens		B07	B11
Yield strength σ_y	(MPa)	767	
Width b	(mm)	67	105
Thickness t	(mm)	9	
Length l	(mm)	250	380
R_R		0.74	1.15

3. EXPERIMENTAL RESULTS

As indicated in Fig.2, the maximum load P_u for B11 was lower than the yield load P_y, while B07 reached higher loads at much larger vertical displacements. Differences were also found between the behaviors after reaching the maximum load. Buckling phenomenon is considered as a significant factor that causes reduction of the load carrying capacity. Experimentally, it can be expressed by the out-of-plane deformation of plates. Such displacements were observed on the plates of B11 before reaching P_y, which resulted in a sudden decrease of strength. Different from B11, the strength of B07 slowly decreased due to both buckling and strain hardening. As a

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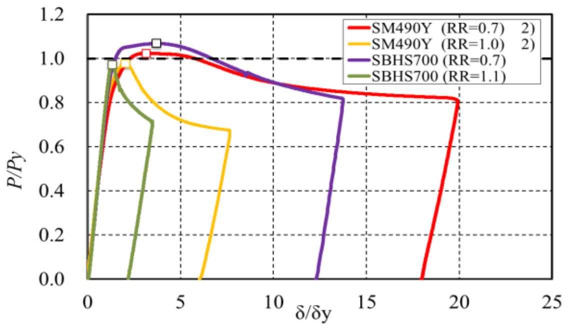

Fig.2 P/P_y - δ/δ_y relation of SBHS700

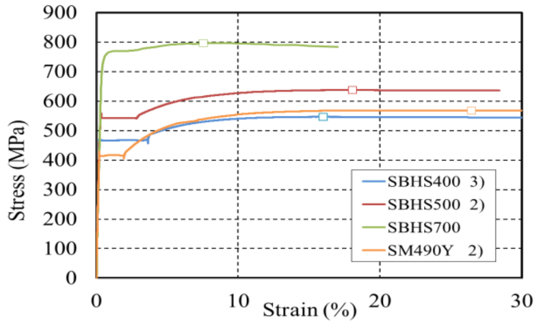

Fig.3 Tensile $\sigma - \varepsilon$ relations of SBHS and SM490Y

consequence, with an increasing width-to-thickness ratio, the load carrying capacity decreased from B07 to B11.

Different steels vary in stress-strain relation, including yield stress σ_y and critical stress σ_{cr}. Tensile tests were conducted on SBHS400, SBHS500, SBHS700 as well as a conventional steel SM490Y, as shown in Fig.3[2)]. As an important factor to evaluate the load carrying capacity regarding the safety design margin, the yield ratio σ_{cr}/σ_y was introduced. It can be calculated as the ratio between the experimental critical stress σ_{cr} based on P_u, and the lower yield stress σ_y obtained from the tensile test. The results of SBHS and SM490Y were plotted with the strength curve specified by Japan Road Association[4)] as well as an ultimate strength curve proposed by Fukumoto[5)], as shown in Fig. 4. Compared with SM490Y, values of σ_{cr}/σ_y for SBHS were at similar levels with the corresponding R_R. Similar results can be found in Fig.2, where the values of P_u/P_y and δ_u/δ_y of SBHS700 and SM490Y were comparable accordingly. Consequently, for large R_R, the load carrying capacity is mainly controlled by buckling phenomenon instead of the material stress-strain relation. By reason that no distinct difference of the σ-ε correlation can be found in the elastic range, the load carrying capacities of different steels with the same R_R are similar. Moreover, test results of SBHS700 were examined to be above the current Japanese Design Specifications for Highway bridges, which proved its applicability and competitiveness with the conventional steels.

4. CONCLUSIONS

The load carrying capacity of SBHS700 with cruciform joint was investigated through compression specimens with different parameter R_R. The strength and

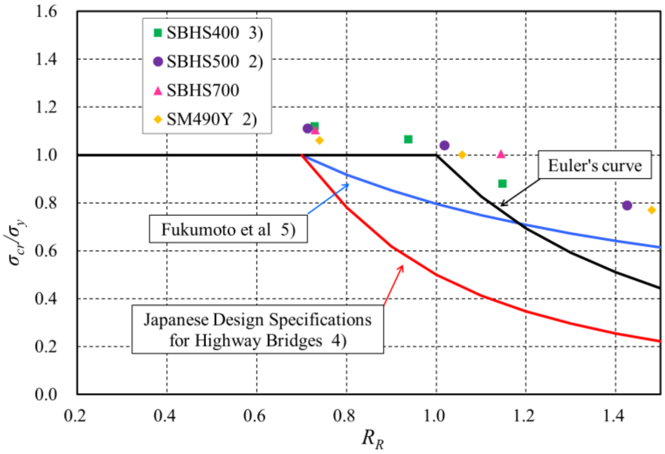

Fig.4 Comparison between experimental results of SBHS and SM490Y with the design standards

the vertical displacement both decreased with an increase of R_R. In addition to the outstanding mechanical characteristics, SBHS was found to have comparable load carrying capacities compared with conventional steels, which makes it possible to be evaluated by the current design specifications.

ACKNOWLEDGEMENT

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