TMCP-type 590N/mm^2 Grade Steel for Seismic-resistant Buildings

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Summary

"HBL^{TM}440" TMCP-type 590 N/mm^2 grade steel for seismic-resistant buildings was developed by JFE Steel Corp. and certified by Japan's Minister of Land, Infrastructure, Transport and Tourism in August 2013 for the plate thickness range of 19-100mm. This paper introduces its mechanical properties and discusses its behavior in columns. In conclusion, columns made of HBL^{TM}440 showed sufficient plastic deformability for seismic-resistant buildings.

Keywords: high-rise buildings; high-strength steel; TMCP; heat treatment; seismic resistant.

1. Introduction

High-strength steel makes it possible to construct high-rise or long span structures. At the same time, it also avoids the need for increased plate thickness in members, which reduces delivery costs and welding work. Although 590 N/mm^2 grade steel plate SA440, which is a JISF (The Japan Iron and Steel Federation) standard of 1996, is now widely used in Japan, JFE Steel recently developed a TMCP (thermo-mechanical control process)-type 590N/mm^2 grade steel plate, HBL^{TM}440, for building application for the first time in the industry[1]. HBL^{TM}440 is advantageous for production period and weldability compared with SA440. In this paper, the structural behavior of HBL^{TM}440 columns in a cyclic loading test is discussed.

2. Bending test of HBL^{TM}440 columns

A three-point bending test was carried out for columns made of HBL^{TM}440. The setup is shown in Fig. 1. Each end of the specimen was simply supported. In order to confirm behavior in a large earthquake, gradually increasing cyclic deformation was applied to the central part until the

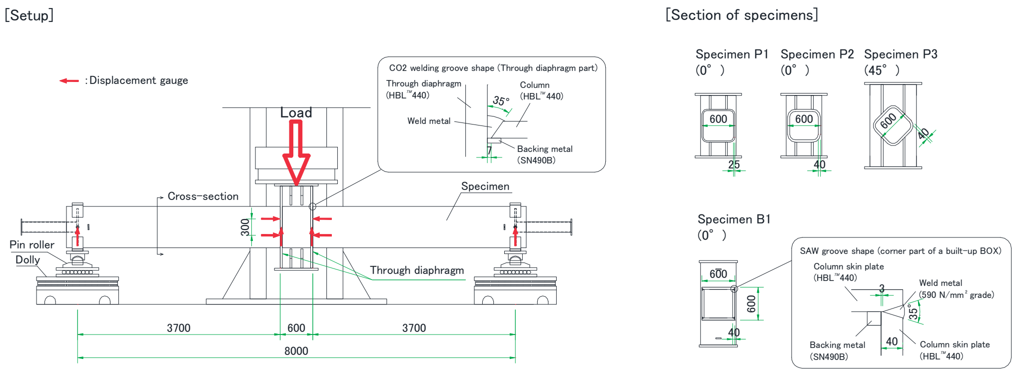


Fig. 1: Setup and section of specimens

specimen broke or its strength decreased to 95% of maximum strength.

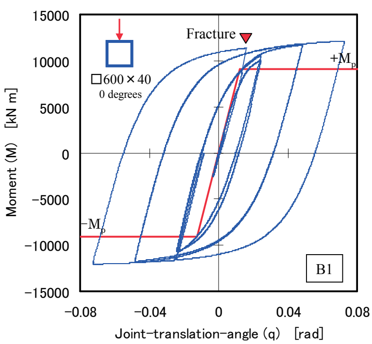
Four specimens were tested, as shown in Fig. 1. Table 1 shows the list of the specimens. The section type, width-thickness ratio (B/t), and loading direction (LD=0°, 45°) were used as parameters.

Table 1: List of specimens and their properties

Specimen	Section Type	B (mm)	t (mm)	B/t	R (mm)	B/t Rank*	1/α	LD	A (cm^2)	I (cm^4)	Z (cm^3)	Z_p (cm^3)	TS (N/mm^2)	YS (N/mm^2)
P1	Cold press -formed	600	25	24.7	97.8	FB	0.67	0°	532	285342	9446	11254	501	634
P2		600	40	15.4	145.2	FA	1.87	0°	794	387375	12899	15967	464	619
P3		600	40	15.3	144.2	FA	1.91	45°	796	387441	10632	15525	459	600
B1	Built-up	600	40	14.8		FA	1.94	0°	904	473173	15786	18976	481	620

B: Width, t: Thickness, R: Outer radius of corner part, LD: Loading direction, A: Area, I: Geometrical moment of inertia,
Z: Section modulus, Z_p: Plastic section modulus, α: Equivalent width-thickness ratio = $(YS/E)*(B/t)^2$, E: Young's modulus,
YS: Yield strength, TS: Tensile strength (YS, TS are the values of the column in the cross-sectional flat part.)

Fig. 2 shows the moment vs. joint-translation-angle relation. The cumulative ductility ratios in Fig. 3 which are obtained from the moment vs. joint-translation-angle relations reflect the plastic deformability of the specimens. All specimens with 0° and FA-rank section outperformed the target cumulative ductility ratio of 28 given in Reference [3].



(B1)

Fig. 2: Moment vs. joint-translation-angle relation

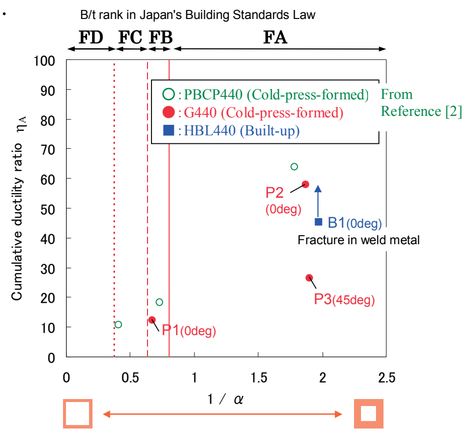


Fig. 3: Result of cumulative ductility ratio

3. Conclusion

The following points were revealed by an experimental study of HBL™440 columns.

(1) In both cold-press-formed square steel pipe sections and built-up box sections, HBL™440 columns have sufficient plastic deformability for application to seismic-resistant buildings.

(2) "G440," which is a cold-press-formed square steel pipe made of HBL™440, has equivalent plastic deformability to "PBCP440," which is made of SA440.

References

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