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Overview and Application of Steel Materials for High-Rise Buildings†

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Abstract:

JFE Steel has been producing plates, wide flange H-shapes and pipes by applying thermo-mechanical control process (TMCP) technology using the most advanced on-line accelerated cooling system in order to meet customers' needs while considering various design methods and construction technologies for high-rise buildings. This paper introduces the overview and application of representative JFE Steel's steel products for high-rise building.

1. Introduction

The Kasumigaseki Building, constructed in 1968, was Japan's first superhigh-rise building. Design methods progressed with help from advancing techniques in computer analysis, leading to the establishment of a basic groundwork for realizing superhigh-rise buildings. Thus, computer technology and design methods contributed greatly to the construction of the Kasumigaseki Building. Another important contributor was the supply of steels with improved performance and working properties by the steel material makers. Since the construction of Kasumigaseki Building, superhigh-rise office buildings have been erected one after another, mainly in big cities. Steel-frame structures of relatively lightweight, high strength, and high ductility have become mainstream for the earthquake-resistant construction of superhigh-rise office buildings.

Large-span designs and multi-story designs in commercial spaces, offices, and hotels are common features of the high-rise buildings recently being built mainly in urban districts[1)]. This requires the use of high-strength, heavy-wall steel materials. On the other hand, the fracture damage to the beam-end connections sustained in the 1995 Hyogo-Ken Nanbu Earthquake of and other disasters clearly pointed to a need for improved steel materials. Thus, there has been a steadily increasing demand for high-performance steel materials with low yield ratios (yield point/tensile strength), high toughness, and good weldability[2)]. And with the introduction of the performance based design method, engineers are placing increasing importance on high-quality designs with various kinds of steel materials suited to performance specifications and welding techniques, in order to effectively exploit the properties of the materials.

The thermo-mechanical control process (TMCP) technology[3)] of JFE Steel is one of the most accurate and in the industry the highest cooling rates, as well. With this technology, JFE Steel has placed steel plates, wide-flange H-shapes, and steel tubes on the market to meet diversifying design and construction needs in high-rise buildings.

This paper presents the features and applications of the steel materials JFE Steel uses in superhigh-rise buildings.

2. Product Development and Applications at JFE Steel

2.1 High-Performance Steel Materials

2.1.1 550 N/mm^2 TMCP steel material (HBL385)

At the beginning of this decade, JFE Steel developed HBL385, a TMCP plate with a tensile strength

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Table 1 Chemical compositions of HBL385

(mass%)

	Thickness	C	Si	Mn	P	S	C_{eq}	P_{CM}*
HBL385B	$19 \le t \le 50$	≤0.20	≤0.55	≤1.60	≤0.030	≤0.015	≤0.40	≤0.26
	$50 < t \le 100$						≤0.42	≤0.27
HBL385C	$19 \le t \le 50$	≤0.20	≤0.55	≤1.60	≤0.020	≤0.008	≤0.40	≤0.26
	$50 < t \le 100$						≤0.42	≤0.27

C_{eq} = C+Si/24+Mn/6+Ni/40+Cr/5+Mo/4+V/14
P_{CM} = C+Si/30+Mn/20+Cu/20+Ni/60+Cr/20+Mo+/15+V/10+5B
*By the agreement of shipping and receiving parties concerned, it is possible to apply the P_{CM} instead of C_{ep}.

Table 2 Mechanical properties of HBL385

	Thickness	YP (N/mm^2)	TS (N/mm^2)	YR (%)	El (%)	$vE_{0^\circ C}$ (J)	RA_Z (%)
HBL385B	$19 \le t \le 100$	385–505	550–670	≤80	≥26 (t<50)* ≥20 (t<50)**	≥70	—
HBL385C							≥25(Ave.) ≥15(Each)

YP: Yield point TS: Tensile strength YR: Yield ratio El: Elongation $vE_{0^\circ C}$: Charpy absorbed energy at 0°C
RA_Z: Reduction of area in Z-direction *JIS No. 5 **JIS No. 4

of the 550 N/mm^2 class as a high-tensile steel material excellent in the balance of economy, earthquake resistance, and weldability[4]. HBL385 was approved by the Minister of Land, Infrastructure and Transport in 2002, earlier than any other equivalent in the industry. Through the full application of high-accuracy TMCP technology based on *Super*-OLAC, JFE Steel's unique accelerated cooling device, the company realized low yield ratios of 80% or less and a standard strength of 385 N/mm^2 in HBL385 while maintaining a weldability equivalent to that of conventional 520 N/mm^2 class TMCP steels (standard strength: 355 N/mm^2). Steel materials with strength levels higher than that of a 590 N/mm^2 class steel (SA440) must be heat treated with dual-phase quenching at least twice in order to achieve low yield ratios. HBL385, a steel of the highest strength, has realized a low yield ratio without this complex heat treatment. The chemical compositions and mechanical properties of HBL385 are shown in **Tables 1** and **2**, respectively.

Thanks to the adoption of HBL385, the minimization of steel frame costs can be expected from a reduction of steel material weight due to an increase in strength, a reduction of the man-hours in steel frame fabrication and welding, and the like. To quantitatively evaluate the effect, steel material weight was estimated by carrying out a design trial in which a 490 N/mm^2 class TMCP steel (TMC325) was replaced with HBL385.

The object of the design trial was a 25-story high-rise building with a height of 122 m (**Fig. 1**). The plane of the building was square, and vibration controlling dampers were arranged within. Columns with three types of sectional shapes were used: a box section, an H-section, and a circular section (CFT).

Table 3 shows the maximum sections used in the

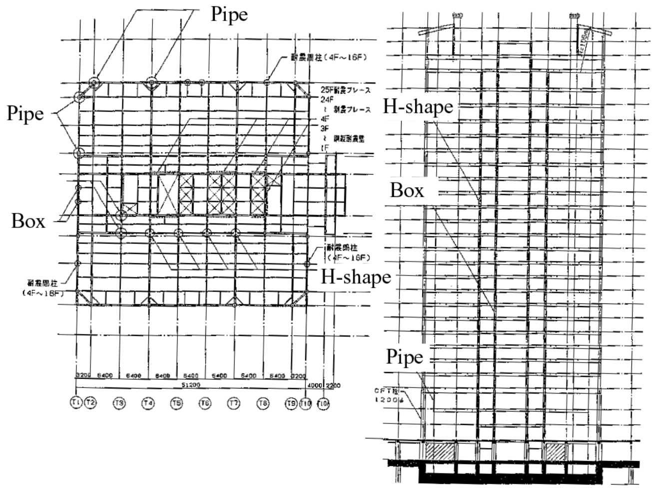

Fig. 1 Building for trying to design

Table 3 Maximum member section

	Original design		Interchange	
BOX	□-600 × 70	"TMC325"	□-600 × 60	"HBL385"
H-shape	H-612 × 520 × 70 × 80	"TMC325"	H-592 × 510 × 60 × 70	"HBL385"
Pipe (CFT)	○-1 200 × 50	"TMC325"	○-1 200 × 40	"HBL385"
Beam (H-shape)	H-1 500 × 400 × 16 × 40	"SN490"	H-1 500 × 400 × 16 × 32	"HBL385"

Table 4 Quantity of steel as a result of trying to design

(unit:t)

Quantity of Steel	Original	Case 1	Case 2	Case 3	Case 4
Total	9 607 (100%)	9 194 (96%)	9 356 (97%)	8 943 (93%)	9 190 (96%)
Columns	3 881 (100%)	3 881 (100%)	3 630 (94%)	3 630 (94%)	3 630 (94%)
Beams	4 190 (100%)	3 777 (90%)	4 190 (100%)	3 777 (90%)	4 024 (96%)
Others	1 535 (100%)	1 535 (100%)	1 535 (100%)	1 535 (100%)	1 535 (100%)

original design. The design trial was performed by replacing the members section by section based on the strength ratios and building properties after the replacement was confirmed. The member replacement was performed in four cases: for beams in Case 1, for columns in Case 2, for beams and columns in Case 3, and for beams and columns on the tenth story and below in Case 4. Only the thickness was changed in terms of the strength ratio in the replacement (only the flange when the H-shapes were used in the beams). The height and width of the sections were left unchanged.

Table 4 shows the weight of the steel materials after the design trial. The total steel material weight relative to the original design decreased by 4.3% in Case 1, by 2.6% in Case 2, by 6.9% in Case 3, and by 4.3% in Case 4. In terms of the kinds of members, the steel material weight decreased by 6% from the original design when the columns were replaced, by 10% when the beams were replaced in all stories, and by 4% when the beams were replaced on the tenth story and below.

Table 5 shows the primary natural periods of the building in each case. Compared to the original design, the natural period increased significantly in Case 1 and Case 3, with replacement of the beams, and increased little in Case 2, with replacement of the columns. In Case 4, with replacement of the columns and beams on the tenth floor and below, the values were midway between the values in Cases 1 and 3. **Figure 2** shows the story drift angles of the building in the first stage design and second stage design based on the original design, in which the story drift angle is 100%. Incidentally, the occurrence of earthquakes is presumed to be very rare in the second stage design. In Case 1 and Case 3, with replacement of the beams, the stiffness decreased remarkably in the upper stories. At the second stage design, the story drift angles of the middle and upper stories increased by more than 20% from the original design, thus making it impossible to meet the design criteria. In Case 2, with replacement of the columns, a design change was thoroughly possible. The design conditions were also met in Case 4, with replacement of the beams and columns on the tenth story and below.

Table 5 Primary natural period as a result of trying to design

(unit:s)

Natural period	Original	Case 1	Case 2	Case 3	Case 4
X direction	3.14	3.23	3.15	3.24	3.19
Y direction	3.02	3.09	3.03	3.11	3.08

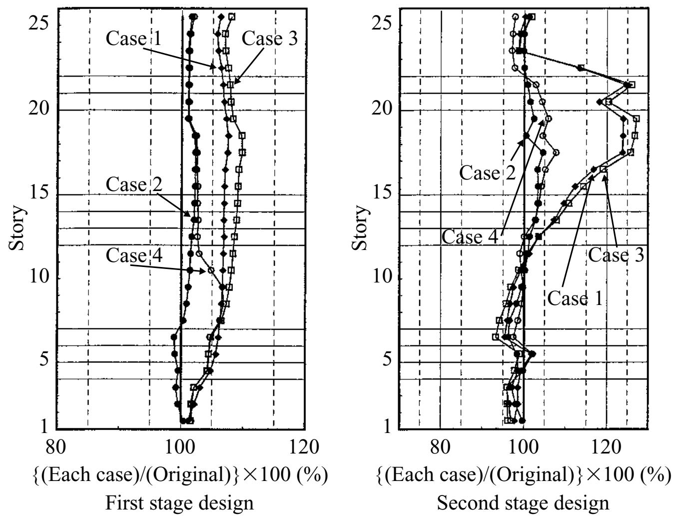

Fig. 2 Story drift

If the beams of all of the stories of this building were replaced, the stiffness decreased and performance was difficult to ensure. In Case 2, with replacement of the columns, the performance and practical use were thoroughly assured and enabled. This also applied to the beam replacement of the tenth story and below in Case 4. In the design trial, the replacement of 490 N/mm^2 steel columns with HBL385 enables engineers to target the effects of the reduced steel weight and to ensure performance without any apparent problems. HBL385 can also be thoroughly applied to beams of the lower stories alone.

The superiority of HBL385 through its weight reduction effect was thus evaluated highly. From the start of

Photo 1 Gran Tokyo North Tower

production up to March 2007, HBL385 was applied to about 40 buildings. The cumulative shipping quantity during this period reached 25 000 t. As an example, more than 5 000 t of HBL385 was adopted for box columns in the Gran Tokyo North Tower (stage I) (number of stories, 4 stories below ground, 43 stories above ground; penthouse, 2 stories; maximum height, about 205 m, **Photo 1**) and Gran Tokyo South Tower (number of stories, 4 stories below ground, 42 stories above ground; penthouse, 1 story; maximum height, about 205 m).

2.1.2 High-weldability 590 N/mm^2 steel material (SA440-U)

The conventional 590 N/mm^2 steel for buildings (SA440) has a high carbon equivalent C_{eq} and a high content of P_{CM}, a component highly susceptible to welding cracks. Hence, there were many restrictions on preheating and bead length with this material. The high-weldability 590 N/mm^2 steel (SA440-U) has substantially improved weldability, thanks to an optimum composition design and a special heat treatment for weldability improvement. With certain plate thicknesses and under certain restraint conditions, the preheating can be reduced in temperature or entirely omitted by limiting P_{CM} to 0.22 or less. Moreover, a reduction of the carbon content has reduced a hardness increase in the HAZ of short beads. **Table 6** compares the chemical composition of the conventional SA440 with that of the high-weldability SA440-U.

Photo 2 Shin-Marunouchi Building

Since its approval by the Minister of Land, Infrastructure and Transport in 1996, the SA440 grade (including SA440-U) has been shipped in a cumulative quantity of about 400 000 t and SA440-U has been used by multiple builders. A representative high-rise structure using SA440 is the Shin-Marunouchi Building (4 stories below ground, 38 stories above ground; height, 198 m, **Photo 2**). The steel material for large-heat-input welding to be described in the following section is also used in this building.

2.1.3 Steel materials for large-heat-inputwelding

High-efficiency submerged arc welding (SAW) and electro slag welding (ESW) are used in box columns. SAW relies on large-heat-input welding methods with a heat input of 600 kJ/cm, while ESW relies on a maximum heat input of 1 000 kJ/cm maximum. The toughness of the heat-affected zone (HAZ) deteriorates greatly if the welding is performed with steel materials untreated by special measures.

JFE Steel previously developed a high-HAZ-toughness steel plate treated by JFE EWEL[5)], a technology for improving the toughness of the large-heat-input HAZ. JFE EWEL integrates four element technologies: (1) low carbon equivalent (low C_{eq}) via the high-accuracy TMCP technology using *Super*-OLAC, (2) γ grain refinement by finely-dispersed TiN, (3) control of the γ intra-granular microstructure by micro alloying control, and (4) γ grain refinement using B solution from the weld metal. JFE Steel has commercialized a lineup of HBL325-E, HBL355-E, HBL385-E, and SA440-E as steel materials for building (the suffix -E in the specification symbols denotes that JFE EWEL has been applied)[6)]. These steels satisfy the specifications of HBL325 to HBL385 and SA440, grades that have been approved by the Minister of Land, Infrastructure

Table 6 Chemical compositions of SA440 plates (80 mm in thickness)

(mass%)

		C	Si	Mn	P	S	C_{eq}	P_{CM}
Conventional SA440C		0.13	0.25	1.44	0.012	0.002	0.45	0.24
	Spec.	≤0.18	≤0.55	≤1.60	≤0.020	≤0.008	≤0.47	≤0.30
Developed SA440C-U		0.09	0.25	1.5	0.01	0.002	0.46	0.2
	Spec.	≤0.12	≤0.55	≤1.60	≤0.020	≤0.008	≤0.47	≤0.22

C_{eq} = C+Si/24+Mn/6+Ni/40+Cr/5+Mo/4+V/14 P_{CM} = C+Si/30+Mn/20+Cu/20+Ni/60+Cr/20+Mo+/15+V/10+5B

Table 7 Mechanical properties of steel plates and welded joints with JFE EWEL (80 mm in thickness)

Grade	Base material				
	YP (N/mm^2)	TS (N/mm^2)	YR (%)	El* (%)	$vE_{0°C}$ (J)
HBL325-E	325–445	490–610	≤80	≥21	≥27
HBL355-E	355–475	520–640	≤80	≥21	≥27
HBL385-E	385–505	550–670	≤80	≥20	≥70
SA440-E	440–540	590–740	≤80	≥20	≥47

YP: Yield point TS: Tensile strength YR: Yield ratio
El: Elongation $vE_{0°C}$: Charpy absorbed energy at 0°C
*JIS No. 4

Table 8 Mechanical properties of steel pipes

Grade	Tensile test				
	YP (N/mm^2)	TS (N/mm^2)	YR (%)	El* (%)	$vE_{0°C}$ (J)
P-325	325–475	490–610	≤85	≥23	≥27
P-355	355–505	520–640	≤85	≥21	≥27
P-385	385–535	550–670	≤85	≥19 ≥21	≥70
P-440	440–590	590–740	≤85	≥20	≥47

YP: Yield point TS: Tensile strength YR: Yield ratio
El: Elongation $vE_{0°C}$: Charpy absorbed energy at 0°C
* JIS No. 12A, No. 12B, or No. 4

and Transport, and they also realize high Charpy absorption energy in welded joints. **Table 7** shows the basic mechanical properties of these steel grades.

HBL325-E, HBL355-E, HBL385-E, and SA440-E can be welded as easily than steel materials untreated by the usual large-heat-input measures, if not more easily. Thus, they can be welded under the same preheating conditions. For SA440-E, the company has developed a low-P_{CM} SA440-E grade that can be welded as easily as the high-weldability SA440B-U and SA440C-U described in the preceding section.

2.2 Thick-Wall, High-Strength Steel Tubes

2.2.1 High-strength square steel tubes, "P Column G385" and "PBCP440"

Square steel tubes are widely used as square columns for building structures. Cold press-formed square steel tubes of the 550 N/mm^2 and 590 N/mm^2 classes, the P column G385 and PBCP440[7], were jointly developed by JFE Steel and Seikei Corp. for use in large-scale buildings such as high-rise buildings. The P Column G835 has a unique strength level as a circular steel tube for building structures. **Figure 3** shows the relationship between the diameter-thickness ratio and plastic deformation capacity, a property assessed by a 3-point cyclic bending test conducted on a test specimen in which a through diaphragm was welded to the middle part. The high-strength square steel tubes have sufficient yield strength and plastic deformation capacity, and their performance is equivalent to that of the conventional BCP325.

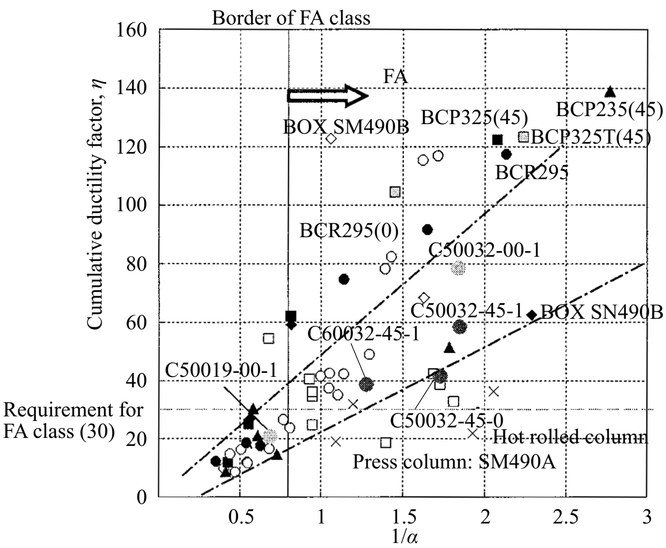

Fig. 3 Relationship between cumulative ductility factor, η and general width-thickness ratio, α

2.2.2 High-strength tubular columns "P-325/355/385/440"

Because the shape and sectional performance of tubular columns are isotropic, beams can be attached from any angle. Moreover, the use of the tube as a concrete-filled tubular (CFT) column can be expected to provide a constraining force to increase the compressive strength of the concrete. As such, the tube offers excellent economy as a steel member. JFE Steel's high-strength tubular columns for building structural use include the four grades shown in **Table 8**. The products can be manufactured by either the UOE process or press bending. The process of choice should be determined based on the thickness/diameter ratio (D/t), in order to satisfy the yield ratio requirements[8].

2.3 H-Shapes

2.3.1 Superlarge, constant-outer-size H-shapes

To accommodate the further increases in the size of structural members following from the tendency toward higher-rise and larger-space building structures, JFE Steel developed the Super Hislend H-shape H1000 and 950 series of large-section wide flange beams with constant outer sizes and web heights of 1 000 mm and 950 mm[9]. **Table 9** shows the sizes of the H-shapes with constant outer sizes produced at JFE Steel. There are now 311 sizes available, exceeding the number available from any other manufacturer in Japan. A Super Hislend

Table 9 Super Hislend H section table

Web \ Flange		200						250							300							350						400					
		12	16	19	22	25	28	16	19	22	25	28	32	36	16	19	22	25	28	32	36	22	25	28	32	36	40	22	25	28	32	36	40
400	9	◇	◇	◇	◇																												
	12				◇																												
450	9	◇	◇	◇	◇			◇	◇	◇																							
	12			◇	◇	◇				◇	◇	◇																					
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	16																●	●	●														
550	9	◇	◇	◇	◇			◇	◇	◇																							
	12			◇	◇	◇				◇	◇	◇			●	●	●	●															
	16																●	●	●														
600	9	◇	◇	◇	◇			◇	◇																								
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650	9	◇	◇	◇	◇																												
	12			◇	◇	◇	◇		◇	◇	◇	◇			●	●	●	●															
	16											◇					●	●	●	●													
700	9	◇	◇	◇	◇			◇	◇																								
	12				◇	◇	◇		◇	◇	◇					◇	◇	◇				●	●										
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750	12								◇	◇	◇																						
	14										◇	◇					●	●	●				●	●	●								
	16																	●	●	●				●	●	●							
800	14									◇	◇						◇	◇	◇				●	●					●	●			
	16										◇	◇					◇	◇	◇	◇			●	●	●	●			●	●	●	●	
	19																						●	●	●	●	●			●	●	●	●
850	14									◇	◇																						
	16										◇	◇					◇	◇	◇	◇			●	●	●				●	●	●		
	19																							●	●	●	●			●	●	●	●
900	16								◇	◇	◇	◇				◇	◇	◇	◇	◇			●	●	●				●	●	●		
	19																	◇	◇	◇			●	●	●	●	●			●	●	●	●
950	16									●	●	●	●				●	●	●	●		●	●	●	●			●	●	●	●		
	19										●	●	●	●				●	●	●	●		●	●	●	●			●	●	●	●	
1000	16									●	●	●	●				●	●	●	●		●	●	●	●			●	●	●	●		
	19										●	●	●	●				●	●	●	●		●	●	●	●			●	●	●	●	

Fillet size: 13 mm Fillet size: 10 mm

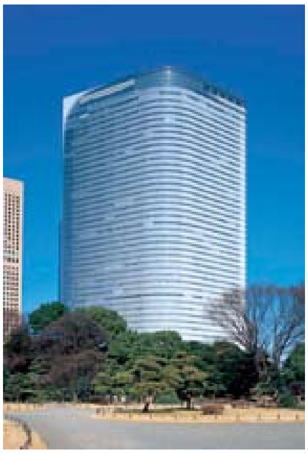

Photo 3 Dentsu Building

H-shape is a hot-rolled H-shape composed of a web and flanges, with a plate thickness identical to that of a steel plate series. Outstanding shape and dimensional accuracy are assured in its manufacture. The sectional dimensions of Super Hislend H-shapes can have the same shapes as built-up H-shapes, structures obtained by welding steel plates together. The use of Super Hislend H-shapes makes it possible to execute construction work economically in the building field.

Photo 3 shows the Dentsu Building, a high-rise building in which Super Hislend H-shapes are applied, as an example. Large- size Super Hislend H-shapes are used in the beam materials.

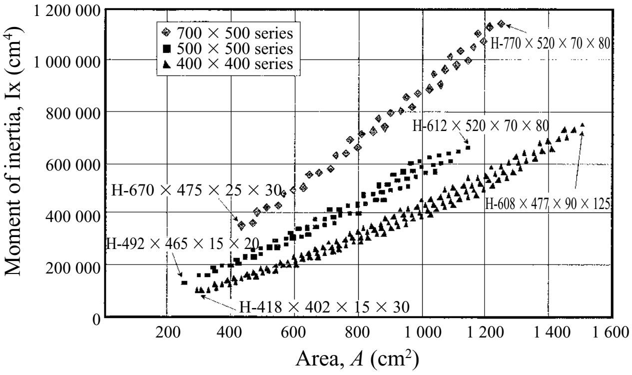

Fig. 4 Relation between area and moment of inertia

Photo 4 Dojima Avanza

2.3.2 Heavy gauge H-shapes

Heavy gauge H-shapes with flange thicknesses exceeding 40 mm have large sections equivalent to those of box columns assembled by welding steel plates together. They are ideal for use as column materials for high-rise buildings, as they require fewer welded joints than box columns and offer advantages such as improved safety and shorter manufacturing terms.

JFE Steel developed the heavy gauge H-shape 700 × 500 series as column materials of high-rise buildings[10]. The 700 × 500 series has outstanding material characteristics. Their strength, toughness, and weldability are equivalent to those of the TMCP type heavy gauge H-shapes (400 × 400 and 500 × 500 series) developed earlier, and their sectional performance in the direction of the strong axis increases by about 20% due to the increase in the section. **Figure 4** shows the relationship between sectional area and section modulus of these H-shapes. The material selection menu is improved and optimum column sections can be selected.

The TMCP type heavy gauge H-shapes are used in about 15 buildings. The tubes are used mainly in tube constructions, such as that adopted in Dojima Avanza (**Photo 4**).

Table 10 Mechanical properties of low yield strength steel

Grade	Plate /Pipe	Tensile test				
		YS (N/mm²)	TS (N/mm²)	YR (%)	El* (%)	$vE_{0°C}$ (J)
JFE-LY100	Plate	80–120	200–300	≤60	≥50	≥27
JFE-LY225		205–245	300–400	≤80	≥40	≥27
JFE-LY100S	Pipe	80–120	200–300	≤60	≥50	≥27
JFE-LY225S		205–245	300–400	≤80	≥35	≥27

YP: Yield point TS: Tensile strength YR: Yield ratio El: Elongation $vE_{0°C}$: Charpy absorbed energy at 0°C *JIS No. 5

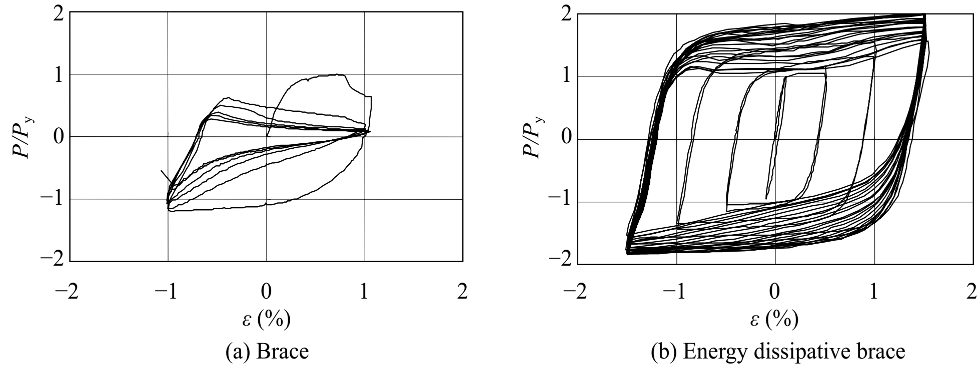

Fig. 6 Comparison of hysteresis loop of brace

(a) Tube-in-tube type (b) Flat-bar type

Fig. 5 Energy dissipative brace

2.4 Low-Yield-Point Steel Materials

Low-yield-point steel materials are steel products for use in vibration control devices. These dampers reduce the response of structures to earthquakes by preferentially dissipating the earthquake energy they absorb. They have been installed in high-rise buildings as standard since the 1955 Hyogo-Ken Nanbu Earthquake.

JFE Steel has a lineup of four types of low-yield-point steel materials (**Table 10**). The JFE Steel Group developed three types of vibration dampers, i.e., the brace type, the assembled type, and the wall type as damper products. Two types of braces are applied[11,12]: the tube-in-tube type buckling bracing, in which a seamless tube (JFE-LY100S or JFE-LY225S) is used as the axial material, and the flat-bar type, a buckling braced by a square steel tube in which a flat bar cut out of a plate (JFE-LY100 or JFE-LY225) is used as the axial material (**Fig. 5**). **Figure 6** compares the restoring characteristics between a conventional steel tube brace and the developed damping brace. The energy-dissipative brace, in which compression and tension are equivalent for both stiffness and yield strength, has stable hysteretic characteristics and a high plastic deformation capacity

2.5 Welding Techniques

As buildings become larger, more emphasis is placed on efficiency for ease of welding.

J-STAR® Welding is a CO_2 arc welding method using a wire with an appropriate amount of rare earth metal added and electrode negative polarity in place of the conventional electrode positive mode[13, 14]. With this welding method, an arc plasma forms in the shape of a circular cone with an apex at the tip of the wire in high-current welding of 250 A or more. Under this condition, the droplet transferred from the tip of the wire to the molten pool performs a fine and continuous spray transfer with a depth of penetration about 1.5 times that of a conventional method. By studying a form of narrow-gap welding that exploits this characteristic, JFE Steel established a high-efficiency welding technique with an I-bevel gap of 5 mm and a single-bevel 25° gap of 2 mm. The column-beam joints to which this narrow-gap welding is applied have been ascertained to have a sufficient deformation capacity in loading tests.

3. Conclusions

As an integrated iron and steel manufacturer, JFE

Steel must constantly develop and supply new high-performance steel materials suited to the design methods of the age. After about a decade of initial diffusion of the "New Seismic Design Codes" introduced in 1981, the need for steel materials suitable for plasticity design increased and new standards for building structures were created. These new standards include the SN standard (Rolled steels for building structures) as an extension of the SM standard (Rolled steels for welded structures), the STKN standard (Carbon steel tubes for building structures) as an extension of the STK standard (Carbon steel tubes for general structures), and the BCR standard (Cold-press-formed square steel tubes for building structures) and BCP standard (Cold-roll-formed square steel tubes for building structures) as extensions of the STKR standard (Square steel tubes for general structures).

The revised Building Standard Law of 2001 incorporates a new series of "performance regulations." Since its introduction, there has been a gradual shift in many fields, the building field among them, to designs that prioritize performance requirements. According to the prevailing concept, a steel material is accepted if it meets specific performance requirements regardless of the kind of material adopted in the building or the structural method. Thus, the task for steel material makers is no longer to supply conventional steels to meet standardized requirements for use in any part of a building. Instead, steel material makers need to supply steel materials tailored to specific performance specifications stipulated for the different parts of buildings where the materials are used.

The Ministry of Economy, Trade and Industry, the Ministry of Land, Infrastructure and Transport, and other entities are now carrying out a joint project to "Develop Buildings with a New Construction System Using Innovative Structural Materials." This project proposes high-rise buildings characterized by an elastic structure capable of resisting an earthquake of Japan Meteorolo-ical Agency (JMA) intensity 7, on the assumption that high-strength steels of 780 N class and above will be used. This is a structure system in which seismic energy is dissipated by use of damping devices and column materials that make the most of the large elastic deformation of high-strength steels in order to prevent damage to buildings. The development of steel materials and members tailored to specific performance requirements is indispensable for realizing this structure system, as is the development of positive joining techniques.

By ascertaining economical environments and technological trends, the JFE Group intends to accurately grasp the needs of users in the future and develop and propose high-quality products to meet requirements of more sophisticated building structures.

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