

For 590-780MPa High Tensile Strength Steel and Low Temperature Steel

A guide for selecting welding consumables ⁽¹⁾

	≥490MPa	≥520MPa	≥550MPa	≥610MPa	≥670MPa	≥770MPa
TS	≥350MPa	≥400MPa	≥420MPa	≥500MPa	≥550MPa	≥690MPa
YS	≥35J	≥40J	≥42J	≥50J	≥55J	≥69J
IV						
SMAW						
-20°C	LB-52 (AC, DC-EP, SR) LB-52A (AC, DC-EP, SR)	LB-57 (AC, DC-EP, SR)	LB-62UL (AC, DC-EP, SR) LB-62 (AC, DC-EP, SR)	LB-62UL (AC, DC-EP, SR) LB-62 (AC, DC-EP, SR)	LB-106 (AC, DC-EP)	LB-80UL (AC)
-40°C	LB-7018-1 (DC-EP) LB-52LT-18 (DC-EP, SR)	NB-1SJ (AC, DC-EP, SR) LB-52NS (AC)	NB-1SJ (AC, SR) LB-62L (AC, DC-EP, SR)	LB-65L (DC-EP, SR) LB-62L (AC, SR)	LBY-75 (AC)	LB-88LT (AC)
-60°C	NB-1SJ (AC, DC-EP, SR) LB-52NS (AC, DC-EP, SR))					
FCAW, GMAW ⁽²⁾						
-20°C	DW-100E (100%CO ₂) MGS-50 (Ar-20%CO ₂ , SR)	DW-55L (100%CO ₂) DWA-55L (Ar-20%CO ₂) MGT-1NS (Ar-20%CO ₂) DWA-81Ni1 (Ar-20%CO ₂)		DWA-65L (Ar-20%CO ₂) MGT-1NS (Ar-20%CO ₂)	MGS-70 (Ar-20%CO ₂)	MGS-80 (Ar-20%CO ₂)
-30°C	DW-55E (100%CO ₂) DWA-55E (Ar-20%CO ₂)					
-40°C	DWA-55ESR (Ar-20%CO ₂ , SR)					MGS-88A (Ar-20%CO ₂)
-60°C	DW-55L (100%CO ₂) DWA-55L (Ar-20%CO ₂) MGS-50LT (Ar-20%CO ₂ , SR)	DW-55LSR (100%CO ₂ , SR) DWA-55LSR (Ar-20%CO ₂ , SR) MGS-50LT (Ar-20%CO ₂)	DW-55LSR (100%CO ₂) DWA-55LSR (Ar-20%CO ₂)	DW-62L (100% CO ₂) DWA-62L (Ar-20%CO ₂)	—	
GTAW ⁽³⁾						
-20°C	TGS-50 (SR) TGS-51T (SR)	TGS-62 (SR) TGS-60A (SR)	TGS-62 (SR) TGS-60A (SR)	TGS-62 (SR) TGS-60A (SR)	TGS-80AM (SR)	
-40°C						
-60°C	TGS-1MT TGS-1N	TGS-60A (SR)	TGS-60A (SR)	TGS-60A (SR)		
SAW						
-20°C	MF-300 / US-36 (AC, SR)	MF-300 / US-49A (AC, SR)		MF-300 / US-40 (AC)	PFH-80AK / US-255 (AC)	
-40°C	PFH-55AS / US-36J (DC-EP, SR)	PFH-55S / US-49A (AC, SR)	PFH-55S / US-49A (AC, SR) PFH-80AK / US-56B (DC-EP)	PFH-55S / US-40 (AC) PFH-80AK / US-56B (AC, DC-EP)		
-60°C	PFH-55LT / US-36 (AC, SR)	PFH-55AS / US-36J (DC-EP) PFH-55LT / US-36 (AC) PFH-55LT / US-36J (AC, SR)	PFH-55LT / US-36J (AC)	PFH-80AK / US-56B (AC) PFH-55S/US-2N (AC, SR)		

Note (1) Welding consumables shown with SR are suitable for the as-welded and PWHT conditions.

(2) DW-XXX and DWA-XXX are flux-cored wires. MGS-XXX and MGT-XXX are solid wires.

(3) In one-side welding, back shielding is recommended.

(4) To prevent cold cracks or to assure mechanical properties of weld metals, preheating and interpass temperatures must be controlled as per an appropriate welding procedure spec.

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■ Tips for better welding results

Common to individual welding processes

- (1) Use an appropriate welding procedure taking into account the requirements for the mechanical properties of the weldment, because heat input, Interpass temperature and plate thickness affect the cooling rate of welds and, where the cooling rate is excessively low, the tensile strength and notch toughness of the weld decrease.
- (2) Use appropriate preheat and Interpass temperatures to prevent cold cracking assisted by the diffusible hydrogen in welds. Suitable preheat and Interpass temperatures vary depending upon welding process, plate thickness, and kind of steel plate. In general, higher tensile strength steels need higher preheat and interpass temperatures.
- (3) Select appropriate welding consumables and welding conditions carefully particularly in cases where the weld metal dilution by the base metal is large, because the chemical composition of the weld metal can markedly be affected by the base metal chemical composition and thereby the properties of the weld metal can be varied.
- (4) Confirm the applicability of postweld heat treatment for welding consumables before use, because some welding consumables can provide good notch toughness only in the as-welded condition and some welding consumables can provide sufficient notch toughness in the postweld heat treated conditions.
- (5) Confirm the suitable electric current characteristics for welding consumables before use, because each welding consumable is designed to provide the highest performances with specific type of electric current (AC, DC, or both) and polarity (DC-EP, DC-EN, or both). Therefore, when a welding consumable designed for AC is used in DC or in opposite case, there are possibilities to deteriorate the properties of the weld metal and usability.
- (6) Some welding consumable can be used by both AC and DC-EP; however, the use of DC-EP causes a little decrease in strength of the weld metal.

SMAW

- (1) Low-hydrogen type electrodes should be stored in an oven (100-150°C) placed near the welding area after re-drying was finished. Take out minimize amounts of electrodes needed for a certain work from the oven. This manner is to keep the diffusible hydrogen content of the weld metal in a low level.
- (2) Use the backstep technique directly in the welding groove or strike an arc on a scrap plate before transferring the arc into the groove to prevent cracking.
- (3) Keep the arc length as short as possible to maintain good shielding by the coating flux decomposed gases during welding. The use of a long arc can cause a decrease of impact value of the weld metal caused by the nitrogen in the atmosphere and, where the arc length is excessive, blowholes can occur in the weld metal. Use a wind screen in windy areas.
- (4) Refer to the tips for Mild Steel and 490MPa High Tensile Strength Steel for other notes.

FCAW, GMAW, and GTAW

- (1) Use suitable shielding gas for each welding wire because the composition of a shielding gas can affect the mechanical properties of the weld metal.
- (2) Use a wind screen in windy areas to maintain the shielding gas in good condition. Insufficient or irregular shielding gas can cause weld defects.
- (3) Refer to the tips for welding Mild Steel and 490MPa High Tensile Strength Steel for other notes.

SAW

- (1) Remove rust, oil, grease, and water in the welding groove beforehand because such dirt can cause weld defects like pits and blowholes.
- (2) Select suitable steel plates and welding consumables carefully taking into account the dilution of weld metal by the base metal. Submerged arc welding characterizes deeper penetration and thus larger dilution; therefore, the properties of the weld metal can markedly be varied by the chemical composition of the base metal. Especially in the single-pass-on-both-side welding, the dilution ratio becomes as large as about 60% and thus the properties of the weld metal is considerably affected by the chemical composition of the base metal.
- (3) Refer to the tips for Mild Steel and 490MPa High Tensile Strength Steel for other notes.