

## LAMPIRAN

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**LAMPIRAN 1**

**Sertifikat Pabrik (*Mill Certificate*) dari Baja Lembaran**





## **LAMPIRAN 2**

### **Parameter Pengelasan**

## WELDING PROCEDURE SPECIFICATION

Manufacturer's Welding Procedure Specification (WPS)

Examiner or Examining Body : Mr. X

Location : Jakarta

Reference : 02/WPS/2009

Method of Preparation and Cleaning : Flame Cutting

WPAR No : 02/WPAR/2009

Parent Metal Specification : SHT 780

Manufacturer : PPIKI

Material Thickness : T.12

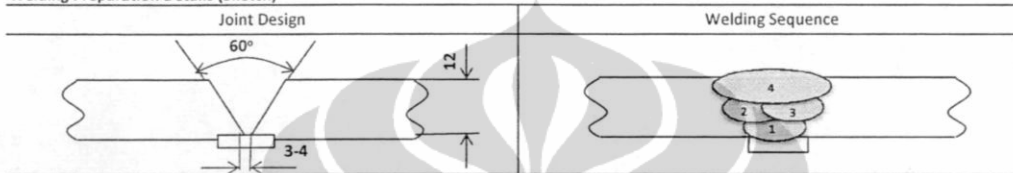
Welding Process : Gas Metal Arc Welding (GMAW)

Outside Diameter : -

Joint Type : Single V Butt Weld (Back Plate)

Welding Position : Downhand Position

### Welding Preparation Details (Sketch)



### Welding Parameter

Run	Process	Size of Filler Metal	Current (A)	Voltage (v)	Type of Current Polarity	Wire Feed Speed	Travel Speed (mm/sec)	Heat Input (J/mm)
1	GMAW	1.2 mm	280	30	DCRP	-	4.84	1562.40
2	GMAW	1.2 mm	280	30	DCRP	-	7.79	970.20
3	GMAW	1.2 mm	280	30	DCRP	-	6.86	1101.24
4	GMAW	1.2 mm	290	31	DCRP	-	2.88	2812.97

### Welding Consumables

Type, Designation Trade Name:	AWS ER70S-6	Other Information*) e.g :	-
Any Special Baking or Drying :	No	Weaving (Maximum Width of Run) :	Yes
Gas Flux:	80% CO <sub>2</sub> + 20 % Ar	Oscillation (Amplitudo, Frequency Dwell Time) :	-
Gas Flow Rate : Shield	25 lt/min	Pulse Welding Details :	-
Backing	No	Contact Tube to be Workpiece Distance :	10-15 mm
Tungsten Electrode Type/Size :	No	Plasma Welding Details :	-
Details of Back Gouging/Backing :	No	Torch Angle :	90°
Preheat Temperature :	170 - 190 °C		
Interpass Temperature :	170 - 190 °C		
<b>Post Weld Heat Treatment :</b>	Not Required		
Time, Temperature, Methode :			
Heating and Cooling Rate*) :			



**LAMPIRAN 3**  
**Sertifikat Pabrik (*Mill Certificate*) dari Kawat Las**

## SM-70

AWS ER70S-6  
BS A18  
JIS YGW12

For welding mild and 50kgf/mm<sup>2</sup> class high tensile steel

- Applications  
Butt and fillet welding of vehicles, buildings, ships, machinery and bridges.
- Characteristics on usage
  - ① As the deposition rate is high and penetration is quite deep which is common features of solid wire, highly efficient welding can be performed.
  - ② As the deposition efficiency is high because of no slag formation, the welding time is saved.
  - ③ Arc is stable and spatter loss is low.
- Notes on usage
  - ① Use welding grade CO<sub>2</sub> gas.
  - ② Flow quantity of shielding gas should be 25ℓ/min. generally.
  - ③ Use the wind-screen against wind.
  - ④ Keep the distance between tip and mother plate within 6~15mm for 250A, and under or within 15~25mm for more than 250 Amp. of welding current.

### Typical chemical composition of weld metal (%)

C	Si	Mn	P	S
0.09	0.41	1.10	0.012	0.011

### Typical mechanical properties of weld metal

N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	YP	TS	EL (%)	IV J (kgf.m) (0°C)
430(44)		540(55)	30	120(12.1)

### Sizes available and recommended currents (DC+)

Diag. (mm)	0.9	1.2	1.6
F	50 ~ 200	80 ~ 350	170 ~ 550
OH	50 ~ 120	50 ~ 140	—
VTU	50 ~ 140	50 ~ 160	—
VD	50 ~ 200	50 ~ 250	—

## SM-70-G

AWS ER70S-G  
JIS YGW11 ✓

For high efficient welding of mild and 50kgf/mm<sup>2</sup> class high tensile steel.

- Applications  
Flat and horizontal fillet welding of construction machinery, structural steels, bridges, ships, vehicles and steel fabrications.
- Characteristics on usage
  - ① SM-70-G is a solid wire for flat and horizontal fillet welding which has been designed to get good weldability and good notch toughness.
  - ② As the deposition rate is high and penetration is quite deep, highly efficient welding can be performed.
  - ③ In the high current welding (more than 300 Amp.), arc stability is excellent and spatter loss is comparatively low.
  - ④ As the wire contains special elements, its weldability and impact values are extremely good.

### Notes on usage

- ① Use welding grade CO<sub>2</sub> gas only.
- ② For other notes, refer "Notes on Usage" of SM-70.

### Typical chemical composition of weld metal (%)

C	Si	Mn	P	S
0.09	0.52	1.07	0.015	0.009

### Typical mechanical properties of weld metal

N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	YP	TS	EL (%)	IV J (kgf.m) (0°C)
450(46)		560(57)	30	140(14)

### Sizes available recommended currents (DC+)

Diag. (mm)	1.2	1.6	2.0
F	200~350	300~550	400~650
A	HF 200~350	300~550	400~650





KES	HIGH TENSILE ROLLED STEEL PLATES FOR WELDED STRUCTURES OF 780N/mm <sup>2</sup> CLASS SHT780 (W)	07.(MATERIAL) 116 (2008)

**1. SCOPE** Of high-tensile rolled steel plates for welded structure of good weldability (hereafter referred to as steel plates), steel plates of tensile strength class of 780N/mm<sup>2</sup>{80kg/mm<sup>2</sup>} shall conform to this standard.

**Remark** The figures and units in the brackets { } are for reference.

**2. SELECTION OF STEEL PLATES** Conform to **KES 45.200.7** (SELECTION OF IRON AND STEEL MATERIALS).

**3. PRODUCTION METHOD** The standard steel plate shall be quenched and tempered steel plate after rolling a slab of killed steel, which shall be produced by a steel converter and ladle scouring with degassing and grain refining. The slab shall be continuous-casted with electromagnetic mixing.

Though it is permissible for the steel plate to be produced by an electric furnace, or be casted as an ingot, or be produced without degassing and grain refining, each influence shall be confirmed according to **KES 07.103.2** (EXAMINATION PROCEDURE OF USE PROPRIETY OF IRON AND STEEL MATERIAL) if it is used for a structural member.

**4. QUALITY**

**4.1** The steel plates shall be well finished, uniform in quality, and free from detrimental defects in use.

**4.2 Symbol, chemical compositions and heat treatment** Conform to **Table 1**.

**Table 1**

Symbols	Equivalent old symbols	Chemical composition%					Heat treatment	Welding crack sensitivity index (Chemical composition term) PCM	Applicable thickness mm
		C	Si	Mn	P	S			
SHT780A*	SHT80-SHT80A	0.10 to 0.22	0.15 to 0.55	1.00 to 1.60	0.025	0.015	Quenched and tempered after rolling	0.30 MAX	6 to 19
SHT780B*	SHT80-SHT80B	0.10 to 0.16	0.15 to 0.55	0.90 to 1.50	MAX	MAX		0.30 MAX	22 to 60

\* These symbols are peculiar to **KES** and not specified in **JIS**.

**Remarks 1.** Chemical compositions in **Table 1** show fundamental compositions; if required, variation within the range of the compositions in **Table 1** is permissible, and alloy elements other than those in **Table 1** may be included.

The following alloy elements are added other than the ones listed in **Table 1**.

Cr and B in specification SHT780A

Cr, Mo, B and Ni and Cu according to the application or the plate thickness in SHT780B

**2. Welding crack sensitivity index (Chemical composition term) PCM** is the index for the welding crack in a steel plate for welded structural use. The calculation formula is as follows:

$$PCM = C + \frac{Si}{30} + \frac{Mn + P + Cr}{20} + \frac{Ni}{60} + \frac{Mo}{15} + \frac{V}{10} + 5 \times B$$

In addition to PCM, the quantity of the hydrogen diffused in a deposited metal zone and its degree of constraint affect the welding crack. In general, however, pre-and post-heating shall not be required in CO<sup>2</sup> gas welding with a PCM value of 0.30 and below. Where the PCM value is over 0.30, consult with the departments in charge of design and welding to determine the appropriate welding method.

**3.** The values of the chemical compositions are those obtained by a ladle analysis.

The product analysis shall conform to **JIS G 0321** (Product analysis and its tolerance for wrought steel).



KES	CARBON STEEL FOR MACHINE STRUCTURAL USE S-C	(W)	07.(MATERIAL)
			211.1 (2007)

**1. SCOPE** The standard stipulates the production method, quality, testing, and inspection of carbon steel (hereafter referred to as steel product) for machine structural parts. The carbon steel for gears and swing circles shall conform to **KES 07.211.12 (CARBON STEEL FOR GEARS)**.

The steel product of which the forging ratio is 4S or less shall conform to **KES 07.211.14 (LOW FORGING-RATIO STEEL)**.

**2. PRODUCTION METHOD**

**2.1** The standard steel product shall be rolled (forged) killed slabs or killed ingots of steel that is melted in a converter or electric furnace and refined in a ladle refining/degassing furnace and cast with continuous casting or ingot casting method afterwards.

**2.2** The steel product shall be produced from steel slabs or ingots from which flaws have been cut off and its surfaces and internal structures free from harmful defects in the production process.

**2.3** The forging ratio of the steel product produced from ingots, in principle, shall be 4S and above for forging, and 7S and above for direct machining.

**2.4** The steel product shall be rolled or forged unless otherwise specified.

**2.5** It is desirable to understand the production method and process as they affect the steel product quality.

**3. QUALITY**

**3.1 Kinds and chemical composition** The steel product shall undergo the test specified in 5.1 and shall conform to the following.

(1) Molten steel analysis values shall conform to **Table 1**.

(2) Product analysis tolerance shall conform to **Table 2 in JIS G 0321** (Product analysis and its tolerance for wrought steel).

**Table 1**

Symbol	Chemical composition%					Example of applicable parts
	C	Si	Mn	P	S	
<b>S22C</b>	0.20 to 0.25	0.15 to 0.35	0.30 to 0.60	0.030 or less	0.035 or less	Brackets
<b>S25C</b>	0.22 to 0.28					Lock nuts
<b>S35C</b>	0.32 to 0.38		Idler rims and flanges			
(S43C)	0.40 to 0.46		-			
<b>S45C</b>	0.42 to 0.48	0.60 to 0.90				General shafts and bosses
<b>S53C</b>	0.50 to 0.56					Pins and bosses

**Remark.** The chemical composition of impurity for all steel products shall be the following:  
Cu≤0.30%, Ni≤0.20%, Cr≤0.20% and Ni+Cr≤0.35%.

**3.2 Macrostructure** The steel product shall undergo the test specified in 5.2 and shall conform to the following.

The steel product shall be free from air bubbles, pipes, hair cracks, and forging cracks. The acceptance limit of each uneven structure such as looseness, ingot pattern, white band, or segregation that is harmful in use shall conform to **KES 86.220 (MACROSTRUCTURE OF STEEL)**.

**3.3 Grain size** The steel product shall undergo the test specified in 5.3 and shall conform to the following.

The austenite grain size shall be uniform and GH5.0 and above in size without mixed grain sizes.

**3.4 Allowable limit of non-metallic inclusion** The steel product shall undergo the test specified in 5.3 and shall conform to the following.

The cleanliness shall be dT=0.25% or less.

Attached Table 1 Conditions for heat treatment of S48C-KN and S50C-KN to be used for induction hardening gears

Type of steel	Type of heat treatment	Heat treatment number	Pre-treatment	Quenching temperature °C	Surface hardness after hardening	Tempering temperature °C	Tempering hardness of surface	Applied thickness (Dia.) mm			Mechanical property			Example of applicable parts												
								Oil cooling	Water cooling	Water injection	Yield point (kg/mm <sup>2</sup> )	Tensile strength (kg/mm <sup>2</sup> )	Elongation %		Impact value (Charpy) J/cm <sup>2</sup>											
S43C S45C S48C-KN S50C-KN	Quenching and tempering of raw material	1121001900	The structure of gear material before the heat treatment shall be equivalent to or better than normalized structure if necessary.	Water quenching: 810 to 850 Oil quenching: 830 to 860	MIN 30HRC	500 to 600	201 to 255 HB 229 to 277 HB	-	-	MIN 490 (90)	MIN 686 (70)	MIN 20	MIN 78 (8)	General gears Final reduction gears for bulldozers (small through large size) Final reduction gears for superbulldozers General gears												
															S43C S45C	2146191100 2146192100	1121001900	840 to 910	MIN 55HRC	180 to 210 135 to 165	52 to 60 HRC	-	-	-	-	-

Remark 1. Viewed in quenching crack prevention and distortion suppression, it is desirable to use the water soluble coolant.

2. One-slot hardening shall be applied to S48C-KN and S50C-KN in principle. If it is impossible to do so, then determine in consultation with the department in charge of heat treatment.

3. S50C-KN is used for further hardening in the surface, so tempering temperature shall be 145 to 155°C.

4. Regarding S48C-KN and S50C-KN, KES 04.015.31 Annex has already been formulated in accordance with the actual results of material, surface hardness, matrix hardness and hardened layer depth, refer to this for the selection of material and heat treatment.

5. The hardness measuring point of gear shall conform to the following:

(1) Surface hardness Refer to KES 86.222.01 (Hardness measuring positions of gears) for the hardness of the tooth tip, pitch circle, root circle.

(2) Matrix hardness This shall be measured at point B (intersecting point of the root circle and the center line of the tooth thickness) shown in Attached Figure 1, and shall conform to Attached Table 2. However, when the upper limit specified in existing drawings is less than the value shown in Attached Table 2, the part criterion shall be performed according to Attached Table 2. Attached Table 2 shall be used for new design.

Attached Table 2

Material	Module	Matrix hardness
(S43C) - S45C	Under 6	-
	MIN 6	201 to 277 HB
S48C-KN	5.5 to 8	229 to 362 HB
	MIN 9	229 to 331 HB
S50C-KN	MIN 10	229 to 294 HB

Attached figure 1  
Measuring point of matrix hardness





**LAMPIRAN 6**

**Spesifikasi Teknis SS400**

KES	ORDINARY ROLLED STEELS FOR WELDED STRUCTURES OF 400N/mm <sup>2</sup> SS400•SM400B	07. (MATERIAL)
	(W)	111.1 (2008)

**1. SCOPE** This standard stipulates steel plates used for structures and steel bars and shapes used for structures without being subject to heat treatment of construction machinery, industrial vehicles, industrial machines, etc.

**Remark 1.** Use **SMM400B** stipulated in **KES 07.115.2 (STEEL PLATE FOR ROPS )** for ROPS.

2. The figures and units in the brackets { } are for reference.

**2. PRODUCTION METHOD** Steel plates shall be produced, in principle, by rolling a slab which was made into an ingot in a converter and cast by continuous casting. Use of those produced from being made into an ingot in an electric furnace and those rolled from a steel ingot shall require approval by material experts. Steel bars and shape steel, and flat steel shall be produced by being made into an ingot in a converter or an electric furnace and by rolling from a slab or steel ingot. They shall be all made of killed steel.

**SM400B**, especially, shall be made of aluminum-killed steel.

**3. SYMBOL** Conform to **Table 1**.

**Table 1**

Symbols	Equivalent old symbols	Application	Reference
SS400 <sup>(1)</sup>	SS41 SE400P SE41P	Main structures	When identifying steel plate, flat steel, shape steel, and steel bar, the letters P, F, A and B shall be suffixed to the symbol, respectively. Shape steel: Equal angle steel, unequal angle steel, channel steel, unequal and uneven thickness angle steel, I-steel, bulb flats, T-steel and H-steel
SM400B <sup>(2)</sup>	SM41B WS41P	General welded structures	Steel sheet
SSC400	SSC41	Auxiliary structures	Light section steel: Light-gage channel, light Z-steel and hat-steel

**Note<sup>(1)</sup>** Although this is the same material symbol as it is in **JIS**, specifications which are peculiar to **KES** are added.

**(<sup>2</sup>)** Use **SM400B** to indicate the material symbol to designate the use in extremely cold regions (see **4.2** and **7**).

Although it is permissible to use the relevant brands of old SE400P for **SS400** described in **7** for extremely cold regions because they satisfy the impact strength of **SM400B** as stipulated in **4.2**, it is necessary for the purchasing department to pay attention to the applicable steel products.

#### 4. QUALITY

**4.1 Chemical composition** Conform to **Table 2**.

**Table 2**

Symbols	Chemical composition %					Pcm <sup>(2)</sup>	Applicable plate thickness t
	C	Si	Mn	P	S		
SS400P <sup>(1)</sup>	0.05 to 0.25	0.55 or less	0.30 to 1.60	0.035 or less	0.035 or less	0.30 or less	(4.5, 6) to 100
SM400B			2.5×C				
SS400A, F, B SSC400	---	---	---	0.050 or less	0.050 or less	---	---

**Note<sup>(1)</sup>** Ni, V, Nb, Cu, B, etc. may be added as necessary.

**(<sup>2</sup>)** Welding crack sensitivity index (chemical composition term) is the index for welding cracks in a steel plate for welded structural use. The calculation formula is as follows:

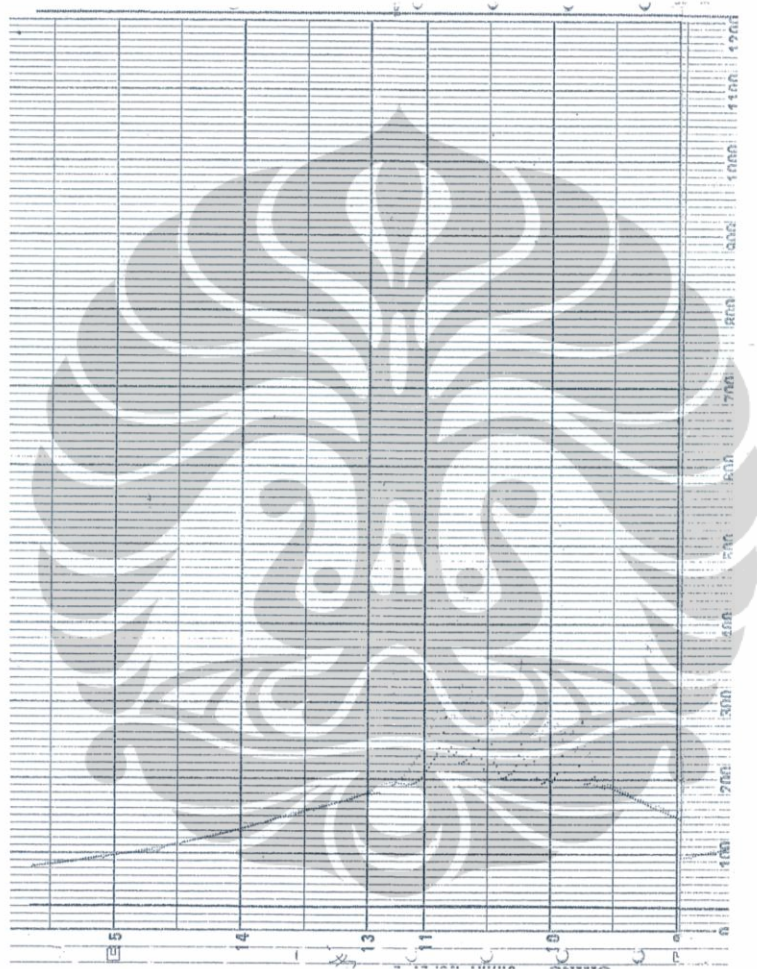
$$P_{CM} = C + \frac{Si}{30} + \frac{Mn + Cu + Cr}{20} + \frac{Ni}{60} + \frac{Mo}{15} + \frac{V}{10} + 5 \times B$$



**LAMPIRAN 7**

**Hasil Pengukuran Laju Pendinginan**

## MEDIA PENDINGINAN HEATER 1





## MEDIA PENDINGINAN HEATER 2

