Industeel

ArcelorMittal

SuperElso® 690 CR

SuperElso® 690 CR: Quenched and Tempered High Strength Steel for Leg Components of Jack-up Rigs

SuperElso® 690 CR (SE 690 CR) is a high strength quenched and tempered steel adapted for jack-up rig legs of offshore platforms. **SuperElso® 690 CR** is manufactured via the low carbon footprint electric arc furnace route with dephosphorisation, ladle refining and vacuum degassing to provide a reproducible, clean and homogenous steel.
This material has been specially designed for offshore applications requiring the use of extra heavy plates meeting stringent mechanical properties requirements. The chemical composition of SuperElso® 690 CR has been carefully adapted and allows the achievement of high impact toughness values (> 50 J at - 60 °C) across the thickness while respecting the required tensile properties.
The main application of **SuperElso® 690 CR** being the manufacturing of racks and chords, particular attention has been paid on forming, flame cutting and welding properties. The low carbon equivalent of this material allows cutting and welding under optimal conditions, increasing in this way the cost efficiency of manufacturing.

PROPERTIES

CLASSIFICATION SOCIETY AND STANDARD (MAX. THICKNESS)

> DNV	NV FO690 (215mm), NV EO690 and NV E690 (254 mm)
> ABS	AB FQ70 Z35 (210 mm), AB EQ70 Z35 (254 mm)
> ASTM	A514, A517 A-Q (11'' or 279.4 mm)

CHEMICAL ANALYSIS - WEIGHT %

Heat analysis in mass weight % (guaranteed values)

	C	Mn	Si	P	S	Ni	Mo	Cr	Al
SuperElso® 690 CR	≤ 0.15	≤ 1.2	0.15/0.45	≤ 0.01	≤ 0.002	≤ 4.0	≤ 0.7	≤ 0.7	≤ 0.05
DNV	≤ 0.18	< 1.70	0.1/0.5	≤ 0.025	≤ 0.02				0.04/0.1
ABS	≤ 0.16	0.9/1.6	0.1/0.5	≤ 0.025	≤ 0.025				0.04/0.1

MECHANICAL PROPERTIES

Typical and guaranteed mechanical properties (thickness ≤ 254 mm).
Please consult us for more stringent requirements.

	YS (½ thickness)	UTS (¼ thickness)	A%	KVT (¼ thickness)	KVL (¼ thickness)	KVT (½ thickness)
	(MPa)			-60 °C (J)		-37 °C (J)
Guaranteed	≥ 690	790 / 940	≥ 16	46 / 32 ave./mini.	46 / 32	46 / 32
Typical	770	840	20	65 / 120	80 / 130	50 / 110
DNV / ABS (≤150 mm)	≥ 690	770 / 940	≥ 14	46 / 32	69 / 48	/

Plate compactness is guaranteed to ultrasonic levels determined by EN10130-S1E3.

Recommendations and data given in Plate Processing section are based on Industeel experience and best knowledge. They are intended to help the manufacturer in developing his own manufacturing procedures. The final choice of the processing conditions and the resulting consequences are the responsibility of the manufacturer.

FLAME CUTTING

SuperElso® 690 CR being a high strength steel, Industeel usually recommends for flame cutting a preheating at a temperature in the range 300°C - 350°C, without exceeding 400°C. Temperature shall not fall below 180°C during the entire cutting process. A stress relieving at 300°C immediately after end of cutting is also advised.

WELDING CONDITIONS

The reduced carbon content of SuperElso® 690 CR allows the use of low preheating temperature. According to the range of thickness commonly used for this material, optimal conditions have been determined taking into account all the usual processes and welding parameters used for assembling.

Pre-heating temperature	Post-heating temperature	Interpass
120°C (+ 25°C /-0°C)	**250°C** (± 10°C / 2 h)	**170°C** (max).

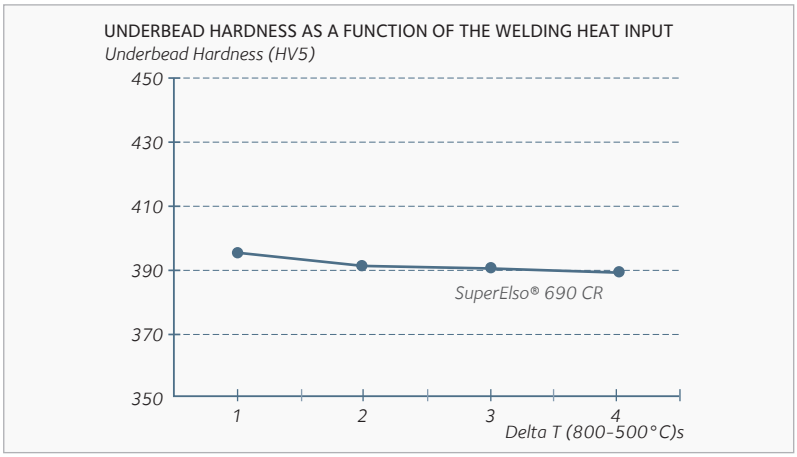
These welding conditions have been determined for highly clamped welds (implant tests, NFA 89100).

HEAT TREATMENT

Water quenching followed by tempering at approx. 600°C (1112°F). PWHT is not recommended for welded structures due to the risk of degradation of mechanical and toughness properties.

HAZ PROPERTIES

SuperElso® 690 CR is designed such that the underbead hardness is relatively independent of heat input. In most cases, underbead hardness ≤ 400Hv5 can be met, as recommended by DNV



HAZ IMPACT PROPERTIES

Typical HAZ results for SuperElso® 690 CR, taken from a welding procedure qualification on a 190 mm thick plate:
Process: SAW Heat input: 1.8 KJ/mm

LOCATION		TYPE	TEMPERATURE	ENERGY (J)	AVERAGE (J)
TOP CAP	Fusion line (FL)	KV	- 60°C / - 76°F	97 - 72 - 90	85
	FL + 2 mm			135 -100 - 115	116
	FL + 5 mm			91 - 92 - 86	89
ROOT	Fusion line (FL)	KV	- 60°C / - 76° F	106 - 94 - 106	102
	FL + 2 mm			85 - 95 - 150	110
	FL + 5 mm			50 - 50 - 55	51

NDT PELLINI

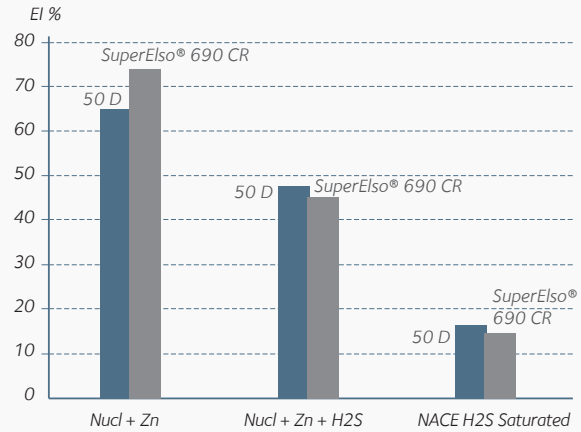
Drop Weight / Pellini tests have been performed on SE 690 CR steel. Typical NDT values of about –50°C are currently obtained. Different CTOD Tests in accordance with BS 5762 standard have been performed in different locations.

		SuperElso® 690 CR plate		CG HAZ	Weld metal
		thk =127 mm	thk = 180 mm		
KVT - 60°C (J)		140-150	50 - 70	180 - 190 - 120	140- 84 - 104
δ CT 50 specimens (mm)	0°C	0.49 (m)	0.21 (u)	0.19 (m)	0.15 (m)
	- 20°C		0.15 (u)	0.15 (u)	0.13 (u)
	- 40°C	0.51 (m) 0.50 (m)		0.10 (u)	

m = maximum - u = ultimate

CATHODIC PROTECTION

The evaluation of hydrogen assisted cracking resistance of high strength jack-up steels has been done using a Slow Strain Rate Tests approach. This test shows that SuperElso® 690 CR is at the same level of sensitivity than conventional normalized steels (for the same testing conditions).



Slow Strain Rate Tests results of 50D and SuperElso® 690 CR steels under cathodic protection (E= -1000 mV/ SCE) in synthetic seawater; (strain rate: 2.10^{-6} s^{-1}).

- **> EI = (RA% air - RA% cor) / RA%air**
- **> RA%air = reduction of area of reference specimen**
- **> RA%cor = reduction of area in the corrosive environment**

WELDING CONSUMABLES

A non-exclusive list of consumables is given hereafter. Some of these products have been tested and homologated by Industeel and the corresponding data sheets are available on demand.

	SMAW	FCAW	SAW
OERLIKON	Tenacito 80 CI	Fluxofil 42 Fluxofil 42 LT	Fluxocord 42 OP 121 TTW
BOHLER WELDING GROUP	FOX EV 85 SH Ni 2 K100		3 NiCrMo 2.5-UP BB 420 TTR, BB 420 TTR-C
NIPPON STEEL	Nittetsu L-80 SN		
ESAB	OK 75.75	Pz 6148 (Filarc)	

APPLICATIONS

SuperElso® 690 CR is specially designed for manufacturing jack-up rig legs. The following components can be supplied by Industeel:

> Racks

> Chords

> Windows

> Welded elements up to 24 m in length

> Rack chocks for locking systems

YOUR CONTACTS

Valéry NGOMO
Tel. +33 6 10 49 59 48
valery.ngomo@arcelormittal.com

https://industeel.arcelormittal.com

Industeel France
Châteauneuf plant
BP 368 Châteauneuf
F- 42803 RIVE-DE-GIER Cedex