



## 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 690 MPa (100 ksi) yield strength quenched and tempered steel adapted for jack-up rig legs of offshore drilling platforms. **SuperElso® 690 CR** is manufactured via the electric furnace 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 heavy thick plates (up to 250 mm/10") with demanding mechanical properties requirements. The chemical composition of SuperElso® 690 CR has been carefully adapted and allows the achievement of high impact values (> 50 J at - 60°C) across the thickness while respecting the tensile properties required.

The main application of **SuperElso® 690 CR** being the manufacturing of racks and chords, particular attention has been paid on forming, oxycutting and welding properties. The very low carbon content of this material allows cutting and welding under classical conditions, increasing in this way the cost efficiency of manufacturing.

## PROPERTIES

### STANDARD

- > DNV                      NVF 690 / grade F
- > ASTM                    A 514 - A 517
- > ABS                      FH 40

### CHEMICAL ANALYSIS - WEIGHT %

Heat analysis in 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	≤ 0.7	≤ 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 ≤ 210 mm)

	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.

**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).

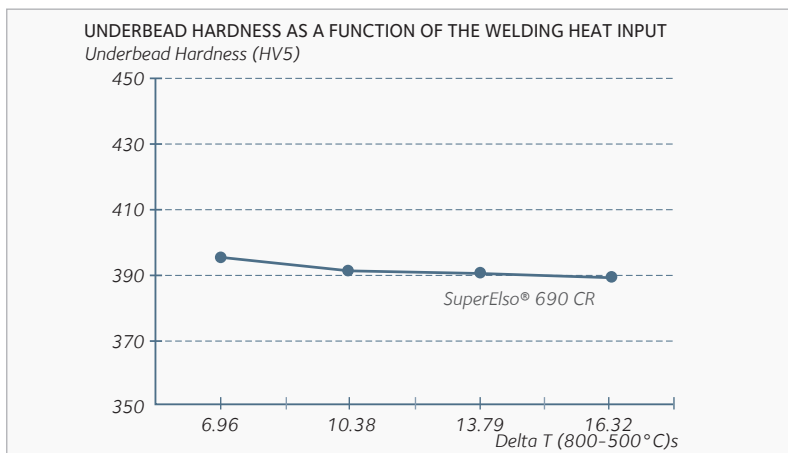
These welding conditions have been determined for highly clamped welds (implant tests, NFA 89100).

**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
	FL + 2 mm			135 - 100 - 115
	FL + 5 mm			91 - 92 - 86
ROOT	Fusion line (FL)	KV	- 60°C / - 76°F	106 - 94 - 106
	FL + 2 mm			85 - 95 - 150
	FL + 5 mm			50 - 50 - 55

### NDT PELLINI

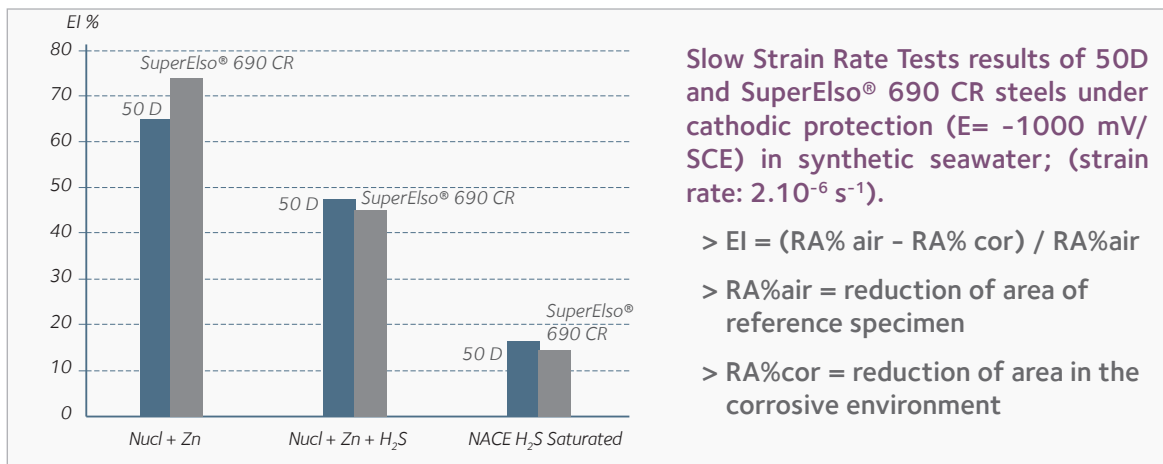
Drop Weight / Pellini tests have been performed on SE 690 CR steel. Typical NDT values of about  $-50^{\circ}\text{C}$  are currently obtained. Different CTOD Tests in accordance with BS 5762 standard have been performed in different locations.

		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 ( $E = -1000 \text{ mV/SCE}$ ) in synthetic seawater; (strain rate:  $2 \cdot 10^{-6} \text{ s}^{-1}$ ).

- >  $EI = (RA\% \text{ air} - RA\% \text{ cor}) / RA\% \text{ air}$
- >  $RA\% \text{ air}$  = reduction of area of reference specimen
- >  $RA\% \text{ cor}$  = 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 Cl	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

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*Technical data and information are to the best of our knowledge at the time of printing. However, they may be subject to some slight variations due to our ongoing research programme on steels. Therefore, we suggest that information be verified at time of enquiry or order. Furthermore, in service, real conditions are specific for each application. The data presented here are only for the purpose of description, and considered as guarantees when written formal approval has been delivered by our company. Further information may be obtained from the address opposite.*