CLIFFS

COLD ROLLED AND ELECTROGALVANIZED

DUAL PHASE STEELS

Auto Body Panels

Auto Body Structure Applications

Auto Safety Cage Components

DUAL PHASE (DP) STEELS are one of the important Advanced High Strength Steels (AHSS) developed for the automotive industry. Their microstructure typically consists of a soft ferrite phase with dispersed islands of martensite. The martensite phase is substantially stronger than the ferrite phase.

Cleveland-Cliffs produces two types of DP steels: conventional dual phase grades and higher yield strength grades. Conventional dual phase grades exhibit low yield-to-tensile strength ratios, high initial work hardening (n-value), no yield point elongation (YPE) and significant bake hardening. The higher yield strength grades exhibit high yield-to-tensile strength ratios, some YPE and lower bake hardening than the conventional dual phase grades.

With careful schedule selection, the DP steels are joinable by all current welding processes, including resistance spot, resistance seam, arc and laser methods.

Grade Availability

Cleveland-Cliffs offers a full spectrum of Dual Phase (DP) steels with tensile strength levels ranging from 590 to 1180 MPa.

TABLE 1 – SPECIFIED COMPOSITION

	Uncoated	EG
DP590/600	U	U
DP690/700	U	U
DP780	U	U
DP980	U	U
DP1180	U	U

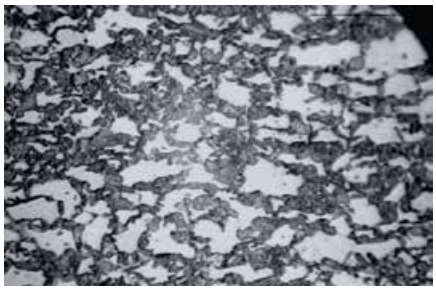
U - Unexposed, commercially available

Applications

The low and intermediate tensile strength, low yield ratio grades (590 to 980 MPa tensile strength) are frequently used in body structure applications requiring high energy absorption (i.e. the crumple zones – front and rear longitudinal rails and supporting structure). The low yield strength helps keep the initial deceleration pulse low, yet the high work hardening rate and excellent ductility absorb greater deformation energy than conventional steels. Good formability permits the use of these products in complicated shapes, and good weldability permits using these steels in tailored blank and hydroformed tube applications.

The intermediate to highest strength grades, including the high yield ratio dual phase steels, are typically used in applications requiring extremely high yield strength and adequate formability, such as passenger safety cage components, limited by axial or transverse bending. These components (rockers, pillars, pillar reinforcements, roof rails and cross members) rely on high yield strength to prevent intrusion into the passenger compartment during a collision. Dual Phase steels enable designers to apply high yield strength steels to safety cage components that are too complex to form with higher strength Martensitic steels.

Metallography - Dual Phase 980



Magnification 1000X
Approximately 60% Martensite/40% ferrite

Chemistry - Typical

	C	Mn	Si	Other
Cold Roll/EG				
DP590/600	0.10	1.0	0.3	
DP690	0.15	1.4	0.3	
DP780	0.10	1.6	0.3	
DP980 – mid C	0.15	1.4	0.3	
DP980 – low C	0.09	2.1	0.65	Mo
DP980 – high YS	0.09	2.1	0.65	Mo
DP1180 - RF	0.15	1.8	0.4	Nb, Ti
DP1180 - CS	.015	2.2	0.6	Nb, Ti, Al

Mechanical Properties - Typical

	Test – Direction	Yield strength (MPa)	Ultimate tensile strength (MPa)	Total elongation (percent)
Cold Roll/EG				
DP590/600	ASTM – L	370	635	24.5
DP690	ASTM – L	600	760	16.6
DP780	ASTM - L	480	830	18.2
DP980 – mid C	ASTM – L	600	1030	13.8
DP980 – low C	JIS – T	650	1030	14.7
DP980 – high YS	ASTM – L	800	1050	11.9
DP1180 - RF	ASTM – L	960	1270	10.1
DP1180 - CS	JIS – T	940	1250	11

Computer Aided Engineering (CAE) structural engineers should be cautioned that the unique high work hardening and bake hardening characteristics of DP steels require special treatment in finite element analysis crash models. Generally, accounting for high strain rate behavior and forming effects (thinning/thickening, work hardening, bake hardening) will yield more accurate crash simulation results. CAE engineers should contact Cleveland-Cliffs for product specific mechanical property information to use in these situations.

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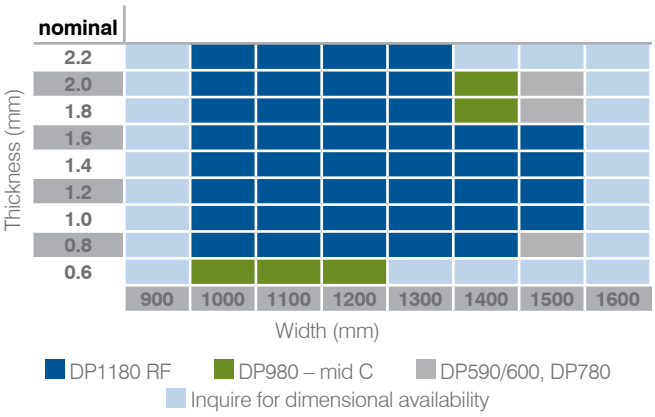
Size Availability

COLD ROLL/EG



About Cleveland-Cliffs Inc.

Cleveland-Cliffs is the largest flat-rolled steel producer in North America. Founded in 1847 as a mine operator, we are also the largest producer of iron ore pellets in North America. In 2020, we acquired two major steelmakers, AK Steel and ArcelorMittal USA, vertically integrating our legacy iron ore business with quality-focused steel production and emphasis on the automotive end market. Our fully integrated portfolio includes custom-made pellets and hot-briquetted iron (HBI); flat-rolled carbon steel, stainless, electrical, plate, tinplate and long steel products; as well as carbon and stainless steel tubing, hot and cold stamping and tooling. Headquartered in Cleveland, Ohio, we employ approximately 25,000 people across our mining, steel and downstream manufacturing operations in the United States and Canada.

CLIFFS

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