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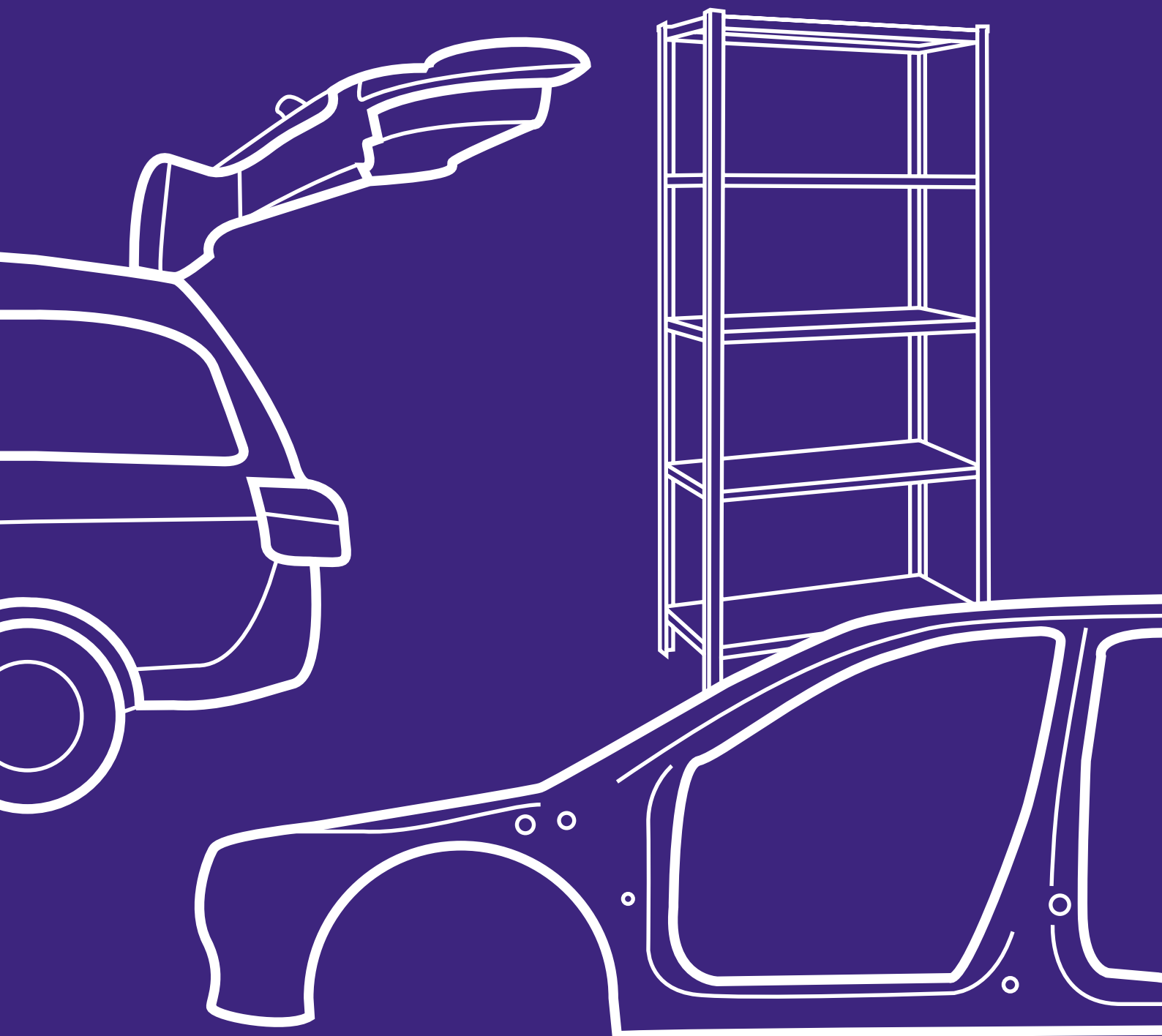
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Corus Strip Products UK

Galvatite hot-dip galvanised steel

Tenform high-strength formable steel substrates



General

Description

Galvatite is available with Tenform high-strength formable steel substrates in a range of strengths, forming capabilities and steel characteristics. It has higher yield strengths than the forming qualities of standard mild steels.

Applications

- Automotive components
- Exterior body panels
- Automotive body-in-white structural panels
- Shelving
- Construction
- General engineering

Benefits

The relatively high yield strength of the Tenform substrate allows the user to increase the strength of the finished component or to reduce the steel thickness, or both. This can make products more profitable and competitive by increasing the output from each tonne of steel and by making them stronger, lighter and safer under load.

The strength and formability of the Tenform substrate expand the scope for design. For example, press forming a single part rather than forming separate parts and welding them together reduces the number of parts.

The close manufacturing tolerances that produce both Galvatite and its Tenform substrate create a consistent, high-quality product which is already well established in the automotive, tube and other industries.

Corus has helped many companies convert successfully to high-strength steels and continues to develop these steels with properties and characteristics for specific applications.

Products

The four high-strength formable steel substrates available with Galvatite are Tenform IF, Tenform BH, Tenform CXK and Tenform CMN.

In this leaflet, all references to the performance of the substrates apply equally to the hot-dip galvanised product.

Tenform IF

Tenform IF is re-phosphorised, interstitial-free steel that gains its strength by solid solution strengthening. Its extremely low and tightly-controlled carbon content gives it excellent formability. Other elements such as nitrogen, sulphur and manganese are also tightly controlled.

With its combination of high-strength and excellent formability, the Tenform IF substrate is suitable for the most difficult automotive applications such as bodysides and exterior body panels.

The grades available are H180YD+Z/+ZF and H220YD+Z/+ZF.

Tenform BH

Tenform BH is bake-hardening steel that gains its strength by solid solution strengthening. Bake-hardening steel starts with good ductility, allowing it to be pressed into complex shapes. It then increases in strength after being heated in the automotive paint stoving process giving it improved dent resistance and a higher strength in the final part. Its improved dent resistance makes bake-hardening steel particularly suitable for automotive body panels.

The grades available are H180BD+Z, H220BD+Z/+ZF, H260BD+Z and H300BD+Z.

Consult Corus about the availability of iron-zinc alloy coatings (+ZF) for H180BD, H260BD and H300BD.

Tenform CXK

Tenform CXK is microalloyed steel that gains its strength by precipitation strengthening and grain refinement.

This product combines high strength with good formability for automotive structural applications including side-members, cross-members, pillars and sills. The construction industry also uses Tenform CXK.

The grades available are H260LAD+Z, H300LAD+Z and H340LAD+Z.

Consult Corus about the availability of iron-zinc alloy coatings (+ZF).

Tenform CMN

Tenform CMN is carbon-manganese steel with properties tightly controlled by Corus' modern manufacturing processes. The range is characterised by high tensile strengths, low yield strength to tensile strength ratios and good formability.

This product combines high strength with good formability for automotive structural applications including side-members, cross-members, pillars and sills. It is also used in the construction industry.

The grades available are CMN260+ZF and CMN300+ZF.

Consult Corus about the availability of pure zinc coatings (+Z).

Basic properties

Mechanical properties

Table 1 shows the mechanical properties of the Tenform substrates.

Table 1: Mechanical properties

Grade	Test	R _{p0.2} (N/mm ²)	BH ₂ (N/mm ²)	R _m (N/mm ²)	A ₈₀ (%)	r ₉₀	n ₉₀
		Min-Max	Min	Min-Max	Min	Min	Min
EN 10292 : 2000							
Tenform IF							
H180YD	t	180-240	–	340-400	34	1.7	0.18
H220YD	t	220-280	–	340-410	32	1.5	0.17
Tenform BH							
H180BD	t	180-240	35	300-360	34	1.5	0.16
H220BD	t	220-280	35	340-400	32	1.2	0.15
H260BD	t	260-320	35	360-440	28	–	–
H300BD	t	300-360	35	400-480	26	–	–
Tenform CXK							
H260LAD	t	260-330	–	350-430	26	–	–
H300LAD	t	300-380	–	380-480	23	–	–
H340LAD	t	340-420	–	410-510	21	–	–
H260LAD	l	240-310	–	340-420	27	–	–
H300LAD	l	280-360	–	370-470	24	–	–
H340LAD	l	320-400	–	400-500	22	–	–
Tenform CMN							
CMN260	t	260-340	–	360-440	29	–	–
CMN300	t	300-400	–	440-500	26	–	–

Note: The letters in the test column indicate test direction. The letter t indicates transverse to the rolling direction and the letter l indicates longitudinal, i.e. in the rolling direction.

Comparisons

Tables 2 and 3 compare the properties of various Tenform substrates. The *Advanced properties* section of this leaflet touches on some of the main differences between the four substrates at similar strengths.

Chemical composition

The chemical compositions of Tenform substrates are shown in table 4, according to the standard indicated.

Typical chemistries are shown in table 5.

Dimensions

The overall thickness and width limits for Galvatite with Tenform substrates are shown in table 6. These dimensions are limits and therefore not all combinations of thickness and width will be available. For specific combinations of thickness and width, please consult Corus.

Table 2: Typical properties of Tenform H220YD and H220BD

Tenform	R _{eL} (MPa)	R _m (MPa)	R _{eL} :R _m (%)	A ₈₀ (%)	ΔBH (MPa)	n	r
H220YD	246	363	68	35.8	–	0.198	1.87
H220BD	248	354	70	35.0	40	0.200	1.90

Note: The values shown in the table above are for 0.7mm thick test pieces taken transverse to the rolling direction.

Table 3: Typical properties of Tenform H300LAD and CMN300

Tenform	R _{eL} (MPa)	R _m (MPa)	R _{eL} :R _m (%)	A ₈₀ (%)	n	r
H300LAD	330	450	85	30	0.195	1.2
CMN300	327	470	70	29	0.190	1.2

Note: The values shown in the table above are for 1.2mm thick test pieces taken transverse to the rolling direction.

Table 4: Chemical composition

Grade	C	Mn	P	S	Si	Al	Ti	Nb
	Max	Max	Max	Max	Max	Min	Max	Max
EN 10292 : 2000								
Tenform IF								
H180YD	0.01	0.7	0.060	0.025	0.10	0.020	0.12	–
H220YD	0.01	0.9	0.080	0.025	0.10	0.020	0.12	–
Tenform BH								
H180BD	0.04	0.7	0.060	0.025	0.50	0.020	–	–
H220BD	0.06	0.7	0.080	0.025	0.50	0.020	–	–
H260BD	0.11	0.7	0.100	0.025	0.50	0.020	–	–
H300BD	0.11	0.7	0.120	0.025	0.50	0.020	–	–
Tenform CXK								
H260LAD	0.11	0.6	0.025	0.025	0.50	0.015	0.15	0.09
H300LAD/H340LAD	0.11	1.0	0.025	0.025	0.50	0.015	0.15	0.09
Tenform CMN								
CMN260/CMN300	0.18	0.9	0.025	0.015	0.03	0.020	–	–

Notes:

1. Values are in weight percentages.
2. The sum of Nb and Ti shall not exceed 0.22wt%.

Table 5: Typical chemical composition

Grade	C	Mn	P	S	Si	Al	Ti	Nb
	Max	Max	Max	Max	Max	Min	Max	Max
H220YD	0.002	0.6	0.02	0.014	0.15	0.04	0.030	0.017
H220BD	0.003	0.5	0.03	0.014	0.15	0.04	0.005	0.007
H300LAD	0.055	0.25	0.05	0.005	0.015	0.04	–	0.008
CMN300	0.165	0.8	0.015	0.010	0.015	0.04	–	–

Table 6: Dimensions

	Thickness		Width	
	>	≤	Min	Max
EN 10292 : 2000				
Tenform IF				
H180YD	0.650	2.000	900	1482
H220YD	0.700	2.000	900	1482
Tenform BH				
H180BD	0.750	1.600	900	1500
H220BD	0.600	1.200	900	1620
H260BD	0.900	1.600	900	1400
H300BD	1.100	2.000	900	1300
Tenform CXK				
H260LAD	0.700	1.600	900	1400
H300LAD	0.900	2.000	900	1300
H340LAD	0.900	2.000	900	1300
Tenform CMN				
CMN260	0.960	2.000	900	1380
CMN300	0.740	2.000	900	1400

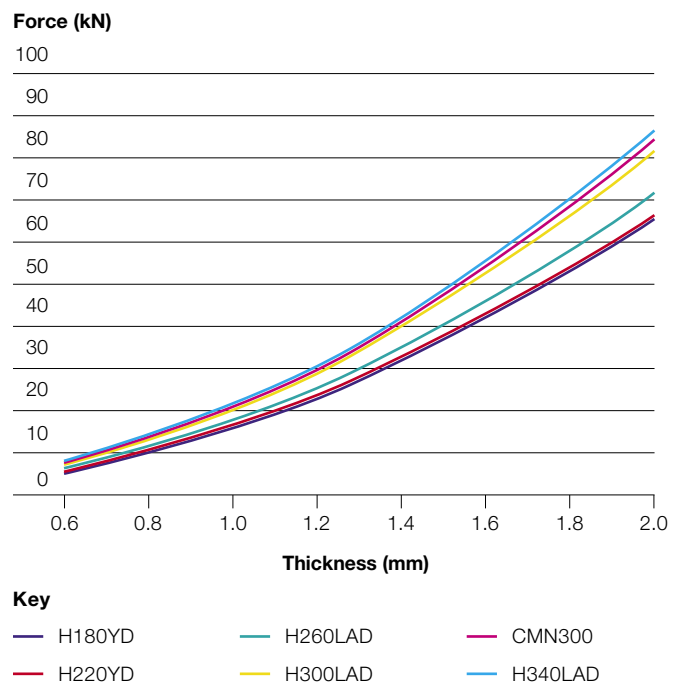
Notes:

- Dimensions are in millimetres.
- For dimensions outside the ranges shown, consult Corus.

Advanced properties

Blanking

The force required to shear Tenform substrates depends on the tensile strength and thickness of the product being cut. Figure 1 shows the range of blanking force expected for these products.

Figure 1: Average theoretical shearing force

Formability

Elongation

Tenform IF and Tenform BH have similar levels of formability for a given yield strength. They are more suited to parts requiring a moderate increase in strength whilst maintaining excellent formability. Bake hardening steels are particularly suited to parts requiring improved dent resistance or which would benefit from an additional increase in strength during the paint stoving process. Tenform CMN and Tenform CXK also have similar levels of formability for a given yield strength. They are more suited to structural components requiring moderate formability.

Products that show minimum r and n values in table 1 are more suited to the most demanding forming operations involving deep drawing or extensive stretching than products not showing those values.

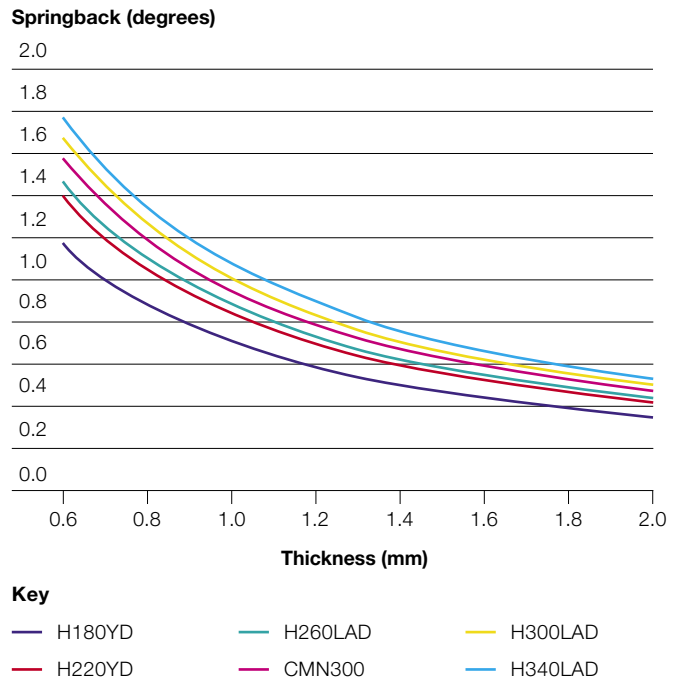
The typical elongation levels of all four products decrease with increasing tensile strength.

Tenform products that have similar strength levels are suitable for similar applications, but they will perform differently in pressing and welding operations, which is an important factor in choosing the right product.

Springback

Springback is the characteristic of strip steel to take a shape that is slightly different from that defined by the forming process, i.e. the steel 'springs back'. The amount of springback depends primarily on the yield stress and material thickness of the product. Springback is normally determined by measuring the difference between the angle at which a channel section is formed and the larger angle reflected in the finished section. Figure 2 shows the theoretical amount of springback for various Tenform products.

Figure 2: Comparison of theoretical springback for a bending angle of 90°



Weldability

General

All four Tenform substrates can be readily spot welded, laser welded or fusion welded. For spot welding, the ranges of current for acceptable weld quality will differ for each product.

The level of elements such as carbon, manganese, silicon and phosphorous are important parameters in determining the optimum currents and electrode forces when resistance spot welding. Fusion welding tolerates higher levels of these elements than resistance spot welding.

The strengthening mechanisms for the four Tenform products are based on the use of different steel compositions—in particular, carbon, manganese, phosphorous and niobium. The level of these elements on their own and in combination with each other will influence the optimum welding characteristics and failure mode (plug or interfacial failure). Therefore, the optimum welding conditions for each product will differ depending on its chemistry.

All Tenform IF products and Tenform H220BD have ultra-low carbon contents (typically $\leq 0.01\text{wt}\%$) and therefore require lower weld currents. Tenform CMN products have carbon contents up to $0.18\text{wt}\%$. Acceptable weld current ranges are possible, although there is a greater risk of interfacial failures at small weld sizes ($< 4\sqrt{t}$).

Tenform H180BD, H260BD, H300BD and all Tenform CXK products have carbon contents between $0.015\text{wt}\%$ and $0.11\text{wt}\%$ and can all be welded using conventional welding parameters.

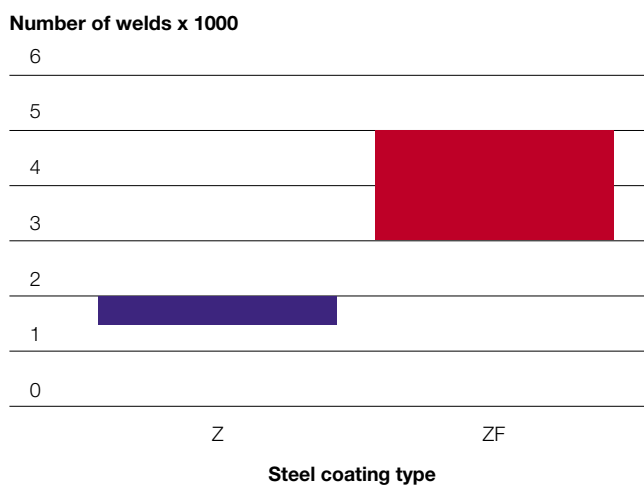
Advice

Corus can provide detailed welding parameters for all of these products.

Metallic coatings

The main effect of the metallic coating is on electrode life. Figure 3 summarises the effect of different coating types on electrode life. Welding steels that have pure zinc coatings (+Z) wears out electrodes more quickly than welding steels with iron-zinc alloy coatings (+ZF), given equivalent coating thicknesses. For either type of coating, an increase in the coating mass will require an increase in current and will decrease the available welding range.

Figure 3: The effect of coating type on electrode life



Key

- (+Z) Hot-dip galvanised steel: 140g/m^2 pure zinc coating mass ($10\mu\text{m}$).
- (+ZF) Hot-dip iron-zinc alloy coated steel: 140g/m^2 ($10\mu\text{m}$).

Note: Laboratory tests of 0.8mm mild steel, 5mm tip diameter, 1.8kN force.

Fatigue

The fatigue test is a measure of the ability to withstand an alternating applied stress. This is normally expressed in the form of an S-N curve, where the number of cycles to failure (N) is plotted against the applied stress range (S).

For all four Tenform substrates, a fatigue limit exists where applied stresses below that limit will not lead to failure. The fatigue limit is normally expressed as a ratio of the tensile strength and is typically between $0.4R_m$ and $0.6R_m$.

Corus can also provide information on these products tested under strain-life conditions.

Consider the position of welds carefully to avoid adversely affecting the fatigue life of welded components.

Health and safety

The four Tenform products in this brochure are covered by *Product health and safety data sheet* numbers 2, 16 and 18.

More information

For more information about this product, contact Corus at the appropriate address on the back cover.