Corus Strip Products UK

Protected with strength

Solutions in Galvatite hot-dip galvanised steel

Strength you can build on

About Galvatite
Galvatite is a range of hot-dip galvanised steel sheet and coil products.

Corus combines 60 years of production experience and modern, sophisticated equipment to ensure a quality product whose benefits include:

- corrosion resistance
- formability
- high strength
- weldability
- paintability

Galvatite has a corrosion-resistant coating that remains firmly attached to the steel under the most severe forming operations. It continues to give general and sacrificial protection to all areas after forming and fabrication. Other important advantages are shown opposite.

- A range of surface finishes, including those for high-class paint requirements.
- Close control of coating mass and alloy phase composition of the iron-zinc coatings minimises the risk of powdering during press forming.
- Galvatite steel grades with forming potential similar to uncoated cold-reduced products.
- The Galvatite range includes highly formable high-strength steels with minimum tensile strengths up to 460N/mm^2.
- A range of weldable products.
- Galvatite products supplied oiled and unpassivated are compatible with many of the phosphate and other pre-treatment processes in current use.
- Passivated Galvatite products can be painted to give enhanced corrosion resistance in severe environments.
- The presence of Galvatite under a paint film greatly improves the overall corrosion resistance of the finished product. It also reduces the incidence of under-film 'creep' and scabbing.

Contents

Front cover: Photograph Hayley Madden
Left: Nissan Motor Manufacturers UK
Right: Metsec Building Products, Oldbury, West Midlands

Coatings

Galvatite is available as 'Galvatite Z', which has a pure zinc coating, or as 'Galvatite ZF', which has an iron-zinc alloy coating.

Galvatite ZF is 'Galvanneal' and contains typically 8-12% iron in its coating.

In this catalogue, references to Galvatite without the suffix Z or ZF refer to both the pure zinc and the iron-zinc alloy products.

Typical applications

- Building and construction components
- Steel framing
- Automotive components and body panels
- Tubes and sections
- Racking and shelving
- Domestic appliances and electrical goods
- Components for agricultural machinery

European standards

Galvatite complies with European standards and is also available to other national and international standards by agreement with Corus. Contact Corus for more information.

For complete, detailed information, readers should consult the standards, which are available from BSI at the address below.

BSI Sales,
389 Chiswick High Road,
London, W4 4AL
T: 020 8996 9000
F: 020 8996 7001
E: cservices@bsi-global.com

Product development

Corus is committed to the continuous development of its product range to maintain its position as a world leader in the manufacture of hot-dip galvanised steel.

The business produces a wide product range. For example, the ability to produce ultra-low-carbon (ULC) IF steels (below 0.0035% carbon) has enabled the development of hot-dip galvanised products with excellent formability. Corus also produces bake hardenable, rephosphorised, and high-strength low-alloy (HSLA) steels and is developing advanced high-strength products such as dual-phase steel, in order to meet ever more demanding requirements. Corus can discuss specific requirements with customers in order to provide them with the best solution for their needs.

For more information about the steels described here, contact Corus.

Quality assurance

Galvatite is manufactured in plants that incorporate some of the most modern technology in steelmaking, rolling, and hot-dip galvanising. To realise the full potential of this modern technology, Corus implements quality assurance principles, operating practices and controls.

Corus Strip Products UK is third-party approved to ISO/TS 16949 : 2002, the global automotive standard for quality management systems, and was one of the first steel businesses to achieve this prestigious award. The standard, based on BS ISO 9001 : 2000, together with customer-specific criteria, defines quality management system requirements for the automotive supply chain.

Far left: Framing Solutions plc., Swadlincote, Derbyshire
Left: Ward Building Components Ltd., Sherburn, North Yorkshire

Properties and composition

Qualities

The Galvatite grades below are shown according to the European standard designations in EN 10142 : 2000 for forming and drawing qualities and EN 10147 : 2000 for structural qualities. Galvatite high-strength formable steel complies with EN 10292 : 2000. Corus can advise customers on the selection and specification of the correct grade of Galvatite for any particular application.

Forming and drawing qualities

DX51D : Bending and profiling quality
This grade is suitable for some profiles and for difficult bending operations.

DX52D : Drawing quality
This grade is suitable for simple drawing or more difficult profiling operations.

DX53D : Deep drawing quality
This grade is suitable for deep drawing or difficult forming, where a non-ageing grade is required.

DX54D : Special deep drawing quality
DX56D : Extra deep drawing quality
These grades are suitable for more difficult deep drawing and forming applications. The grade required depends upon the severity of the application. Please consult Corus for more information.

Non-fluting quality
All the European standard grades shown above are available in non-fluting quality.

Table 1: Mechanical properties : EN 10142 : 2000

Grade	R_e[1] (N/mm²)	R_m (N/mm²)	A_{80}[2] (%)	r_{90}	n_{90}
	Min-Max	Min-Max	Min	Min	Min
DX51D+Z/+ZF	–	270-500	22	–	–
DX52D+Z/+ZF	140-300	270-420	26	–	–
DX53D+Z/+ZF	140-260	270-380	30	–	–
DX54D+Z	140-220	270-350	36	1.6	0.18
DX54D+ZF	140-220	270-350	34	1.4	0.18
DX56D+Z[3]	120-180	270-350	39	1.9	0.21
DX56D+ZF[3,4]	120-180	270-350	37	1.7	0.20

Notes:
1. This range of values applies to skin-passed products only.
2. For thicknesses less than or equal to 0.7mm (including coating), the minimum elongation after fracture is decreased by 2 units.
3. For thicknesses greater than 1.5mm, the r_{90} value is decreased by 0.2 units.
4. For thicknesses less than or equal to 0.7mm (including coating), the r_{90} value is decreased by 0.2 units and the n_{90} value is decreased by 0.01 units.

Table 2: Mechanical properties: EN 10147 : 2000

Grade	R_p (N/mm²)	R_m (N/mm²)	A_{80} (%)
	Min	Min	Min
S220GD+Z/+ZF	220	300	20
S250GD+Z/+ZF	250	330	19
S280GD+Z/+ZF	280	360	18
S320GD+Z/+ZF	320	390	17
S350GD+Z/+ZF	350	420	16
S550GD+Z/+ZF	550	560	–

Note: For thicknesses less than or equal to 0.7mm (including coating), the minimum elongation after fracture is decreased by 2 units.

Structural qualities

The European standard qualities below have guaranteed minimum tensile properties.

S220GD	S280GD	S350GD
S250GD	S320GD	S550GD

High-strength formable qualities

Galvatite high-strength formable steel allows the user to increase the strength of the finished component or reduce the steel thickness, or both. For more information about these steels, contact Corus.

H180BD	H220YD	H340LAD
H220BD	H260YD	H380LAD
H220PD	H260LAD	H420LAD
H300PD	H300LAD	

Mechanical properties

The mechanical properties of Galvatite are shown on page 6 in table 1 for the forming and drawing qualities and table 2 for the structural qualities. Table 3 below shows the mechanical properties for high-strength formable qualities. The test direction for these properties is transverse to the rolling direction for table 1 and in the rolling direction for table 2. Those in table 3 are for temper-rolled material and are for test pieces taken in the direction shown in the table.

Chemical composition

Galvatite's chemical composition is shown on page 8 in table 4 for the forming and drawing qualities, table 5 for the structural qualities and table 6 for the high-strength formable qualities.

Table 3: Mechanical properties: EN 10292 : 2000

		$R_{p0.2}$ (N/mm²)	BH_2 (N/mm²)	R_m (N/mm²)	A_{80} (%)	r_{90}	n_{90}
Grade	Test	Min-Max	Min	Min-Max	Min	Min	Min
H180BD	t	180-240	35	300-360	34	1.5	0.16
H220BD	t	220-280	35	340-400	32	1.2	0.15
H220PD	t	220-280	–	340-400	32	1.3	0.15
H300PD	t	300-360	–	400-480	26	–	–
H220YD	t	220-280	–	340-410	32	1.5	0.17
H260YD	t	260-320	–	380-440	30	1.4	0.16
H260LAD	t	260-330	–	350-430	26	–	–
H300LAD	t	300-380	–	380-480	23	–	–
H340LAD	t	340-420	–	410-510	21	–	–
H380LAD	t	380-480	–	440-560	19	–	–
H420LAD	t	420-520	–	470-590	17	–	–
H260LAD	l	240-310	–	340-420	27	–	–
H300LAD	l	280-360	–	370-470	24	–	–
H340LAD	l	320-400	–	400-500	22	–	–
H380LAD	l	360-460	–	430-550	20	–	–
H420LAD	l	400-500	–	460-580	18	–	–

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.

Table 4: Chemical composition: EN 10142 : 2000

Grade	C	Mn	P	S	Al	N	Ti
	Max	Max	Max	Max	Min	Max	Max
DX51D+Z/+ZF	0.100	0.600	0.030	0.035	0.025	0.010	0.005
DX52D+Z/+ZF	0.070	0.300	0.030	0.035	0.025	0.005	0.005
DX53D+Z/+ZF	0.030	0.300	0.030	0.035	0.020	0.006	0.125
DX54D+Z/+ZF	0.010	0.300	0.030	0.035	0.020	0.006	0.125
DX56D+Z/+ZF	0.005	0.200	0.020	0.020	0.020	0.005	0.085

Note: Values are in weight percentages.

Table 5: Chemical composition: EN 10147 : 2000

Grade	C	Mn	P	S	Al	N
	Max	Max	Max	Max	Min	Max
S220GD+Z/+ZF	0.100	0.550	0.030	0.035	0.025	0.005
S250GD+Z/+ZF	0.110	0.600	0.030	0.020	0.025	0.005
S280GD+Z/+ZF	0.165	1.000	0.100	0.020	0.020	0.005
S320GD+Z/+ZF	0.165	1.000	0.100	0.020	0.020	0.005
S350GD+Z/+ZF	0.165	1.300	0.100	0.020	0.020	0.020
S550GD+Z/+ZF	0.200	1.500	0.100	0.035	0.020	0.020

Note: Values are in weight percentages.

Table 6: Chemical composition: EN 10292 : 2000

Grade	C	Mn	Si	Al	P	S	Ti[1]	Nb[1]
	Max	Max	Max	Min	Max	Max	Max	Max
H180BD	0.04	0.70	0.50	0.020	0.060	0.025	–	–
H220BD	0.06	0.70	0.50	0.020	0.080	0.025	–	–
H220PD	0.08	0.70	0.50	0.020	0.080	0.025	–	–
H300PD	0.10	0.70	0.50	0.020	0.080	0.025	–	–
H220YD	0.01	0.90	0.10	0.020	0.080	0.025	0.120	–
H260YD	0.01	1.60	0.10	0.020	0.100	0.025	0.120	–
H260LAD	0.10	0.60	0.50	0.015	0.025	0.025	0.150	0.090
H300LAD	0.10	1.00	0.50	0.015	0.025	0.025	0.150	0.090
H340LAD	0.10	1.00	0.50	0.015	0.025	0.025	0.150	0.090
H380LAD	0.10	1.40	0.50	0.015	0.025	0.025	0.150	0.090
H420LAD	0.10	1.40	0.50	0.015	0.025	0.025	0.150	0.090

Notes:
1. The sum of the contents of these elements should not exceed 0.22%.
2. Values are in weight percentages.

Coatings and surface qualities

Zinc coatings

The figure after the letter Z (zinc) or after the letters ZF (iron-zinc alloy) is the minimum average triple spot coating mass in g/m², including both surfaces.

Lighter coating masses than those shown below may be available by arrangement. The conversion factor for coating weight in g/m² to coating thickness in micrometres is 7.14g/m² = 1 micrometre.

Light coatings: Z100, Z140, Z200, Z225
These coatings are suitable where the environment is not severe or where forming conditions preclude heavier coatings, or both.

Standard coating: Z275
This is the standard coating classification and the most commonly specified coating for general applications.

Heavy duty coatings: Z350, Z450, Z600
These coatings give longer life relative to standard and light coatings.

Iron-zinc alloy coatings: ZF100, ZF140
These coatings are characterised by ease of painting and welding, particularly resistance welding.

Finishes and surface qualities

The European standards for hot-dip galvanised steels define and designate coating finish and surface quality separately. The first letter of the European designation is coating finish and the second is surface quality. The description of surface quality is shown in *italics* below to help the reader distinguish it from coating finish.

Galvatite Z

NA: Normal Spangle, *as coated surface*: the normal finish.
MA: Minimised Spangle, *as coated surface*: a reduced spangle.
MB: Minimised Spangle, *improved surface*: suitable for decorative finishes.
MC: Minimised Spangle, *best quality surface*: suitable for high-class paint finishes.

Galvatite ZF

RA: Regular iron-zinc alloy coating, *as coated surface*: a matt grey finish.
RB: Regular iron-zinc alloy coating, *improved surface*: suitable for decorative finishes.
RC: Regular iron-zinc alloy coating, *best quality surface*: suitable for high-class paint finishes.

Availability
The combinations of grade, coating, finish and surface quality available from Corus are shown in tables 7, 8 and 9 on pages 10 and 11.

The surface finishes MC and RC are normally supplied non-chromated and oiled. The Normal Spangle coating finish manufactured by Corus is normally passivated. Other finishes are available untreated or passivated, with or without oil.

Protective treatments

A passivated surface treatment reduces the risk of white rust during transport and storage. For this reason, Corus will supply Normal Spangle and Minimised Spangle (*as coated surface* and *improved surface*) passivated unless specified otherwise by the customer. The passivation treatment may affect further treatment with primers, adhesives, and other pre-treatments such as phosphates. If such processes are to be used as part of the painting or finishing sequence, or both, the user should consult Corus.

If a non-passivated surface is specified, the material should be ordered oiled. Oiling is particularly recommended as an added protection for all surface finishes where storage conditions are likely to be wet. See handling and storage guidelines on page 38. For Minimised Spangle, best quality surface (MC) and Regular, best quality surface (RC), Corus will supply oiled and non-passivated material unless agreed otherwise. Further advice about the protection of Galvatite by oiling is available from Corus.

Table 7: Coating, finish and surface quality for EN 10142 : 2000

Zinc coatings (Z)

Grade	Coating designation	Finish and surface quality			
		NA	MA	MB	MC
DX51D	Z100	■	■	■	■
	Z140	■	■	■	■
	Z200	■	■	■	■
	Z225	■	■	■	■
	Z275	■	■	■	■
	Z350	■	■	■	
	Z450	■			
	Z600	■			
DX52D	Z100	■	■	■	■
	Z140	■	■	■	■
	Z200	■	■	■	■
	Z225	■	■	■	■
	Z275	■	■	■	■
	Z350	■	■		
DX53D-56D	Z100	■	■	■	■
	Z140	■	■	■	■
	Z200	■	■	■	■
	Z225	■	■	■	■
	Z275	■	■	■	■
	Z350		■		

Iron-zinc alloy coatings (ZF)

Grade	Coating designation	Finish and surface quality		
		RA	RB	RC
All Grades	ZF100	■	■	■
	ZF120	■	■	■
	ZF140	■	■	

■ Available

Table 8: Coating, finish and surface quality for EN 10147 : 2000

Zinc coatings (Z)

Grade	Coating designation	Finish and surface quality			
		NA	MA	MB	MC
All except S550 GD	Z100	■	■	■	■
	Z140	■	■	■	■
	Z200	■	■	■	■
	Z225	■	■	■	■
	Z275	■	■	■	■
	Z350	■	■	■	■
	Z450	■	■		
	Z600	■	■		
S550GD	Z100	■			
	Z140	■			
	Z200	■	■		
	Z225	■	■		
	Z275	■	■		
	Z350	■			

Iron-zinc alloy coatings (ZF)

Grade	Coating designation	Finish and surface quality	
		RA	RB
All except S550 GD	ZF 100	■	■
	ZF140	■	■

■ Available

Table 9: Coating, finish and surface quality for EN 10292 : 2000

Zinc coatings (Z)

Grade	Coating designation	Finish and surface quality		
		NA	MA	MB
All high-strength grades on page 7	Z100	■	■	■
	Z140	■	■	■
	Z200	■	■	■
	Z225	■	■	■
	Z275	■	■	■
	Z350	■	■	■

Iron-zinc alloy coatings (ZF)

Grade	Coating designation	Finish and surface quality	
		RA	RB
All high-strength grades on page 7	ZF 100	■	■
	ZF140	■	■

■ Available

Note: Consult Corus about the availability of *Best quality surface* (C).

Gaining the most from Galvatite

Corrosion resistance
Of all the methods of protecting mild steel against corrosion, hot-dip zinc coating is the most common.

A zinc coating protects steel in two ways:

- It acts as a physical barrier between a potentially corrosive environment and the steel base.

- The zinc coating gives galvanic or sacrificial protection at cut edges and at scratches.

It must be remembered that zinc itself is not immune from loss through weathering; however, under most conditions it does so at a slower rate than steel. The precise rate depends upon the prevailing conditions, but normal atmospheric exposure results generally in a rate which is between a tenth and a thirtieth of that of the steel base. Therefore, the second factor governing the life of a coating is its thickness, or as it is often referred to in specifications, its mass.

Review of factors affecting the corrosion resistance of Galvatite

The variety of environmental conditions to which a zinc coated structure might be exposed is almost limitless. In turn, these conditions can be very complex.

Nevertheless, it is possible to identify a number of key parameters that will influence the corrosion resistance of Galvatite.

Acidity (pH value)

Zinc coatings should not be used for long-term protection if they are likely to come into prolonged contact with aqueous liquids having a pH value outside the range of 6-12.5. The presence of other chemicals can affect this range. Thus the alkalis in cement, mortar, and plaster will etch Galvatite, but once the mixture has set, the rate of attack is slow. Specifically in the case of plastering, good ventilation is recommended to assist drying. This allows calcium chloride—which is used to assist rapid setting and which is aggressive to zinc—to be used in moderation.

Aeration

Dissolved oxygen and carbon dioxide in aqueous solutions can increase the rate of corrosive attack. This is true particularly where there is high humidity or condensation, regardless of what other agents are present. Failure to provide adequate ventilation when allowing buildings to dry out can result in condensation and lead to corrosion. The prolonged dripping of rainwater into Galvatite gutters can cause rapid, localised attack. Galvatite gutters manufactured for pre-painted steel roofs must be protected with an organic coating such as bitumen.

Temperature

As with most chemical reactions, of which corrosion is merely one example, the rate of reaction (corrosion) is increased as the temperature rises. However, in the case of zinc on steel, this is not a steady and uninterrupted increase; above 70˚C, in the presence of water, the roles of the two metals are reversed. Thus, the steel will corrode in preference to the zinc. The effect of this will be apparent at unprotected cut edges and at scratches.

The maximum operating temperature for Galvatite is 250˚C. For applications where the temperature could exceed this limit, consult Corus.

Presence of other chemical agents

This section considers two types of agent, i.e. liquids and solids.

Liquids

Certain chemical agents (chloride has already been mentioned) can lead to rapid attack, even within the preferred pH range.

Many organic materials are not aggressive to zinc when in their pure form, but become so in the presence of water and impurities such as acids; the rate of corrosion can then increase significantly. Any slight corrosion which does occur can change the nature of the chemical environment, i.e. zinc salts can catalyse the polymerisation of some chemicals. Fuels such as moisture-free petrol, and chlorinated hydrocarbons such as trichloroethylene and non-acidic lubricants, are examples of organic chemicals which can be used in contact with zinc.

Detergents or detergent solutions can cause rapid dissolution of zinc, particularly if additives such as perborates are present. If the solution is hot, the effect is magnified.

Much of the information above can be related directly to one of the most common areas of use—agriculture. However, it should be remembered that certain chemicals, particularly acids, alkalis, animal waste, and copper bearing compounds, can cause rapid corrosion, especially if the humidity is high. Soils present a particularly complex situation encompassing variations in all the parameters mentioned so far. The result is that corrosion conditions may be very severe. In this case it is appropriate to consider the provision of additional protection either by the use of a heavier zinc coating or by painting with bitumen or other thick, barrier-type coatings. In any case it is recommended that potential users consult Corus.

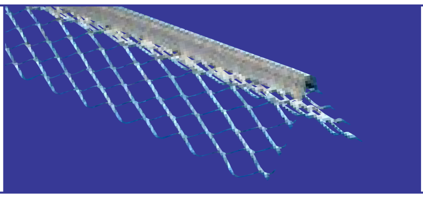
Solids: joining other materials to Galvatite

Whenever two dissimilar metals are brought together in the presence of water, an electro-chemical cell (bimetallic couple) is set up. In this cell, one of the metals is the anode, which corrodes at an accelerated rate; the other is the cathode, which is protected from corrosion. For this reason, materials that join or fix to Galvatite must be chosen carefully to minimise the galvanic or couple corrosion, e.g. the choice of fasteners for fixing roofing or cladding sheets. Such bimetallic action can occur under paint coatings, causing the paint to peel off.

In particular, neither copper nor brass should be used in contact with Galvatite, since this can cause the coating to fail rapidly, especially in wet and polluted atmospheres. Lead and aluminium can be used without serious effects in clean atmospheres. Stainless steel can be used, but some couple effect is apparent in polluted atmospheres. Fixings that incorporate a means of sealing the fixing hole are best, e.g. bolts with integral rubber-faced washers.

Fusion welding damages the zinc coating. This damage should be repaired by painting with zinc-rich paints or by soldering with zinc solder.

Often there is a need to attach Galvatite fittings to timber. Galvatite can be used in contact with certain seasoned timbers. Unseasoned timber and also timber treated with preservatives (particularly those containing copper) can be aggressive. In such cases, painting the wood with bitumen is recommended.



Avoiding ‘couples’

When zinc-coated steel is joined to mild steel, a ‘couple’ is formed in which the steel is the cathode and the zinc coating is the anode. This has two consequences for automotive applications.

First, the zinc will protect the steel during the phosphating process, which may result in a poor phosphate film being applied to the steel surface. This will reduce the effectiveness of the paint system.

Secondly, since all paints are permeable to moisture, such a couple will eventually operate, even under a full paint protection system. The electrochemical action of the couple will generate alkali on the cathode, or steel side, of the couple. This will result in delamination of the paint film, exposing the steel to corrosion.

To minimise the effect of couples, the zinc-coated panels should be joined to steel panels in areas not subject to severe corrosion. As far as possible, zinc-coated steel components should be gathered together; individual steel parts surrounded by zinc-coated parts should be avoided.

Period to first maintenance

For Galvatite used in construction, the principles set out above can be summarised to indicate the period from installation to first maintenance (table 10 below). Because very few real-life situations are as pure as the headings in the table would suggest, this tabulation is a significant over-simplification. Nevertheless, taken in conjunction with the previous information and that which follows, it does provide a useful guide. Many environments can be a combination of two or more of those shown. Furthermore, locally extreme conditions may exist, which could have a severely adverse effect on the performance of the zinc.

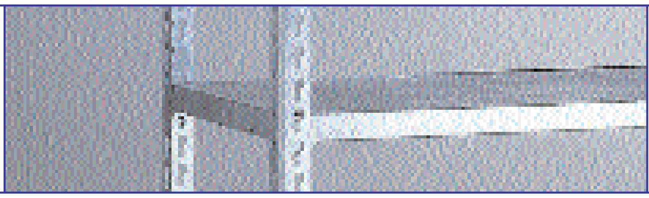
The strength of the prevailing wind and the consistency of its direction, as well as the humidity and the duration of exposure, could determine the rate of corrosion. An example of this is provided by partly sheltered environments: severe corrosion can occur when material is only partly exposed to the elements, such as under the eaves or canopies of buildings. This is particularly true in polluted and severely contaminated environments such as coastal regions and areas of heavy industry. Contaminants can lodge themselves in areas where they are not washed away by rainwater, but where there is moisture or condensation. This can result in corrosion similar to that caused by a poultice.

Table 10: Galvatite Z typical period to first maintenance

Mass (g/m^2) (note 2)	**Coastal**	**Industrial and urban**	**Suburban and rural**	**Internal**	
	Years			Wet and possibly polluted	Dry and unpolluted
275	2-5	2-5	5-10	Note 3	20-50
350	2-5	2-5	5-10	Note 3	20-50
450	5-10	2-5	10-20	Note 3	20-50
600	10-20	5-10	20-50	Note 3	20-50

Notes:
1. The recommendations for period to first maintenance are based on the premise that the strength and integrity of the sheet would diminish after the period specified, unless maintenance was carried out.
2. Minimum average triple spot (including both surfaces).
3. Further protection with a suitable paint is essential for this kind of application.
4. The periods shown are based on theoretical weight loss as a result of natural weathering under test conditions.

Left: Catnic, Caerphilly
Right: Link 51, Telford, Shropshire



Forming and fabricating

Galvatite is a versatile range of steels. In many cases it can replace mild steel, with little or no modification to the production process.

Cutting, blanking, brake forming, roll forming, spinning, crimping, and lock forming are easy with Galvatite, provided the right grade of steel is chosen.

Press forming

The performance of Galvatite during press forming is determined by the thickness of the substrate and its metallurgical properties. The greater punch loads required to form thicker or harder substrates will subject the coating to greater abrasion, surface shear, and die pressure. This can damage the coating or cause areas of increased gloss. On the other hand, the use of soft zinc coatings can increase tool life, reduce the need for lubricants and, in deep drawing, improve formability.

When subjected to rolling processes after coating, DX51D and DX52D are susceptible to ‘strain age hardening’. This may result in stretcher strain-marking or fluting when the steel is formed, together with a reduction in ductility. It is essential that the period between final processing at the mill and fabrication at the customer’s premises is minimised. This precaution applies particularly to the forming grades DX51D and DX52D, which have a minimum recommended stocking period of six weeks. Reasonable freedom from stretcher strain in skin-passed products can be achieved by roller levelling them immediately before they are fabricated. If a non-fluting quality is required for cylindrical forming, this must be stated on the order. In EN 10142, mechanical properties and freedom from stretcher strain are guaranteed for one month for grades DX51D and DX52D and for six months for grades DX53D, DX54D and DX56D.

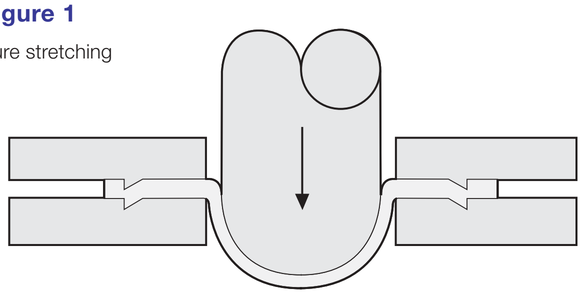
Tool design for press forming Galvatite is basically the same as that for uncoated steel where equivalent levels of springback are involved. The degree of springback is largely a function of material thickness and its yield stress. The increasing use of high-strength steels and ultra-high-strength steels in fabrication, leads to an increase in the levels of springback, due to the increase in material yield stress and decrease in thickness. This must be taken into account when designing press tools for high-strength components. The heavier iron-zinc alloy coatings have a greater tendency to powder under in-plane compressive stresses. The design of both the tool and the part being pressed should take this into account. Tool pick-up of zinc may affect the flow of material during forming, reduce the surface quality of formed parts, and increase the down-time needed for cleaning and maintaining tools.

The business has improved the adhesion of its coatings, control of coating mass, and alloy phase composition. These developments have greatly reduced the risk of iron-zinc alloy coatings powdering under severe press-forming conditions.

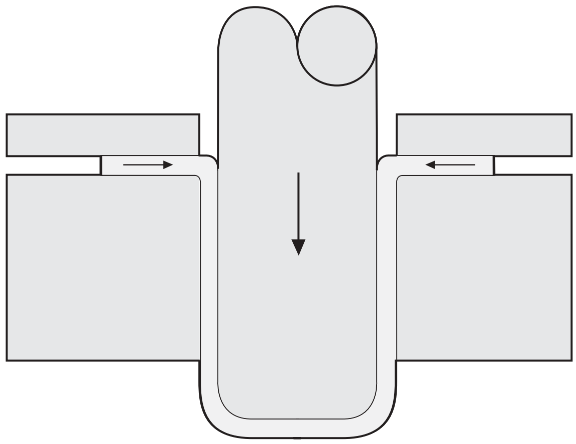
DX52D, DX53D, DX54D and DX56D (in ascending order of forming capability) meet the requirements of the more demanding forming methods such as stretching or deep drawing, which are shown schematically in figure 1 opposite. This arises in part from a decrease in yield stress and an increase in elongation, as measured in the uniaxial tensile test. Careful control of steel chemistry and processing conditions improves the resistance of steel to thinning and fracture during forming.

Figure 1

Pure stretching



Pure drawing



Note
In pure stretching there is no movement of material in the blank holder, whereas in pure drawing there is movement.

The most formable Galvatite steel grades, DX54D and DX56D, combine the greatest ductility with the highest resistance to thinning. Difficult pressing operations involving combined stretch-forming and deep drawing operations are achievable with the special deep drawing quality, DX54D, and particularly with the extra deep drawing quality, DX56D.

Corus has also developed a new generation of high-strength formable steels that will allow complex structural members to be produced from hot-dip galvanised steel.

The selection of the correct grade of Galvatite for a particular forming operation is normally based on the judgement and wide experience of the supplier, in consultation with the end user. Corus has the expertise to give such advice for any type of pressing.

Roll forming

The successful roll forming of Galvatite depends on the design of the section, the Galvatite product being rolled, regular maintenance of the rolls, the forming speed, and efficient lubrication.

Polished, hard chrome-coated rolls will reduce the risk of zinc 'pick-up' and subsequent damage.

Although DX51D is described as a profiling and bending quality, the profiling industry has generally preferred to use S220GD because it has a guaranteed minimum yield stress of 220N/mm^2. The alternative under normal conditions is to use DX51D, provided that its minimum yield stress of 140N/mm^2 is acceptable. If it is necessary to guarantee specific strength levels for structural engineering, a range of higher tensile grades is available.

S550GD is supplied in the fully cold-worked condition and therefore has limited ductility. Nevertheless, cladding profiles can be roll formed satisfactorily from this grade provided profiling conditions are optimised to handle this type of product.

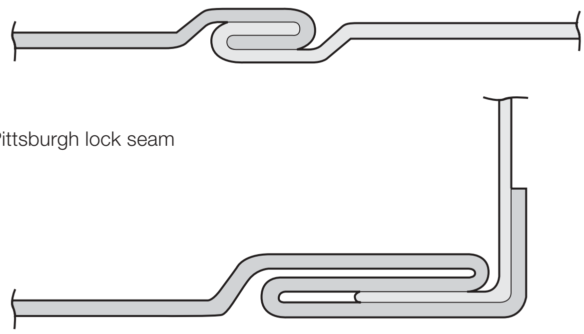
Lock forming

Lock forming is a convenient means of joining two pieces of metal by the formation of a mechanical seam. In the context of roll forming, this can be the opposite edges of the same coil, as in spirally wound tubing. Two commonly used lock seams are illustrated in figure 2. It is important to establish that the material to be ordered suits the type of lock seam intended. This is particularly important for material with a coating mass greater than 275g/m^2 or for structural qualities. All grades from EN 10142 are suitable for lock forming. However, for thicknesses from 1.5mm to 2.5mm, grade DX52D is recommended for making the lock seams shown in figure 2.

Figure 2

Double lock seam

Pittsburgh lock seam



Hydroforming

Hydroforming describes the forming technology that uses fluid pressure, and is commonly associated with tube applications.

There are four main types of hydroforming:

1. Low-pressure hydroforming simply reshapes the tube. It produces a very good shape, but it is less suitable when better cross-sectional definition is required.

2. High-pressure hydroforming changes the tube shape totally, altering the ratio of length to circumference by up to 50%. It gives exceptionally good tolerance control, thanks to the robustness of the process.

3. Panel hydroforming is suited to the manufacture of tight panels, e.g. automotive roof panels. The attraction of hydromechanical forming is that it produces essentially flat panels with a controlled degree of deformation and hence tightness. Hydraulic pressure is used to expand the material into the die set with uniform strain; the punch then comes down to re-deform the metal into the required panel shape.

4. Pillow hydroforming uses hydraulic pressure to form the component from two steel sheets that have been welded around the perimeter. This allows the hydroforming of, for example, vehicle A or B pillars, which need to be slim at the top and wider at the bottom. It also makes it easy to leave a weld flange for subsequent assembly.

Where laser welding is used for tube manufacture, a very limited degree of coating damage is obtained, with limited impact on corrosion protection. However, when welding tubes by electrical resistance heating, a post-galvanising treatment is required to restore adequate levels of corrosion protection.

Tailor welded blanks

Using Galvatite in the automotive industry to construct lightweight vehicles can save material and energy, in line with environmental pressures. Any method which facilitates the production of lightweight components must therefore be considered a key development.

One part of the weight reduction solution is to laser-weld together two or more pieces of sheet steel to form a single composite blank, or a tailor welded blank, which can then be pressed into the required component shape. Different thicknesses of sheet steel can be used to save weight by placing thinner material in less critical regions and thicker or stronger material in more strength-dependent areas. Different grades of steel with different coating thicknesses can be combined in a single component to focus enhanced corrosion protection where it is needed most.

Experience has shown that the coating damage associated with the use of laser welding is limited, and does not lead to subsequent corrosion problems.

Cutting

Rake angle

It is important that cutting blades on guillotines are set at the correct rake angle appropriate to the strength of the material being cut.

Shear clearance

The clearance between the fixed and moving blades when shearing, and between the punch and die when blanking or piercing (or both), can influence tool life. Shear clearance can also affect the flatness of blanks, the size of the burr, and the conditions of the sheared edge (blank and pierced hole).

Lubrication

Press lubricants and drawing compounds are rarely needed with mill-oiled Galvatite Z, as the soft zinc coating has a lubricating effect. Where a lubricant is necessary, it should be compatible with the zinc coating and should be easy to remove. Mineral oils are preferred; water-based lubricants should not be used. If the pH value of the lubricant is outside the range 6.5-7.0, it should be removed immediately after pressing. Corus can advise customers on the choice of a lubricant to meet their requirements.

Mechanical fixing

A wide range of commercially available fasteners provides an unlimited choice of joining method and design.

For many applications, standard nuts, screws and bolts are still the most efficient and cheapest options, but in high-volume applications, for economy, special fasteners may be required.

Innovative assembly techniques use the Galvatite sheet itself as the joining medium. These include specially designed, self-assembling joining sections and the use of tags and slots.

The following considerations are important when choosing the type of fastener:

- Loading conditions imposed upon the fasteners in service.
- Shear strength of the joint.
- Environmental effects, e.g. temperature, pollution, and humidity.
- The corrosion resistance of the fasteners.
- Compatibility between the fastener material itself and the material through which it passes.
- Resistance to loading or relaxation under dynamic conditions.
- Accessibility to one or both sides of the fasteners.
- Whether assemblies need to be dismantled at any time.
- The cost of the fasteners and the labour cost of fixing them.

The numerous types of fasteners can be classified broadly into the groups described opposite.

Compressive fasteners

These depend on a squeezing action to bring the fastened components together, e.g. rivets. See figures 3 and 4.

Figure 3: Examples of rivets used in sheet metal fabrication

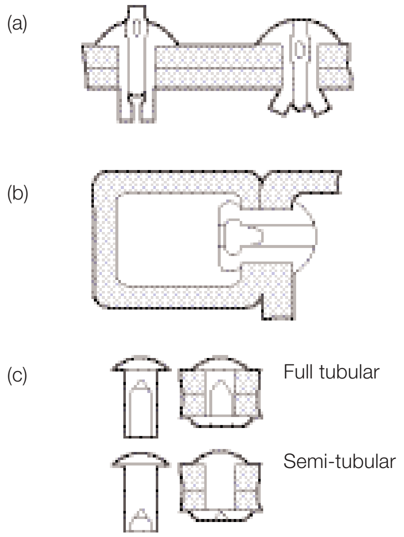
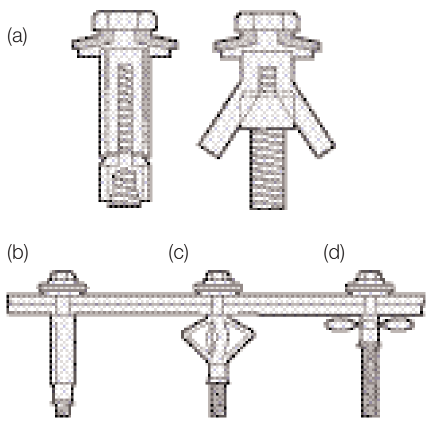


Figure 3:
(a) Steel drive pin rivet is set by a single hammer blow. (b) Blind rivets are ideal for limited access installations. Minimum back-up clearance is needed. (c) Full-tubualr and semi-tubular rivets before and after setting.

Figure 4: Examples of compressive fasteners

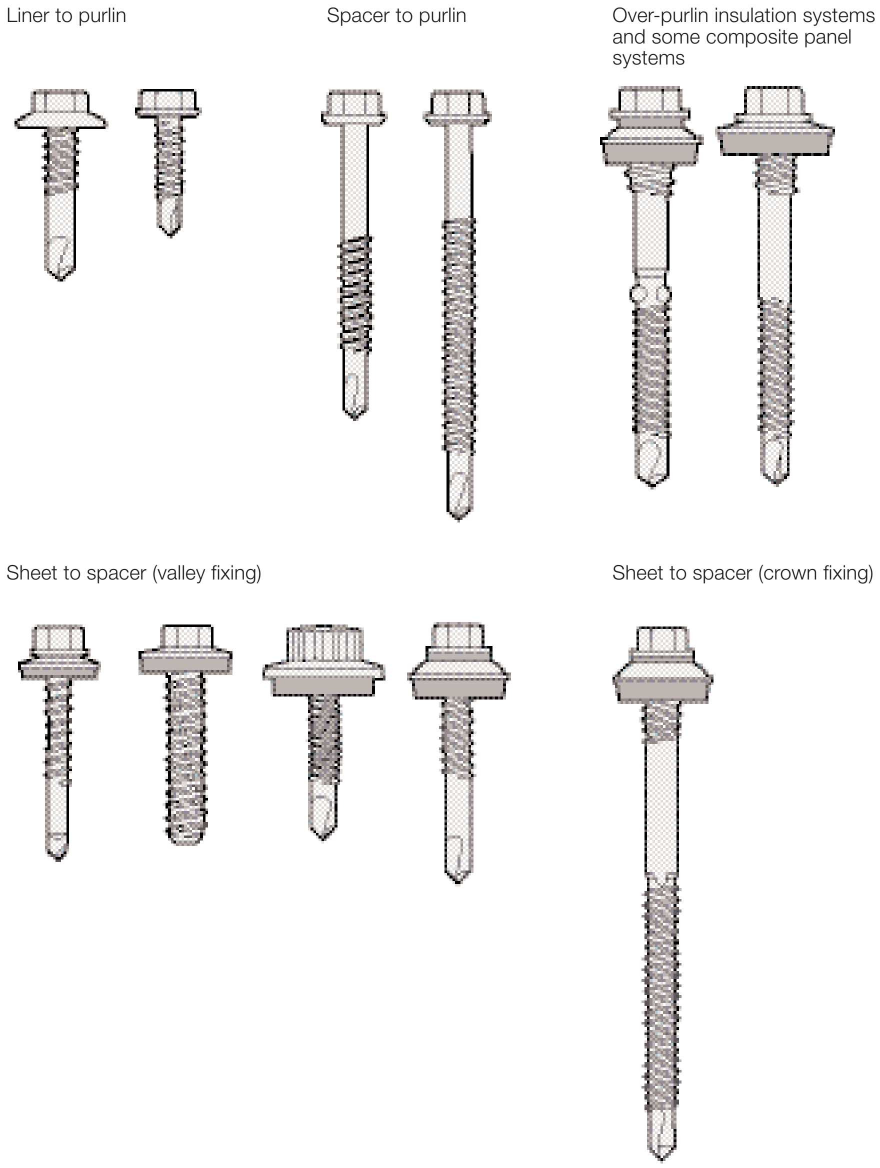


(a) Nut rises forcing legs apart to clamp sheet
(b) Sleeve crimped onto threaded shank
(c) Sleeve collapsing
(d) Sleeve collapsed

Threaded fasteners

These constitute a very diversified group, e.g. self-tapping screws, self-drilling and thread-forming fasteners. Primary fasteners, used in the construction sector for fixing sheeting to spacers or to purlins, often incorporate an integral metal and neoprene, EPDM, or butyl rubber sealing washer pre-assembled to the screw. The shank of some fasteners may incorporate a double thread to accommodate insulation or for use with some composite panel systems. See figure 5.

Figure 5: Examples of threaded fasteners



Left: Banro Sections Ltd, Walsall, West Midlands

Special purpose fasteners

A comprehensive range of proprietary screws, rivets, captive nuts and spring-tension fasteners is available, satisfying almost every need (see figures 6-10).

Figure 6: Self-piercing rivet

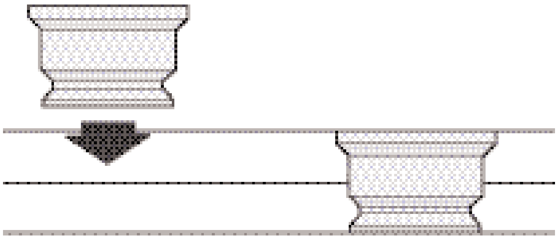


Figure 7: Self-clinching bush

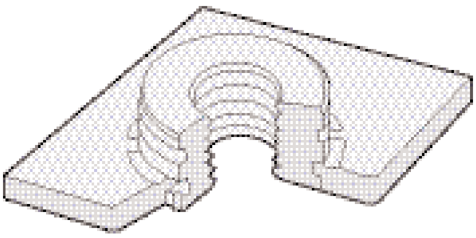


Figure 8: Spring nut

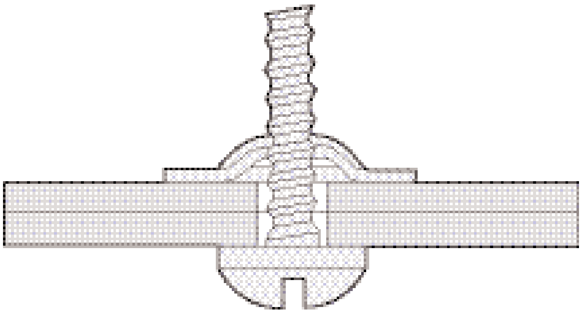
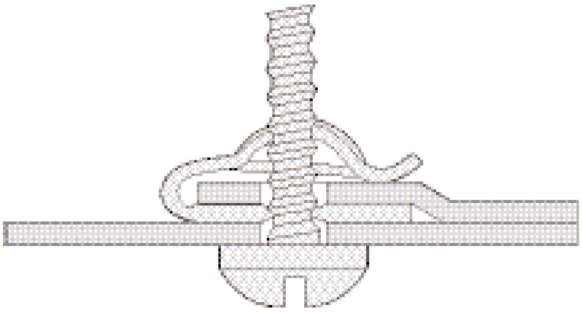


Figure 9: Captive nut



Piercing, riveting and press joining

Two particular developments in self-piercing riveting and press joining can produce high-strength joints with zinc-coated steels.

The self-piercing riveting system (see figure 6) can develop shear strengths up to 3.5kN with 1.2mm Galvatite Z or Galvatite ZF with a base steel yield strength of 280-300 N/mm^2.

A double-acting hydraulic power unit operates the self-riveting system, either as a manually held riveting gun or as part of a fully automated unit. To give the hand-held unit flexibility in setting rivets, a counterbalance needs to be fitted on an overhead tracking system. Automated rivet-feed systems operate at cycle times of three to five seconds. Self-piercing riveting gives high rates of production with minimum downtime for maintenance. Multi-rivet head configurations that are engineered for specific components can offer maximum productivity where pre-jigged components are indexed through a fixed riveting station. Alternatively, the rivet setters can be mounted on a CNC controlled 'x-y' positioning system.

A number of press-joining techniques offer considerable potential for joining coated steels. They aim to simplify the joining process and to increase its reliability by simplifying inspection of the joint. The press-joining process for the standard rectangular joint can be thought of as consisting of two phases: a cutting and an upsetting operation. When the punch moves towards the expanding die (see figure 11 on page 23), the pieces of sheet metal to be joined will first be pressed against the expanding die. This results in a double cut, whereby a bulged area is pressed out of the sheets. In the second phase of press-joining, the strip comes to rest on the anvil where it is upset between the punch and the bomb-shaped anvil. At the same time, the strip is further sheared by the angular edges of the punch. The resulting spread of the strip takes place against the resistance of the spring plates.

An alternative press-joining technique is the Tog-L-Loc system. Figure 12 shows the Tog-L-Loc joint. It is formed in a single motion or press stroke. The metals are held between the punch and the die; the non-piercing punch draws the metals into the die and continues to travel, squeezing the metals. Moving die blades accommodate the lateral flow of metal, forming a lock of greater diameter than the drawn section, which accounts for the high strength and vibration resistance of the joint. The strength of press formed joints depends on the strength of the base steel and the sheet thickness.

Figure 10: **Push-on spring fastener**

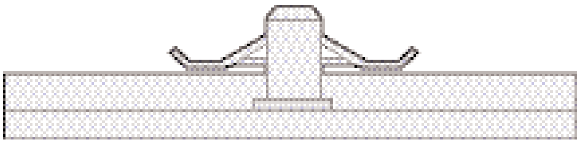
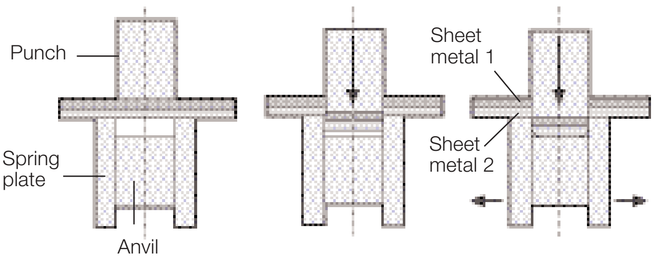
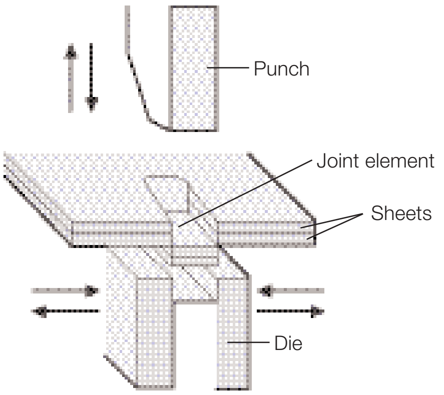


Figure 11: **Eckold press-formed joint**

Formation of Eckold press-formed joint



Insertion and penetration of Eckold joint

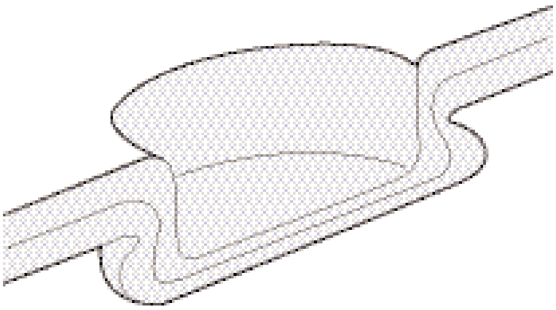


Eckold Clinching Systems, Eckold Limited, Coventry.

Integral assembly techniques

Many types of clinched section have been devised that are particularly suitable for use with Galvatite. These interlocking joints are useful when box shapes are being formed (see figure 13). There are other integral techniques that punch, pierce or stitch the Galvatite to create an interlocking joint with minimal effect on the integrity of the coating. Another technique uses a stitch folding gun. This is a pneumatic tool which joins two components by punching out and folding two tabs together in a single operation (see figure 14).

Figure 12: **Tog-L-Loc® joint**



Tog-L-Loc sheet metal joining system, BTM (UK) Automation Products Limited, St Ives, Cambs.

Figure 13: **Types of clinched sections**

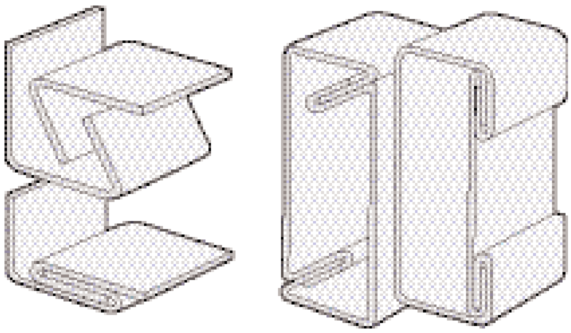
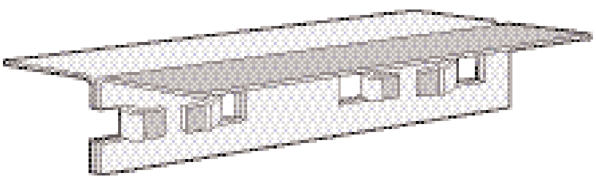


Figure 14: **Stitch-folded joints**



Welding and adhesive bonding

Galvatite can be welded readily using resistance, laser and conventional fusion welding techniques.

Satisfactory weld quality can be obtained at high-volume production rates with minimal coating damage. Resistance welding is generally preferred because it is less likely to cause significant damage to the coating and thereby reduce Galvatite's corrosion resistance.

Resistance welding

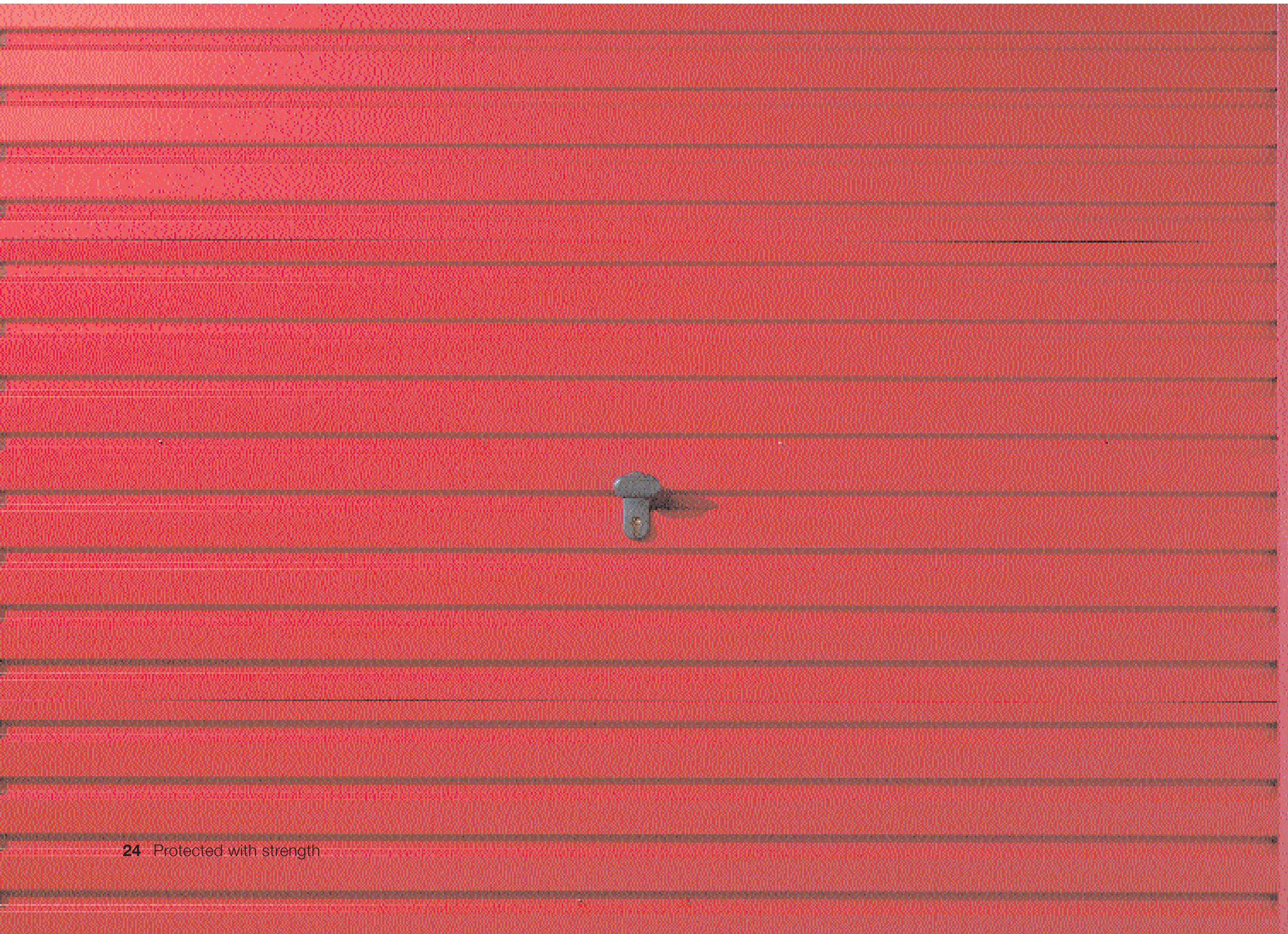
Spot, seam or projection welding can be used, with only minor variations in the conditions that apply to uncoated steels.

Spot welding

Guidelines for resistance spot welding of uncoated and coated sheet steel are defined in ISO 14373. Welding conditions for coated steels depend on the type of coating being welded.

Weldability lobes obtained for Galvatite are narrower than those for equivalent thicknesses of uncoated steels. Iron-zinc alloy coatings tend to show lobe widths which are similar to, or approach, those obtained for uncoated steels because of the larger contact resistances developed by the alloy coating (figure 15). For coating masses of 275g/m^2 or less, the position and width of the weldability lobes are insensitive to coating thickness.

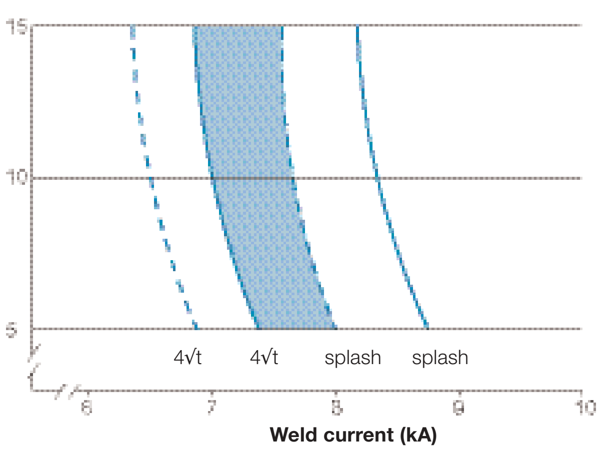
Because of its lower contact resistance, Galvatite Z275 requires higher welding currents than those necessary for equivalent thicknesses of uncoated steel—an approximate increase of 20% on average. Galvatite ZF, having higher surface resistance than Galvatite Z, requires slightly higher welding currents than those necessary for equivalent thicknesses of uncoated steel. Weld times are generally



longer by as much as 50% to 100% compared with those necessary for uncoated steel. The electrode pressure must be in the region of 90N/mm² for Galvatite Z275 when using truncated cone type electrodes. Higher welding forces may be necessary for high-strength steel substrates.

Typical welding conditions for a range of thicknesses in both Galvatite Z and Galvatite ZF are given in table 11 on page 26.

Figure 15: Comparative weldability lobes 0.7mm Galvatite Z and ZF



0.7mm Galvatite Z 120g/m²* – electrode force 1.8kN
0.7mm Galvatite ZF 120g/m²* – electrode force 1.8kN

* The automotive industry commonly refers to this coating mass as 60/60, viz. Z 60/60 and ZF 60/60

These values are only a guide for initial machine set up and may require slight adjustment depending on local conditions of manufacture, the type of machine used and the characteristics of the secondary circuit. It should be emphasised that these welding conditions are applicable for truncated cone electrodes made from a Class A2/2 (ISO 5182) material; they may require modification for other electrode shapes and material. Generally, the electrode dimensions should comply with the requirements of ISO 5184 (Straight Electrodes), ISO 5830 (Male Electrode Caps), or ISO 5821 (Female Electrode Caps) where applicable. When welding sheets of single thickness up to 3mm, the best results are obtained using truncated cone electrodes. In this case, the electrode tip diameter chosen shall approximate to the following formula:

$$d = 5\sqrt{t}$$

d is the initial tip diameter, in mm; t is the thickness of the sheet in contact with the electrode, in mm.

Caution: The use of a weld size smaller than that given by the equation above will result in a lower weld strength. This must be taken into account in any design calculations. Lap shear strengths for various weld sizes are given in table 12 on page 27 for guidance. Generally, the weld size should not fall below $3.5\sqrt{t}$. Note that the available tolerances of welding conditions and machine operation may be reduced at these small weld sizes.

The initial weld diameter should be equal to the diameter of the electrode tip. If a smaller initial weld diameter is specified, then the initial electrode tip diameter should be equal to the specified weld diameter.

For coated mild steel products, plug failure is the predominant mode of failure of spot welded joints. However, for high-strength steels, such as carbon-manganese variants, the type of failure is related to the size of the weld. Chisel testing shows that welds at the minimum acceptable size give mainly interface failures. Increased weld sizes increase the potential for plug failure, until mostly plug failures or >80% partial plugs are produced as the splash limit is approached. Joining to a lower carbon equivalent product would tend to give a higher incidence of plug failures.

The diameter of at least one of the electrode tips should not normally be allowed to increase to a size that reduces the weld diameter by more than 30%. When this diameter is reached, the electrode must be replaced or redressed to its initial size and contour.

Left: PC Henderson Limited, Bowburn, County Durham

The distance from the edge of the component to the centre of the weld should not be less than 1.25d, where d is the initial weld diameter. The use of edge distances less than the recommended values will adversely influence weld quality and should be used only by agreement between contracting parties. The pitch between welds, i.e. the centre-to-centre distance of the spot welds, should not be less than 3d and preferably greater, when welding material of single sheet thickness up to and including 3mm. With zinc-coated steels, a larger weld pitch should be used to minimise the effects of current shunting. The effects of shunting are lower for Galvatite ZF than for Galvatite Z.

Spot welding Galvatite shortens electrode life more than spot welding uncoated steel. Truncated cone electrodes are recommended in preference to domed electrodes, although domed electrodes may be necessary in applications where correct alignment of the electrodes, relative to the sheet being welded, is difficult to achieve. Up to 2000 welds can be achieved with Galvatite Z275 and approximately 5000 welds with Galvatite ZF100. The actual electrode life obtained depends on many factors, including the welding conditions, electrode configuration and type, effectiveness of cooling, type of welding machines used, and angle of approach of electrodes. The electrode life is insensitive to small changes in coating thickness. In all cases, the use of domed or pointed electrodes results in shorter electrode life than that obtained with truncated cone electrodes. Results obtained for a domed electrode (ISO 5184 – Type F) and a pointed nose electrode (ISO 5184 – Type E) indicate reductions in electrode life of at least 50% and 80% respectively, compared with the performance of a truncated cone electrode (see table 13).

For the production of non-marking welds, a pad or mandrel may be used as the second electrode to ensure no visible indentation. Such procedures, however, result in a reduced current range over which acceptable welds can be produced, and they also reduce the electrode life that would otherwise be achieved with a symmetrical electrode configuration. For best results in all applications, a water flow rate in excess of 4 litres per minute is necessary when welding coated steels. The water cooling tube should be arranged so that the water

Table 11: Spot welding conditions for Galvatite Z and Galvatite ZF in thicknesses of 0.6mm – 3.0mm

Single sheet thickness (mm)		Electrode tip diameter (mm)	Galvatite Z[1]			Galvatite ZF[2]		
>	≥		Force (kN)	Weld time* (cycles)	Current (kA)	Force (kN)	Weld time* (cycles)	Current (kA)
0.6	0.8	4	1.9-2.2	8-10	8.0-10.0	1.8-2.1	6-8	7.0-9.5
0.8	1.0	5	2.2-2.9	9-12	9.0-11.0	2.1-2.8	7-10	8.0-10.5
1.0	1.2	5	2.8-3.6	10-13	10.0-13.0	2.7-3.4	8-12	9.0-12.0
1.2	1.6	6	3.4-4.5	11-15	14.0-16.0	3.2-4.3	9-13	11.0-14.0
1.6	2.0	7	4.4-5.5	12-16	18.0-21.0	4.2-5.3	10-14	13.0-16.5
2.0	2.5	8	5.4-6.8	14-18	22.0-26.0	5.2-6.5	12-16	16.0-21.0
2.5	3.0	9	6.6-8.0	17-21	26.0-30.0	6.4-7.8	15-20	18.0-23.0

Notes:
1. Applicable for coating thickness Z275 (approximately 20µm per side).
2. These conditions are applicable to the alloy coatings ZF100 and ZF140 (approximately 7µm and 10µm per side, respectively).

These welding conditions may require modifications depending on the type of welding machine used and the characteristics of the secondary circuit.

These welding conditions apply to truncated cone electrodes, Class A2/2 material, and may require modification for other electrode shapes and materials.

*1 cycle equals approximately 0.02 sec

impinges on the back of the working face of the electrode. The distance between the back and the working face of the electrode should not exceed the values given in the appropriate ISO standard.

Copper-chromium, copper-zirconium or copper-chromium-zirconium alloy electrodes should be used to obtain the best electrode life. Good results can be achieved with copper-alumina dispersion-hardened electrodes. The tendency of the electrode to stick to the sheet is reduced significantly if copper-alumina or copper-zirconium electrodes are used, particularly in 'hot' welding conditions.

Table 12: Lap shear strength (typical minimum values for steel T.S. = 280N/mm²)

Sheet thickness	Nominal 3.5√t		Nominal 4√t		Nominal 5√t		Nominal 6√t	
(mm)	Weld diameter (mm)	Weld strength (kN)	Weld diameter (mm)	Weld strength (kN)	Weld diameter (mm)	Weld strength (kN)	Weld diameter (mm)	Weld strength (kN)
0.6	2.7	1.3	3.1	1.6	3.9	2.0	4.6	2.3
0.8	3.1	2.3	3.6	3.0	4.5	3.6	5.4	4.2
1.0	3.5	3.2	4.0	3.7	5.0	4.3	6.0	5.1
1.2	3.8	4.1	4.4	4.6	5.5	5.4	6.6	6.2
1.6	4.4	5.5	5.1	6.0	6.3	7.4	7.6	8.3
2.0	5.0	7.2	5.7	8.4	7.1	10.8	8.5	13.5
2.5	5.5	10.6	6.3	11.8	7.9	14.5	9.5	17.3
3.0	6.0	12.0	6.9	14.0	8.66	17.8	10.4	22.0

Table 13: Influence of electrode tip shape on electrode life for 0.7mm Galvatite Z275

Electrode shape	Typical electrode life (number of welds)
Truncated cone (120°)	2000
Pointed nose (Type E)	750
Domed (Type F)	500

Table 14: Machine settings for projection welding Galvatite

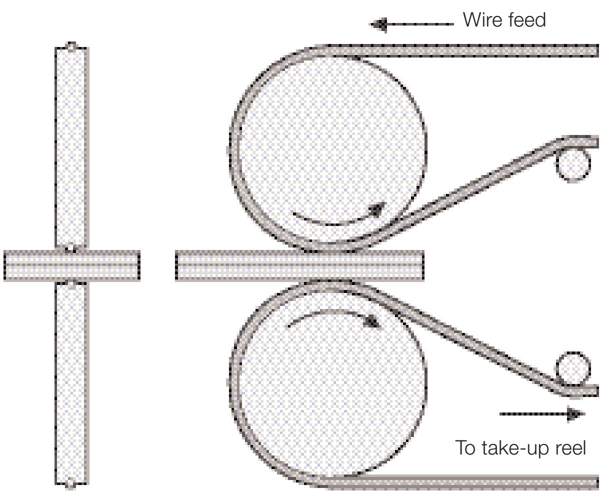
Material thickness (mm)	Projection base diameter (mm)	Projection height (mm)	Electrode force (kN)	Welding current (kA)	Weld time (cycles*)
1.0	4.8	1.0	1.1	10.0	15
1.6	5.5	1.2	1.8	11.5	20
2.0	6.4	1.4	2.5	16.0	25
2.4	6.4	1.4	3.3	16.0	30
2.7	6.4	1.4	4.2	22.0	33

* 1 cycle = 0.02 seconds

Seam welding

It is generally considered that the resistance seam welding of zinc coated steels is a critical process requiring very closely defined operating limits. Conventional seam welding of zinc coatings is not recommended owing to gross contamination of the electrode wheels, which results in excessive maintenance and poor weld quality. However, modifications to the basic systems are now available using a number of techniques that allow effective seam welding without the drawbacks mentioned previously. Processes have been developed to overcome electrode contamination. One of these is the foil butt seam welding process where steel foils are continuously fed between the work and top and bottom electrodes. This method is limited in its application. A more popular variant of the same principle is the Soudronic copper wire feed system. Here, any coating pick-up is continuously removed by means of the copper wire (fig. 16); the weld is effectively made using 'clean' electrodes at all times.

Figure 16: Principle of the Soudronic process



Projection welding

Galvatite can be projection welded satisfactorily whether using embossed projections, singly or in clusters, or elongated projections, provided that projection dimensions and welding machine settings are controlled closely.

Galvatite Z275 coatings produce solid phase bonds. The weld size is controlled by the projection base or die diameter, which should be larger than that for equivalent thicknesses of uncoated steel. Liquid phase welds are obtained easily with Galvatite ZF100, where the weld size depends on the weld time and is generally greater than the projection size. Projection tool design and welding conditions specified by the American Welding Society and the International Institute of Welding have been found to give sufficiently large weld diameters, even if short weld times are chosen (see table 14, page 27).

Stud welding

This is a high speed, semi-automatic process in which coalescence is produced by an arc drawn between a metal stud and the workpiece. The metal stud and workpiece are then brought together under pressure. Two basic variations of the process are in use:

Arc stud welding

A ceramic shield (ferrule) surrounds the stud and dams the molten metal to form a fillet weld. The weld time and final plugging of the stud are controlled automatically; the sequence is initiated by a manual trigger on the stud gun. The studs are from 3.0mm to 31.0mm (approximately) in diameter. High strengths can be obtained, provided that the thickness of the parent material is at least one third the diameter of the stud weld base. Lift and plunge settings are higher for arc stud welding Galvatite than for uncoated mild steels. Weld current must also be significantly higher. Castellated ferrules are recommended.

Capacitor discharge stud welding
A variety of stud sizes and shapes are widely used on thin sheets of Galvatite. High capacitor bank and voltage settings are required, as compared with uncoated steels.

Fusion welding

Conventional fusion welding processes can be used to join the various types of Galvatite. Techniques and procedures used are similar to those used for uncoated steel. Whilst these processes can result in a certain amount of damage to the zinc coating in the vicinity of the weld, this can be minimised by the choice of process and welding conditions. For example, coating damage is much less with metal active gas welding than with either gas or manual metal-arc welding. Heavier zinc coatings, e.g. Galvatite Z600, can only be welded at much reduced welding speeds. In certain instances, it may be necessary to remove the zinc coating in the vicinity of the joint before welding.

Gas welding
This process can be used for welding Galvatite, but coating damage and the likelihood of distortion are greater than with other fusion welding processes.

Manual metal-arc welding
Electrodes similar to those used for arc welding uncoated mild steel can be used. The major differences when welding zinc-coated steel compared with uncoated steel may be summarised as follows:

- A higher input of heat is needed to remove zinc from the weld pool.
- Lower welding speed (10%-20%) for Z275 coatings owing to the need for a ‘whipping action’.
- A more disturbed weld pool.
- Greater fluidity of the slag.
- Rougher weld profile.
- Emission of zinc fume.
- An increase in the amount of spatter.
- Lower penetration with butt welds. This necessitates larger root gaps than generally specified for uncoated steels.

Laser welding

The use of laser welding is increasing in a number of areas where the continuous low-heat-input weld can give improved structural performance. The continuous joint can give increased torsional rigidity compared to discrete spot welding thereby enabling the use of thinner, high-strength steels in appropriate areas. The ability to focus the beam to a fine spot (<0.5mm) minimises problems with distortion, which exist with some higher-heat-input processes.

Laser welding is used for tailor welded blanks (TWB) where different steels are butt welded to give the required properties in specific areas. Three-dimensional laser welding is used in product build to give continuous joints in overlapped sheets. Lasers involve high capital costs and therefore generally need high-volume production for economies of scale. Lasers can also be used in areas where the reduced distortion minimises high re-work costs.

Both CO_2 and Nd:YAG lasers are used for two-dimensional TWB’s. However, Nd:YAG laser light can be transmitted through fibre optics, making it more attractive for three-dimensional construction. The presence of a zinc coating has little influence on butt welding, however, for overlap welding the volatilised zinc can give porosity in the weld. This can be reduced or even eliminated with the introduction of a small gap between the sheets (0.1mm) or possibly with a modified weld pool shape (e.g. elongated molten pool).

The small volume of liquid metal results in fast cooling rates and an increase in hardness of the weld compared to the parent metal, e.g. x2. Depending on the composition of the parent plate, the hardness of the weld can rise above 400Hv. This can influence the degree of formability which can be achieved in the weld area, although Galvatite ZF CMN 300 is laser welded and used in a number of TWB applications. The concentrated nature of the focused laser spot requires very good fit up of the sheets to be welded. This is generally achievable in off-line butt-weld configurations with good edge preparation, but it can be more difficult in three-dimensional welding of formed components. Depending on the application, the tolerance to fit-up may be relaxed slightly by the use of filler wire additions to bridge any gaps or by hybrid laser-plasma welding, or in thicker sections, by hybrid laser-gas metal arc welding.

After-weld treatments

If the component is to be subjected to severely corrosive conditions in service, then it is advisable to repair any coating damage which may occur as a result of welding. This can be done with zinc-rich paints or zinc-rich paint sticks, which may be applied to the weld while it is hot. Zinc metallising is also extremely satisfactory. A coat of aluminium paint on top of any weld-protective paint used on Galvatite Z will give an improved colour match.

Welding fume

Welding Galvatite inevitably generates fumes. The volume of fume produced is dependent on the thickness of the coating, the welding process, the welding conditions (particularly the heat input), and the configuration of the joint as well as the welding position. The amount of fume generated during resistance welding is considerably less than that generated when using any of the fusion welding processes. Good general ventilation is essential when welding zinc-coated steels. In particular situations, e.g. confined spaces, it is necessary to locate additional extraction units close to the work or to use respiratory protection, or both (see pages 48-50).

Brazing

Brazed joints can be produced using a number of heat sources including MIG brazing, plasma brazing with cold wire, plasma-MIG brazing and laser brazing. Although several types of brazing wires are available, copper and silver-based wires are the most frequently used.

Since the boiling point of zinc is around 900°C, every effort should be made to optimise temperature and speed of operation to minimise coating damage. The more expensive silver-based filler alloys have a significantly lower melting temperature than copper based alloys, which could be beneficial if both coating integrity and joint appearance are critical.

Contamination or oxides on the surface of the component must be removed to ensure adequate joint quality. Previously this has been achieved with the use of fluxes, which also promote surface wetting. However, the use of such substances is avoided wherever possible because they have negative effects on both health and the environment. In addition, it is essential to remove flux residues after brazing to avoid corrosion. As a consequence and to ensure adequate wettability, an alternative methodology has been developed, which involves the use of a shielding gas with a high affinity to oxygen.

Soldering

It is essential that the correct fluxes are used when soldering Galvatite. Zinc chloride and ammonium chloride based fluxes are suitable for non-passivated materials. Whilst these fluxes give reasonable levels of wetting with passivated material, stronger aminoborate fluxes give optimum results. In general, significantly weaker fluxes are suitable for soldering non-passivated material compared with passivated material.

Galvatite ZF is the most difficult of the materials to solder. Strong acid or aminoborate fluxes are essential to ensure adequate wetting. A caustic treatment prior to soldering improves the wettability such that weaker fluxes can be used. A 60% tin, 40% lead solder is generally used for soldering Galvatite. Higher strength joints can be achieved by the use of silver-tin-lead solders.

Brazing and soldering fumes

Although the temperatures attained when brazing and soldering are not as high as those encountered in welding, forced ventilation or fume extraction must be provided, particularly in confined spaces.

Adhesive bonding

Galvatite can be bonded using a wide range of adhesive types. The choice of adhesive depends on the end application. For example, for gap-filling purposes, a sealant would be sufficient, whereas for a continuously stressed joint, a structural adhesive such as an epoxy would be required. Silicone rubber sealants that are free from acetic acid or amines are suitable for sealing Galvatite. Other generic types such as butyl rubber and styrene butadiene rubber are quite acceptable where the optimum characteristics of the recommended sealant are not required. Sealants should be applied according to the manufacturers' instructions. Sealed seams should always be fastened mechanically for strength. Although some adhesives are tolerant of minor surface contamination, degreasing is recommended to ensure a consistent joint quality.

Table 15: Bonding strength and failure modes

Adhesive type	Bond strength (N/mm^2)	Failure mode
Toughened or conventional epoxy	25-30	Coating
Nitrile phenolic	12	Cohesive/ coating
Acrylic	6-12	Cohesive
Neoprene	7	Cohesive

Note: This table shows the influence of bond strength and adhesive type on the failure mode obtained in shear for Galvatite ZF100.

Left: FKI Switchgear, Blackwood, Gwent

Typical lap shear strengths are shown in figure 17 below. The shear strength of bonds depends on the type of coating and adhesive used where, in general, Galvatite Z275 will develop higher lap shear strengths than Galvatite ZF100 with high modulus epoxy adhesives. The reverse is true for the more flexible lower modulus types of adhesives such as acrylic and polyurethane adhesives.

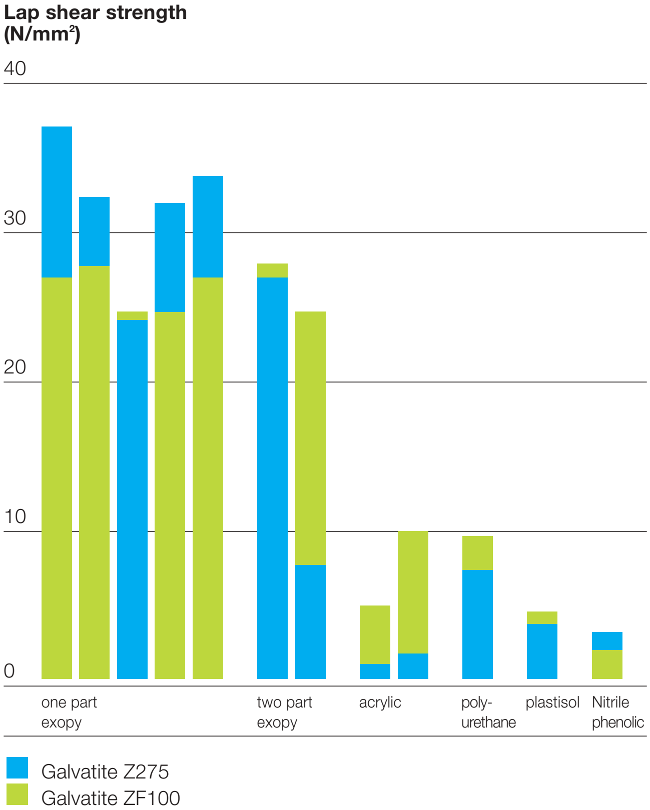
The failure of bonds using Galvatite Z275 is a mixture of adhesive and cohesive failure. With Galvatite ZF100 there is a threshold strength level above which the failure changes from a mixture of adhesive and cohesive to predominantly coating failure (see table 15 on page 31), i.e. at the interface between the coating and the steel base. The occurrence of coating failure does not limit the maximum strength of the joint; the strength developed is a function of the type of adhesive and not the type of failure.

When using acrylic adhesives, lower shear strengths are obtained with Galvatite Z275 than with Galvatite ZF100. This is because the free zinc in Galvatite's zinc coating passivates the reaction radicals in the adhesive and thereby inhibits curing. The absence of free zinc in Galvatite ZF100 allows acrylic adhesives to cure effectively. A primer, e.g. an epoxy primer, should be applied to Galvatite Z275 before using either polyurethane or acrylic adhesives, particularly if the zinc coating has been chromate passivated.

The long-term durability of bonded joints needs to be considered when using high-strength adhesives in a load-bearing application, since it is essential that any bonded structure retains a high proportion of the initial strength over the life of the component. Long term studies have indicated that for both a Galvatite Z275 coating and a Galvatite ZF100 alloy coating, surface pre-treatment has an important influence on durability.

The results of weathering trials indicate improved performance on iron-zinc alloy coatings compared with standard zinc coatings. This is attributable to the crystalline morphology of the former affording a greater number of sites for bonding, together with enhanced interlocking of the adhesive onto the surface. Good durability depends on coating selection, adhesive type and surface condition. To promote long-term bond strength, the morphology of surfaces should allow a keying action. Surfaces should also be degreased before they are bonded.

Figure 17: Shear strengths for a range of adhesives with 1.2mm thick Galvatite



Right: Ward Building Components Ltd., Sherburn, North Yorkshire

Adhesion of foam to Galvatite

Foams can be attached to Galvatite either by adhesive bonding or by injection foaming into a cavity. Solvent-based neoprene contact adhesives can be used for bonding rigid foam to Galvatite: the adhesive is generally sprayed onto both the foam and the metal substrate. Polyurethane adhesives give better results than neoprene systems and are applied to one substrate only, either the foam or the metal. A range of polyurethane chemistries can be used. This includes 'one-component moisture-curing solvent-free' systems, and 'two-component solvent-free' systems. The introduction of increasingly stringent environmental legislation may inhibit the use of solvent-based systems in the future.

Two-part polyurethane foams comprising a polyol and a catalyst are used for cavity injection foaming. The components are mixed prior to injection into the cavity. It is sometimes necessary to prime the zinc surface to ensure satisfactory adhesion. Neoprene-based primers are generally preferred; the exothermic curing of the polyurethane foam acts to enhance its adhesion to the primed surface.

When using adhesives, the supplier's advice must be followed and fume extraction used where required.

Painting

Galvatite may be painted either to decorate it or to enhance its corrosion resistance.

If Galvatite is to be painted for decoration, then its coating finish and surface quality are important. For example, a Normal Spangle will show through paint films. If this is undesirable, then Minimised Spangle with either an improved surface or best quality surface should be specified, depending on the quality of paint finish required.

Painting Galvatite to enhance its corrosion resistance has other benefits too. Suitable paint systems used on Galvatite will give a much better standard of performance and longer life than they would on mild steel. General rusting and creepage of rust from areas of damage in the paint film will be less than they would be on mild steel. Re-painting in the course of normal maintenance can be delayed longer with Galvatite than with mild steel. The costly de-rusting and surface preparation, which would be essential on mild steel, is not necessary with Galvatite. Galvatite's coating protects areas such as overlaps, which are not accessible for painting after fabrication. If the conditions of exposure are expected to be very severe or if a long life is required, then it is advisable to paint such areas before fabrication, even when using Galvatite.

Requirements for painting

Painting Galvatite is similar to painting mild steel and can frequently be carried out with little or no modification to existing equipment. The main requirements are listed below.

- The surface must be clean and free of oil, grease, corrosion products, and moisture.
- The surface must be pre-treated or suitably primed, or both, to maintain paint adhesion in service.
- Undercoats and topcoats must be chosen to withstand the environment in which the material will be exposed and also to meet the life requirement.

The way in which these requirements are met will vary depending mainly on whether the paints are applied in a factory (where pre-treatment facilities exist) or on site (where they do not).

Painting on site

Cleaning

Soil and dirt should be removed by scrubbing with a bristle brush and water. Detergents are not recommended, since residues left on the surface can cause problems after painting.

Grease and oil should be removed by swabbing with rags soaked with organic solvents such as paint thinners. Frequent rag changes will be necessary to avoid spreading deposits rather than removing them. All cleaning chemicals should be used carefully according to manufacturers' instructions. Corrosion products, if present, should be removed by the use of mild abrasives such as a Scotch-Brite™ pad, taking care not to remove too much zinc. Wire brushing is not generally recommended, since this can remove large quantities of zinc. Suitable chemicals also exist for the removal of corrosion products (contact Corus for further advice). De-rusters for use on mild steel should not be used on zinc coated steel since they are frequently very acidic and can easily strip the zinc coating.

Priming

For on-site painting, where air-drying paints are used, the choice of primer is of great importance. Primers which perform well on mild steel frequently perform badly on zinc. Some paint resins degenerate in the process of weathering to give acidic products. These products react with zinc to form zinc soaps, which destroy the adhesion between the paint and the zinc. Paint suppliers should be consulted about suitable primers. This does not usually complicate the application process. Primers that can be brushed, applied by roller, or sprayed are available.

Weathering is sometimes suggested as a 'pre-treatment' before painting, but in practice it is not recommended because it is not always effective. It is also difficult to carry out uniformly over large areas of a building. The subsequent cleaning process that is then necessary before painting can be very expensive.

Galvatite ZF can often be painted without pre-treatment or special priming and gives very good standards of paint performance. Removal of oil, grease and soil is again essential to achieve good results with Galvatite ZF.

Finishing coats

The environment in which exposure is envisaged and the life requirement for the finish will determine the paint system. Advice on suitable systems can be obtained from paint suppliers. If the coatings that constitute the paint system are purchased from different suppliers, the compatibility and mutual adhesion of the coatings should be checked.

Scotch-Brite is a trademark of the 3M Company.

Left: Metsec Building Products,
Oldbury, West Midlands

Factory applied paints

Normally, stoving paints are applied in factories, to pre-treated or phosphated sheets. Phosphating of zinc coated steels promotes paint adhesion and increases corrosion resistance, e.g. by limiting the spread of corrosion from damaged areas in paint films.

Pre-treatment processes for zinc and iron-zinc alloy coated steels are available from companies that specialise in this sort of process. A typical process would be:

1. Clean with a spray-applied, mildly alkali cleaning solution.
2. Rinse with water.
3. Pre-treat, normally with a zinc phosphate treatment.
4. Rinse.
5. Passivation rinse.

In some factories, the pre-treatment process is replaced by the use of a two-pack etch primer based on polyvinyl butyral, which gives very good standards of performance on zinc surfaces. If such a primer is used, the paint supplier's instructions for mixing, application, and for the length of time they can be kept once mixed should be followed carefully if the best results are to be obtained. Two-pack etch primers are also highly recommended for use on site. Pre-treatments and etch primers should be applied to unpassivated material only.

A wide range of stoving paints can be applied to suitably pre-treated Galvatite. Acrylics and polyesters are used on domestic appliances; silicone polyesters, acrylic polyesters, and alkyds are used on pre-treated and suitably primed Galvatite for exterior use. Galvatite is an excellent base for powder paints, but pre-treatment is required, particularly for Galvatite Z.

To overcome problems of pimpling, the substrate should be heated to 10-20°C above the subsequent curing temperature before applying the powder coating. Paint suppliers will advise on the most suitable paint system for the application envisaged.

Galvatite ZF can be painted direct with many stoving paints without the need for pre-treatment, apart from removal of grease, oil and soil. If a high standard of appearance must be maintained for a prolonged period in an aggressive environment, then Galvatite ZF must be pre-treated and primed before applying a topcoat.

Note

A passivation treatment on Galvatite will minimise white rusting or storage staining. However, the treatment may affect further application of primers, adhesives, and other pre-treatments such as phosphates. If such processes are to be used in part of the painting or finishing sequence, or in both, the user should consult Corus. See *Protective treatments*, page 9.

Left: Hotpoint, Merioni Elettrodomestici UK, Peterborough, UK
Right: Honda UK, Slough, Berkshire

Organic coated steel

Pre-finished, hot-dip zinc coated steel (organic coated) is available from Corus and is sold under the trademarks of Colorcoat and Stelvetite. The paint coating on Colorcoat is applied as a liquid, whereas the Stelvetite coating is a polymer film bonded to the substrate to form a laminate. The pre-treatments, primers, and finishing coats for both products are carefully selected to give both systems the maximum flexibility and durability. More information about these products is available from Corus at:

The Colorcoat Connection,
T: +44 (0)1244 892434
E: colorcoat.connection@corusgroup.com
W: www.colorcoat-online.com

Automotive painting

Tri-cationic phosphate treatments are particularly suitable for use with Galvatite. Treatments that are sensitive to aluminium contamination should be avoided since the galvanised coatings contain a small amount of aluminium.

Galvatite products give excellent corrosion performance with cathodic electropaints.

Packing, handling and storage

Packing
Galvatite coils and sheets for home trade and for export are delivered in packs to protect the material while in transit and in storage. Packing styles vary according to customers' requirements and the destination of the material. Typical packs are illustrated below.

Handling
Reasonable care must be taken to avoid damaging the edges or scratching the surfaces during handling. The number of coils or sheet packs which are stored on top of each other should be limited and stacking of coils should be avoided wherever possible.

Products are secured with bands and these should not be used for lifting. Bands can cause eye or other injury when tension is released and coils may spring apart when banding is removed.

Suitable protective clothing and equipment, such as hand and eye protection, should be worn. Systems of work should be designed to take account of any hazards arising from the risk of fracturing or the release of tension or stress when breaking open banding.

Storage
Galvatite should always be stored:

1. Off the ground on wooden or metal skids/stillages.

2. Indoors, in a clean, dry area away from open doorways and sources of chemical pollution.

3. At an even temperature, above the dew point to avoid condensation.

If Galvatite has to be stored out of doors, some precautions are essential:

1. If stacks or coils cannot be kept under cover, erect a simple scaffolding around them and cover it with a waterproof sheet, tarpaulin or polythene.

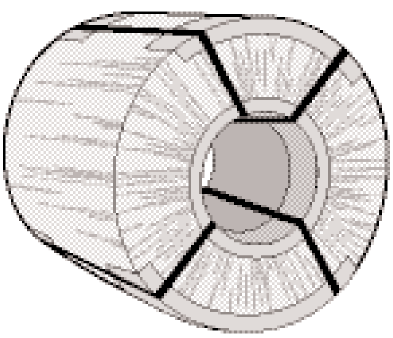
2. Leave space between the cover and the sheets to allow air to circulate.

3. Be aware of condensation arising due to temperature inversions.

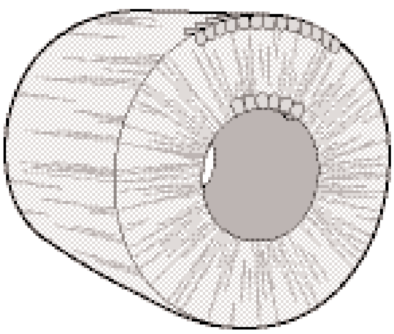
4. Inspect storage site regularly to ensure that moisture has not penetrated the stack or coils (even if precautions have been taken).

Figure 18: Typical coil packs

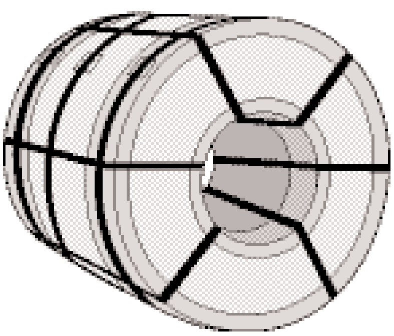
Home trade manual wrap



Home trade machine wrap



Full metal protection for export



Galvatite product range

This Galvatite product range is expressed in terms of EN 10142, EN 10147 and EN 10292 : 2000.

Dimensions

Width and thickness limits for the forming and drawing qualities are shown in tables 16-30, for the structural qualities in tables 31-46 and for the high-strength formable qualities in table 47. The minimum width for grades from these standards is 900mm. Widths below this may be available after consultation.

Table 16: Dimensions: EN 10142 : 2000

Z100, Z140: Coating finish NA

Thickness		Width		
		Max		
>	≤	DX51D	DX52D	DX53D-56D
0.43	0.49	1420	1420	–
0.49	0.62	1420	1420	1250
0.62	0.63	1420	1420	1350
0.63	0.70	1520	1520	1350
0.70	1.00	1520	1520	1380
1.00	1.25	1520	1520	1250
1.25	2.00	1520	1520	–
2.00	2.20	1375	1370	–
2.20	2.50	1375	1220	–

Note: Dimensions are in millimetres.

Table 17: Dimensions: EN 10142 : 2000

Z100, Z140: Coating finish MA

Thickness		Width		
		Max		
>	≤	DX51D	DX52D	DX53D-56D
0.35	0.38	1270	–	–
0.38	0.40	1370	970	1200
0.40	0.43	1370	1220	1250
0.43	0.48	1520	1220	1250
0.48	0.61	1520	1520	1350
0.61	0.63	1525	1525	1350
0.63	0.66	1550	1525	1550
0.66	0.68	1650	1650	1550
0.68	0.70	1650	1650	1650
0.70	0.78	1780	1780	1750
0.78	0.80	1790	1790	1850
0.80	1.32	1820	1820	1850
1.32	1.40	1770	1770	1810
1.40	1.50	1700	1700	1730
1.50	1.60	1620	1620	1650
1.60	2.00	1470	1470	–
2.00	2.20	1375	1370	–
2.20	2.50	1375	1220	–

Note: Dimensions are in millimetres.

Table 18: Dimensions: EN 10142 : 2000

Z100, Z140: Coating finish MB

Thickness		Width		
		Max		
>	≤	DX51D	DX52D	DX53D-56D
0.50	0.55	1375	1400	1400
0.55	0.61	1520	1520	1400
0.61	0.66	1525	1600	1600
0.66	0.70	1650	1650	1600
0.70	0.79	1700	1750	1750
0.79	1.50	1800	1800	1800
1.50	1.61	1750	1750	1750
1.61	1.71	1650	1650	1650
1.71	1.81	1550	1550	1550
1.81	1.91	1450	1450	1450
1.91	2.00	1400	1400	1400

Note: Dimensions are in millimetres.

Table 19: Dimensions: EN 10142 : 2000

Z100, Z140: Coating finish MC

Thickness		Width		
		Max		
>	≤	DX51D	DX52D	DX53D-56D
0.50	0.55	1350	1350	1400
0.55	0.60	1520	1520	1400
0.60	0.61	1520	1600	1600
0.61	0.66	1525	1600	1600
0.66	0.70	1650	1650	1600
0.70	0.79	1700	1750	1750
0.79	1.00	1800	1800	1800
1.00	1.20	1800	1650	1550
1.20	1.25	1650	1650	1550
1.25	2.00	1375	1375	–

Note: Dimensions are in millimetres.

Table 20: Dimensions: EN 10142 : 2000

Z200, Z225, Z275: Coating finish NA

Thickness		Width		
		Max		
>	≤	DX51D	DX52D	DX53D-56D
0.43	0.49	1420	1420	–
0.49	0.62	1420	1420	1250
0.62	0.63	1420	1420	1350
0.63	0.70	1520	1520	1350
0.70	1.00	1520	1520	1380
1.00	1.25	1520	1520	1250
1.25	2.00	1520	1520	–
2.00	2.20	1375	1370	–
2.20	2.50	1375	1220	–

Note: Dimensions are in millimetres.

Table 21: Dimensions: EN 10142 : 2000

Z200, Z225, Z275: Coating finish MA

Thickness		Width		
		Max		
>	≤	DX51D	DX52D	DX53D-56D
0.40	0.50	1375	1375	–
0.50	0.55	1375	1375	1250
0.55	0.61	1520	1520	1250
0.61	0.62	1525	1525	1250
0.62	0.66	1525	1525	1350
0.66	0.70	1650	1650	1350
0.70	1.25	1650	1650	1550
1.25	2.00	1375	1375	–
2.00	2.50	1375	–	–

Note: Dimensions are in millimetres.

Table 22: Dimensions: EN 10142 : 2000

Z200, Z225, Z275: Coating finish MB

Thickness		Width		
		Max		
>	≤	DX51D	DX52D	DX53D-56D
0.40	0.50	1350	1350	–
0.50	0.55	1375	1400	1400
0.55	0.61	1520	1520	1400
0.61	0.66	1525	1600	1600
0.66	0.70	1650	1650	1600
0.70	0.79	1700	1750	1750
0.79	1.50	1800	1800	1800
1.50	1.61	1750	1750	1750
1.61	1.71	1650	1650	1650
1.71	1.81	1550	1550	1550
1.81	1.91	1450	1450	1450
1.91	2.00	1400	1400	1400

Note: Dimensions are in millimetres.

Table 23: Dimensions: EN 10142 : 2000

Z200, Z225, Z275: Coating finish MC

Thickness		Width		
		Max		
>	≤	DX51D	DX52D	DX53D-56D
0.40	0.50	1350	1350	–
0.50	0.55	1350	1400	1400
0.55	0.60	1520	1520	1400
0.60	0.61	1520	1600	1600
0.61	0.66	1525	1600	1600
0.66	0.70	1650	1650	1600
0.70	0.79	1700	1750	1750
0.79	1.00	1800	1800	1800
1.00	1.20	1800	1650	1550
1.20	1.25	1650	1650	1550
1.25	2.00	1375	1375	–

Note: Dimensions are in millimetres.

Table 24: Dimensions: EN 10142 : 2000

Z350: Coating finish NA

Thickness		Width	
		Max	
>	≤	DX51D	DX52D
0.43	0.63	1420	1420
0.63	2.00	1520	1520
2.00	2.20	1375	1370
2.20	2.50	1375	1220

Note: Dimensions are in millimetres.

Table 25: Dimensions: EN 10142 : 2000

Z350: Coating finish MA

Thickness		Width		
		Max		
>	≤	DX51D	DX52D	DX53D-56D
0.35	0.38	1270	–	–
0.38	0.40	1370	970	1200
0.40	0.43	1375	1220	1250
0.43	0.48	1520	1220	1250
0.48	0.61	1520	1520	1350
0.61	0.63	1525	1520	1350
0.63	0.66	1550	1550	1550
0.66	0.68	1650	1550	1550
0.68	0.70	1650	1605	1650
0.70	0.78	1780	1780	1750
0.78	0.80	1790	1790	1850
0.80	1.32	1820	1820	1850
1.32	1.40	1770	1770	1810
1.40	1.50	1700	1700	1730
1.50	1.60	1620	1620	1650
1.60	2.00	1520	1470	–
2.00	2.20	1375	1370	–
2.20	2.50	1375	1220	–

Note: Dimensions are in millimetres.

Table 26: Dimensions: EN 10142 : 2000

Z350: Coating finish MB

Thickness		Width
		Max
>	≤	DX51D
0.40	0.50	1350
0.50	0.69	1375
0.69	0.79	1700
0.79	1.51	1800
1.51	1.61	1750
1.61	1.71	1650
1.71	1.81	1550
1.81	1.91	1450
1.91	2.00	1400

Note: Dimensions are in millimetres.

Table 27: Dimensions: EN 10142 : 2000

Z450, Z600: Coating finish NA

Thickness		Width
		Max
>	≤	DX51D
0.40	2.50	1375

Notes: Dimensions are in millimetres.

Table 28: Dimensions: EN 10142 : 2000

ZF100, ZF120: Coating finish RA, RB

Thickness		Width			
		Max			
>	≤	DX51D	DX52D	DX53D	DX54D DX56D
0.38	0.40	1270	970	970	–
0.40	0.43	1370	1070	1070	1170
0.43	0.48	1520	1220	1220	1220
0.48	0.53	1520	1520	1520	1220
0.53	0.58	1520	1520	1520	1335
0.58	0.63	1520	1620	1550	1450
0.63	0.66	1520	1620	1600	1600
0.66	0.69	1550	1620	1600	1600
0.69	0.70	1605	1605	1605	1605
0.70	0.78	1780	1780	1780	1780
0.78	0.80	1790	1790	1790	1790
0.80	1.35	1820	1820	1820	1820
1.35	1.40	1800	1770	1770	1770
1.40	1.50	1800	1750	1750	1750
1.50	1.60	1750	1750	1750	1750
1.60	1.71	1650	1470	1400	1400
1.71	1.80	1550	1470	1400	1400
1.80	1.91	1450	–	–	–
1.91	2.00	1400	–	–	–

Note: Dimensions are in millimetres.

Table 29: Dimensions: EN 10142 : 2000

ZF100, ZF120: Coating finish RC

Thickness		Width			
		Max			
>	≤	DX51D	DX52D	DX53D	DX54D DX56D
0.38	0.40	1270	970	970	–
0.40	0.43	1370	1070	1070	1170
0.43	0.48	1520	1220	1220	1220
0.48	0.53	1520	1520	1520	1220
0.53	0.63	1520	1520	1520	1335
0.63	0.68	1520	1550	1550	1570
0.68	0.70	1605	1605	1605	1605
0.70	0.78	1780	1780	1780	1780
0.78	0.80	1790	1790	1790	1790
0.80	1.20	1820	1820	1820	1820

Note: Dimensions are in millimetres.

Table 30: Dimensions: EN 10142 : 2000

ZF140: Coating finish RA, RB

Thickness		Width	
		Max	
>	≤	DX51D	DX52D-56D
0.50	0.55	1200	–
0.55	0.62	1200	1450
0.62	0.66	1300	1600
0.66	0.70	1550	1600
0.70	0.79	1700	1750
0.79	1.50	1800	1750
1.50	1.60	1750	1750
1.60	1.71	1650	–
1.71	1.81	1550	–
1.81	1.91	1450	–
1.91	2.00	1400	–

Note: Dimensions are in millimetres.

Table 31: Dimensions: EN 10147 : 2000

Z100, Z140: Coating finish NA

Thickness		Width			
		Max			
>	≤	S220GD S250GD	S280GD S320GD	S350GD	S550GD
0.40	0.43	–	–	–	1070
0.43	0.45	1420	1420	–	1070
0.45	0.60	1420	1420	1400	1220
0.60	1.00	1520	1520	1520	1220
1.00	2.00	1520	1520	1520	–
2.00	2.50	1375	1375	1375	–

Note: Dimensions are in millimetres.

Table 32: Dimensions: EN 10147 : 2000

Z100, Z140: Coating finish MA

Thickness		Width		
		Max		
>	≤	S220GD S250GD	S280GD S320GD	S350GD
0.38	0.43	1420	1420	–
0.43	0.45	1520	1520	–
0.45	0.55	1520	1520	1400
0.55	0.61	1520	1520	1520
0.61	0.66	1525	1525	1525
0.66	1.25	1650	1650	1650
1.25	1.40	1620	1620	1520
1.40	1.60	1570	1570	1520
1.60	2.00	1520	1520	1520
2.00	2.50	1375	1375	1375

Note: Dimensions are in millimetres.

Table 33: Dimensions: EN 10147 : 2000

Z100, Z140: Coating finish MB

Thickness		Width		
		Max		
>	≤	S220GD S250GD	S280GD S320GD	S350GD
0.38	0.43	1420	1420	–
0.43	0.45	1520	1520	–
0.50	0.55	1520	1520	1375
0.55	0.61	1520	1520	1520
0.61	0.66	1525	1525	1525
0.66	0.74	1650	1650	1650
0.74	0.79	1780	1650	1650
0.79	1.25	1820	1650	1650
1.25	1.40	1820	1620	1620
1.40	1.51	1820	1570	1570
1.51	1.60	1750	1570	1570
1.60	1.61	1750	1520	1520
1.61	1.71	1640	1520	1520
1.71	1.81	1550	1520	1520
1.81	1.91	1470	1520	1520
1.91	2.00	1400	1520	1520
2.00	2.50	1375	1375	1375

Note: Dimensions are in millimetres.

Table 34: Dimensions: EN 10147 : 2000

Z100, Z140: Coating finish MC

Thickness		Width		
		Max		
>	≤	S220GD S250GD	S280GD S320GD	S350GD
0.38	0.43	1420	1420	–
0.43	0.50	1520	1520	–
0.50	0.55	1520	1520	1350
0.55	0.61	1520	1520	1520
0.61	0.66	1525	1525	1525
0.66	0.70	1650	1650	1650
0.70	0.79	1700	1650	1650
0.79	1.20	1800	1650	1650
1.20	1.40	1620	1620	1620
1.40	1.60	1570	1570	1570
1.60	2.00	1520	1520	1520
2.00	2.20	1370	1370	1370
2.20	2.50	1220	1220	1220

Note: Dimensions are in millimetres.

Table 35: Dimensions: EN 10147 : 2000

Z200, Z225, Z275: Coating finish NA

Thickness		Width			
		Max			
>	≤	S220GD S250GD	S280GD S320GD	S350GD	S550GD
0.40	0.43	1375	1375	1375	1070
0.43	0.45	1420	1420	1375	1070
0.45	0.60	1420	1420	1400	1220
0.60	1.00	1520	1520	1520	1220
1.00	2.00	1520	1520	1520	–
2.00	2.50	1375	1375	1375	–

Note: Dimensions are in millimetres.

Table 36: Dimensions: EN 10147 : 2000

Z200, Z225, Z275: Coating finish MA

Thickness		Width			
		Max			
>	≤	S220GD S250GD	S280GD S320GD	S350GD	S550GD
0.38	0.40	1420	1420	–	–
0.40	0.43	1420	1420	1375	1070
0.43	0.45	1520	1520	1375	1070
0.45	0.55	1520	1520	1375	1220
0.55	0.61	1520	1520	1520	1220
0.61	0.66	1525	1525	1525	1220
0.66	1.00	1650	1650	1650	1220
1.00	1.25	1650	1650	1650	–
1.25	1.40	1620	1620	1520	–
1.40	1.60	1570	1570	1520	–
1.60	2.00	1520	1520	1520	–
2.00	2.50	1375	1375	1375	–

Note: Dimensions are in millimetres.

Table 37: Dimensions: EN 10147 : 2000

Z200, Z225, Z275: Coating finish MB

Thickness		Width		
		Max		
>	≤	S220GD S250GD	S280GD S320GD	S350GD
0.38	0.40	1420	1420	–
0.40	0.43	1420	1420	1350
0.43	0.50	1520	1520	1350
0.50	0.55	1520	1520	1375
0.55	0.61	1520	1520	1520
0.61	0.66	1525	1525	1525
0.66	0.74	1650	1650	1650
0.74	0.79	1780	1650	1650
0.79	1.25	1820	1650	1650
1.25	1.40	1820	1620	1620
1.40	1.51	1820	1570	1570
1.51	1.60	1750	1570	1570
1.60	1.61	1750	1520	1520
1.61	1.71	1640	1520	1520
1.71	1.81	1550	1520	1520
1.81	1.91	1470	1520	1520
1.91	2.00	1400	1520	1520
2.00	2.50	1375	1375	1375

Note: Dimensions are in millimetres.

Table 38: Dimensions: EN 10147 : 2000

Z200, Z225, Z275: Coating finish MC

Thickness		Width		
		Max		
>	≤	S220GD S250GD	S280GD S320GD	S350GD
0.38	0.40	1420	1420	–
0.40	0.43	1420	1420	1350
0.43	0.55	1520	1520	1350
0.55	0.61	1520	1520	1520
0.61	0.66	1525	1525	1525
0.66	0.70	1650	1650	1650
0.70	0.79	1700	1650	1650
0.79	1.20	1800	1650	1650
1.20	1.40	1620	1620	1620
1.40	1.60	1570	1570	1570
1.60	2.00	1520	1520	1520
2.00	2.20	1370	1370	1370
2.20	2.50	1220	1220	1220

Note: Dimensions are in millimetres.

Table 39: Dimensions: EN 10147 : 2000

Z350: Coating finish NA

Thickness		Width			
		Max			
>	≤	S220GD S250GD	S280GD S320GD	S350GD	S550GD
0.40	0.43	1375	1375	1375	–
0.43	0.45	1420	1420	1375	–
0.45	0.60	1420	1420	1400	1220
0.60	1.00	1520	1520	1520	1220
1.00	2.00	1520	1520	1520	–
2.00	2.50	1375	1375	1375	–

Note: Dimensions are in millimetres.

Table 40: Dimensions: EN 10147 : 2000

Z350: Coating finish MA

Thickness		Width		
		Max		
>	≤	S220GD S250GD	S280GD S320GD	S350GD
0.38	0.40	1420	1420	–
0.40	0.43	1420	1420	1375
0.43	0.55	1520	1520	1375
0.55	0.61	1520	1520	1520
0.61	0.66	1525	1525	1525
0.66	1.25	1650	1650	1650
1.25	1.40	1620	1620	1620
1.40	1.60	1570	1570	1570
1.60	2.00	1520	1520	1520
2.00	2.50	1375	1375	1375

Note: Dimensions are in millimetres.

Table 41: Dimensions: EN 10147 : 2000

Z350: Coating finish MB

Thickness		Width		
		Max		
>	≤	S220GD S250GD	S280GD S320GD	S350GD
0.38	0.40	1420	1420	–
0.40	0.43	1420	1420	1350
0.43	0.50	1520	1520	1350
0.50	0.60	1520	1520	1375
0.60	0.69	1520	1520	1520
0.69	0.78	1650	1520	1520
0.78	0.79	1780	1620	1620
0.79	1.40	1820	1620	1620
1.40	1.51	1820	1570	1570
1.51	1.60	1750	1570	1570
1.60	1.61	1750	1520	1520
1.61	1.71	1640	1520	1520
1.71	1.81	1550	1520	1520
1.81	2.00	1520	1520	1520
2.00	2.50	1375	1375	1375

Note: Dimensions are in millimetres.

Table 42: Dimensions: EN 10147 : 2000

Z350: Coating finish MC

Thickness		Width		
		Max		
>	≤	S220GD S250GD	S280GD S320GD	S350GD
0.38	0.43	1420	1420	–
0.43	0.60	1520	1520	–
0.60	0.69	1520	1520	1520
0.69	0.74	1650	1520	1520
0.74	0.78	1780	1520	1520
0.78	0.79	1780	1620	1620
0.79	1.40	1820	1620	1620
1.40	1.51	1820	1570	1570
1.51	1.60	1750	1570	1570
1.60	1.61	1750	1520	1520
1.61	1.71	1640	1520	1520
1.71	1.81	1550	1520	1520
1.81	2.00	1520	1520	1520
2.00	2.20	1370	1370	1370
2.20	2.50	1220	1220	1220

Note: Dimensions are in millimetres.

Table 43: Dimensions: EN 10147 : 2000

Z450, Z600: Coating finish NA

Thickness		Width		
		Max		
>	≤	S220GD S250GD	S280GD S320GD	S350GD
0.40	2.50	1375	1375	1375

Note: Dimensions are in millimetres.

Table 44: Dimensions: EN 10147 : 2000

Z450, Z600: Coating finish MA

Thickness		Width		
		Max		
>	≤	S220GD S250GD	S280GD S320GD	S350GD
0.40	2.50	1375	1375	1375

Note: Dimensions are in millimetres.

Table 45: Dimensions: EN 10147 : 2000

ZF100, ZF140: Coating finish RA

Thickness		Width		
		Max		
>	≤	S220GD S250GD	S280GD S320GD	S350GD
0.550	0.565	1490	1250	1250
0.565	0.590	1490	1300	1300
0.590	0.615	1490	1325	1325
0.615	0.640	1500	1350	1350
0.640	0.660	1500	1400	1400
0.660	0.665	1550	1400	1400
0.665	0.690	1550	1425	1425
0.690	0.700	1630	1450	1450
0.700	0.740	1630	1475	1475
0.740	0.790	1760	1475	1475
0.790	1.090	1800	1475	1475
1.090	1.500	1800	1500	1500
1.500	1.610	1730	1500	1500
1.610	1.710	1620	1500	1500
1.710	1.810	1530	1500	1500
1.810	1.830	1450	1500	1500
1.830	1.910	1450	1445	1445
1.910	2.000	1380	1375	1375

Note: Dimensions are in millimetres.

Table 46: Dimensions: EN 10147 : 2000

ZF100, ZF140: Coating finish RB

Thickness		Width		
		Max		
>	≤	S220GD S250GD	S280GD S320GD	S350GD
0.550	0.565	1490	1250	1250
0.565	0.590	1490	1300	1300
0.590	0.615	1490	1325	1325
0.615	0.640	1500	1350	1350
0.640	0.660	1500	1400	1400
0.660	0.665	1550	1400	1400
0.665	0.690	1550	1425	1425
0.690	0.765	1630	1450	1450
0.765	0.790	1760	1475	1475
0.790	1.090	1800	1475	1475
1.090	1.510	1800	1500	1500
1.510	1.610	1730	1500	1500
1.610	1.710	1620	1500	1500
1.710	1.810	1530	1500	1500
1.810	1.830	1450	1500	1500
1.830	1.910	1450	1445	1445
1.910	2.000	1380	1375	1375

Note: Dimensions are in millimetres.

Table 47: Dimensions: EN 10292 : 2000

Thickness		Width							
		Max							
>	≤	H180BD	H220BD	H220YD	H260YD	H220PD H260LAD	H300PD H300LAD	H340LAD	H380LAD H420LAD
0.38	0.40	–	–	–	–	970	–	–	–
0.40	0.43	–	–	–	–	1220	–	–	–
0.43	0.45	1070	–	–	–	1220	–	–	–
0.45	0.50	1250	–	–	–	1520	–	–	–
0.50	0.56	1520	–	–	–	1520	1300	–	–
0.56	0.60	1520	1520	1320	1320	1520	1300	–	–
0.60	0.63	1520	1520	1580	1580	1520	1500	1450	–
0.63	0.68	1520	1520	1605	1605	1520	1500	1450	–
0.68	0.70	1605	1605	1605	1605	1605	1500	1450	–
0.70	0.75	1605	1605	1620	1620	1605	1500	1450	1500
0.75	0.90	1620	1620	1620	1620	1620	1600	1550	1500
0.90	0.98	1620	1620	1620	1620	1620	1600	1600	1500
0.98	1.10	1620	1620	1620	1620	1620	1600	1600	1550
1.10	1.20	1620	1620	1620	1620	1620	1620	1620	1550

Note: Dimensions are in millimetres.

Product health and safety data sheet no. 18

Zinc-coated steel sheets and coils

Revision April 2004
Originally published: February 1995
Minor changes: 3/96, 8/98, 5/01, 8/01 and 10/03.

1. Identification of the substance and company

ZINC-COATED STEEL SHEETS AND COILS
Trade name: Galvatite.
Steel with improved corrosion resistance.

Corus Strip Products UK
Customer Technical Services
PO Box 10
Newport
South Wales
NP19 4XN
T: +44 (0)1633 755171
F: +44 (0)1633 755177
Outside normal hours:
Security Department
T: +44 (0)1633 290022

2. Composition/Information on ingredients

Mild steel sheet coated with zinc by hot-dip processes (Galvatite Z), including iron-zinc alloy (Galvatite ZF). The hot-dip coatings may contain up to 0.002% lead or up to 0.12% antimony.

The base metal used for the organic coated products Colorcoat and Stelvetite is essentially lead-free.

The sheet may have a protective film of oil, phosphate or chromate.

3. Hazards identification

When subjected to elevated temperatures, e.g. during welding or flame cutting, toxic and irritant fumes may be evolved which can cause metal fume fever. Repeated contact with sheet protective coatings may cause skin problems.

4. First aid measures

Skin and eye contact:
Possible cuts from steel edges. Treat as other cuts; if required, seek immediate medical attention.

Ingestion:
Not relevant.

Inhalation:
Effects of inhaling fumes. Remove to fresh air and seek immediate medical attention.

5. Fire fighting measures

Non-flammable material but see '3. Hazards identification' above.

6. Accidental release measures

Not applicable.

7. Handling and storage

Handling
Some products may be secured by straps or bands. These should not be used for lifting and they could cause eye or other injury when tension is released. Coils and bundled products, such as sections, rods, bars, etc., may spring apart when the banding is removed. Certain products may, as a result of processing, be brittle or have residual stress which might cause fracture or significant movement. All products are likely to have sharp edges which could cause lacerations; flying particles may be produced when shearing, particularly from high-carbon steels. Suitable protective clothing and equipment, such as hand and eye protection, should be worn and the systems of work designed to take account of any hazards arising from the risk of fracturing or the release of tension or stress when breaking open banding.

Storage
Suitable racks should be used to ensure stability when stocking narrow coils.

8. Exposure controls and personal protection

Suitable protective clothing and equipment, such as safety spectacles and cut-resistant gloves, should be worn. When sheet is coated in oil, suitable protective clothing should be worn to prevent skin contact. When fume or dust is generated, provide adequate ventilation to ensure that the Occupational Exposure Limits listed opposite are not exceeded. If necessary, provide local fume extraction. Alternatively, where necessary, suitable respiratory protective equipment should be provided for use by those at risk from inhalation of fumes. A P2 dust mask may be appropriate (to EN 149, FFP2S).

9. Physical and chemical properties

Coating—Melting point in range 419-450°C.
Steel—Melting point in range 1450-1520°C.
Density around 7.85 kg/dm^3 at 20°C.

Current Occupational Exposure Limits

	Type of Limit	Reference Period	
Iron oxide, fume (as Fe)	Occ. Exposure Standard	5 mg/m³	10 mg/m³
Manganese and inorganic compounds	Max. Exposure Limit	0.5 mg/m³	–
Zinc oxide, fume	Occ. Exposure Standard	5 mg/m³	10 mg/m³
Chromium metal, also chromium (II) and (III) compounds (as Cr)	Occ. Exposure Standard	0.5 mg/m³	–
Chromium (VI) compounds (as Cr)	Max. Exposure Limit	0.05 mg/m³	–
Lead and lead compounds excluding tetraethyl lead (as Pb)	Approved Code of Practice Lead in Air Standard	0.15 mg/m³	
Antimony and its compounds (as Sb)	Max. Exposure Limit	0.5 mg/m³	

*Time Weighted Average

10. Stability and reactivity

The product is stable under normal conditions, but when subjected to elevated temperatures fumes are produced.

11. Toxicological information

Mechanical working, such as dry grinding or machining, will produce dust of the same composition as the coating and base metal. If subjected to elevated temperatures, e.g. during welding or flame cutting, fumes are produced containing oxides of zinc, manganese and iron, and also breakdown products of any protective coating if present.

The potential effects on health include metal fume fever, a short-lasting, self-limiting condition with symptoms similar to influenza.

The principal mode of entry into the body is by inhalation and if airborne concentrations are excessive (see EH40) over long periods of time they may have a long term effect on the health of the worker, primarily affecting the lungs. Repeated exposure to manganese can also affect the nervous system, especially the fine control of intentional movement.

Prolonged contact with sheet protection coatings may lead to skin irritation and rarely, in susceptible cases, may lead to dermatitis.

12. Ecological information

No known harmful effects.

13. Disposal considerations

Recycle, or landfill.

14. Transport information

No special precautions.

15. Regulatory information

Coated steel products are articles not substances and, as such, not subject to the Chemicals (Hazard Information and Packaging) Regulations.

Compliant with the Packaging & Packaging Waste EC Directive 94/62/EEC on heavy metal content.

All steels covered by this data sheet comply with the End of Life Vehicles Directive (2000/53/EC).

16. Other information

(a) Some relevant references:

HSE Guidance Notes

EH2 (Rev.): Chromium and its Inorganic Compounds – Health & Safety Precautions

EH26: Occupational Skin Diseases – Health & Safety Precautions

EH40: Occupational Exposure Limits – Current Edition

EH42: Monitoring Strategies for Toxic Substances

EH54: Assessment of Exposure to Fume from Welding and Allied Processes

EH55: The Control of Exposure to Fume from Welding, Brazing and Similar Processes

(b) Revision:

This data sheet has been revised in line with the CHIP 3 Regulations. Changes are indicated by highlighting.

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Corus has a policy of continuous improvement, and as such the information in this document may be subject to change. The latest information is available from the addresses below.

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