corus

Corus Strip Products UK

Cold-rolled strip steel

The enhanced material for manufacturing

Consistently better from Corus

Enhanced material for manufacturing

Cold-rolled strip steel has refined properties for manufacturing. It offers thin, strong and formable strip with a surface capable of the highest quality paint finish. The continuously annealed product from Corus is highly consistent, with tight tolerances on dimensions and shape.

Making it better

Cold-rolled strip steel from Corus helps manufacturers make better products more easily.

- Light gauges
- Widths up to 1815mm
- Formability
- High-strength formable grades
- Clean, high-quality surface
- Consistency
- Tight tolerances
- Shorter lead times
- Coil weight flexibility

Front cover: Land Rover
Left: Honda

Light gauges

Cold-rolled steel is available in light gauges, creating the opportunity for manufacturers to save money and resources by using less steel where strength is not an issue. Corus also offers high-strength formable steel and structural steel, which have guaranteed minimum strength.

Formability

The formable qualities in the cold-rolled range give designers wide scope for complex shapes, including extra deep drawing. Continuously annealed steels have a tighter distribution of mechanical properties, which makes it easy to predict how they will respond when pressed. This helps designers avoid springback, for example. The consistent and reliable performance of these steels allows manufacturers to set their presses and dies to tighter, more efficient limits, and reduces the need for frequent re-adjustment. This is true for individual coils and from coil to coil.

High-strength formable grades

High-strength formable steel helps manufacturers to increase the strength of a component or to reduce the steel thickness, or both. These characteristics create opportunities to make components stronger, lighter and safer. Automotive manufacturers can use high-strength formable steels to reduce the weight of a vehicle and thereby its fuel consumption and consequent emissions. These steels can be used in lighter gauges than ordinary steels, increasing the output from each tonne of steel. High-strength steel allows products to be made to a higher specification, e.g. stronger, lighter and finished to a higher standard.

Clean, high-quality surface

Cold-rolled steel has a consistent surface texture and a high-quality surface finish, with the optimum balance between texture (for paint keying) and smoothness (for image distinction). Continuously annealed strip goes through fewer processing stages, which enhances its surface quality. It is thoroughly cleaned and inspected to the highest standards. This superior cleanliness produces a surface that is ideal for direct painting and lithographic printing, e.g. for drums. It also ensures effective phosphate deposition, which improves the integrity of the paint finish and its aesthetic characteristics. This steel is capable of the very highest quality paint finish and is suitable for large, visible areas where a ‘showroom’ finish is vital, e.g. automotive body panels and office furniture.

Continuous annealing produces a more homogenous and less chemically active surface. This, together with immediate stretch-film wrapping at the end of the line, extends the safe storage period for un-oiled strip.

Consistency

Continuously annealed strip has highly consistent properties, which affect virtually every aspect of its performance. Its consistent mechanical properties make it easier to fabricate, because it is more predictable, and to handle, because its tolerances are tighter. Its more consistent surface makes a high-quality paint finish easier to achieve.

Tight tolerances

Continuously annealed strip is manufactured to tight tolerances. The thickness and width of the strip are accurate and consistent.

The continuous annealing process imparts consistent mechanical properties to this steel, which allows close control of shape and therefore flatness. This is particularly important for applications where large, flat areas of steel are visible in the finished product, e.g. office furniture.

Today’s high-speed, high-volume production lines demand consistent dimensions and shape both for handling and manufacture.

Shorter lead times

Being an unbroken sequence, the continuous annealing process is faster than batch processing.

Coil weight flexibility

The continuous annealing process allows coils to be cut at precise weights.

Left: Caradon Plumbing Limited, Newcastle-upon-Tyne

Service and support

Service

The heart of service at Corus is close relationships with customers. This includes early involvement right at the start of the design process and help choosing the right product for the customer's application. Service continues throughout the relationship, with Corus looking for ways to make the supply chain work more effectively and efficiently. The business operates a continuous programme to shorten the gap between order and delivery and also offers Speedstock, which is steel supplied in less than normal lead time. The e-SURE on-line order-management system enables customers to manage many aspects of their orders on-screen.

Technical support

Highly trained support engineers from Corus work with customers on concept validation, material selection and vetting of parts. They specialise in specific market areas such as automotive, end-users, drums and radiators, and service centres. The aim is to make optimum use of the material's properties and to help the customer produce the best possible finished product.

Technical support ensures that the material continues to meet the customer's requirements. Corus also operates a rapid problem-solving resource and looks for ways of improving in-service performance.

A technical helpline provides information about specifications, applications, performance, health and safety and much more.

Product and market development programmes at Corus help the company and its customers anticipate and meet future market requirements.

Research and development

Corus focuses on innovation in the development of its processes, products and applications. World-class research and development facilities in the UK and the Netherlands develop new and better products and ways of using them.

Quality

Corus Strip Products UK is third-party approved to ISO/TS 16949 : 2002, the global automotive standard for quality management systems, which is based on BS ISO 9001 : 2000.

Top: Caparo Precision Tubes Limited, Oldbury, West Midlands
Above: Greif UK Ltd, Ellesmere Port, Cheshire
Right: Mini

Product range

Cold-rolled strip steels from Corus are available in a variety of specifications for both simple and demanding applications.

General

Corus offers cold-rolled strip steel in forming qualities, high-strength qualities and structural qualities.

Forming quality steels are available as continuously annealed or batch annealed products. High-strength and structural qualities are available as continuously annealed products.

Grades

The grades available are shown in the individual section for each steel.

Typical applications

- automotive components and body panels
- components for building and construction
- tubes and sections
- drums and containers
- radiators and boilers
- office furniture
- domestic appliances
- electrical goods

Most cold-rolled steel grades are suitable for:

- electrolytic coating
- hot-dip coating
- post-galvanising
- organic coating
- powder coating

Above: TBS (South Wales) Ltd, Merthyr Tydfil, Mid Glamorgan
Right: Jaguar

Overall thickness and width limits

The overall thickness and width limits for cold-rolled products are shown in table 1 on page 10. The limits for specific products are shown under individual product headings.

Coil diameters

The coil diameters that apply to cold-rolled coil are shown in table 2 on page 10.

Coil weight

The maximum weight of cold-rolled coils offered by Corus is determined by three factors:

- Manufacturing limit: 32 tonnes
- Maximum safe outside diameter of coil: 1850mm
- Maximum weight allowed by road/rail transport

Corus will discuss these factors with the customer to ensure compatibility with the quantity ordered.

If a minimum coil weight has not been specified by the customer and agreed with Corus, then it will be 50% of the agreed maximum weight.

Tolerances on dimensions and shape

Thickness

The thickness tolerances shown in table 3 on page 10 are from EN 10131 : 1991.

Coil width

The coil width tolerances in table 4 on page 11 are from EN 10131 : 1991.

Flatness

Flatness complies with EN 10131 : 1991 as shown in table 5 on page 11 for steel grades with R_{eL}<280N/mm² and table 6 on page 11 for steel grades with R_{eL}≥280N/mm² and <360N/mm².

Edge camber

The deviation over a length of 2 metres will not exceed 6mm.

Surface

Surface quality

Cold-rolled steels are available in surface quality A or B to EN 10130 : 1999.

Surface quality A

Defects that do not influence the formability or the application of surface coatings are permitted. They are defects such as pores, minor scratches, slight indentations, small grooves or slight discoloration.

Surface quality B

The better side must be free of defects that can spoil the uniform appearance of a high-quality paint or of an electrolytic coating. The other side must at least conform to surface quality A.

Inspected side

As a rule, the upper side of the strip is inspected; on request, the strip can be turned over so that the underside, as delivered to the customer, is the inspected side.

Surface texture

Cold-rolled steel is available in several surface textures. Unless specified otherwise, Corus will supply normal roughness. Surface texture cannot be guaranteed for steel that has not been skin-passed. Table 7 on page 11 shows the range of surface textures according to EN 10130 : 1999. Other surface textures may be available depending upon your requirement.

Preservative oil

The standard oil applied on the line by Corus acts as a protective coating. Other kinds of oil may be available depending upon your requirement. Corus offers a range of oiling levels from 0.4-1.8g/m² per side. Other levels are available on request. Corus is not responsible for the risk of corrosion if material is ordered in the un-oiled condition.

Table 1: Thickness and width limits

Product form	Thickness		Width	
	Min	Max	Min	Max
Continuously annealed				
Mill edges	0.38	2.00	900	1815
Trimmed edges	0.38	2.00	900	1803
Batch annealed				
Mill edges	0.35	3.00	700	1525

Notes:

1. Corus also offers full hard (unannealed) products on request.
2. Trimmed edges are not available on batch annealed products.
3. Dimensions are in millimetres.

Table 2: Diameter of cold-rolled coil

Inside diameter	610mm
Outside diameter	1850mm

Table 3: Thickness tolerances: EN 10131 : 1991

Nominal thickness		Normal tolerances for a nominal width of			Special tolerances (S) for a nominal width of		
		≤1200	>1200 ≤1500	>1500	≤1200	>1200 ≤1500	>1500
>	≤	±	±	±	±	±	±
0.38	0.40	0.04	0.05	–	0.025	0.035	–
0.40	0.60	0.05	0.06	0.07	0.035	0.045	0.05
0.60	0.80	0.06	0.07	0.08	0.040	0.050	0.05
0.80	1.00	0.07	0.08	0.09	0.045	0.060	0.06
1.00	1.20	0.08	0.09	0.10	0.055	0.070	0.07
1.20	1.60	0.10	0.11	0.11	0.070	0.080	0.08
1.60	2.00	0.12	0.13	0.13	0.080	0.090	0.09

Notes:

1. These tolerances are for material with a minimum yield strength less than 280N/mm². For material with a minimum yield strength greater than or equal to 280N/mm² and less than 360N/mm², tolerances are increased by 20%. For material with a minimum yield strength greater than or equal to 360N/mm², tolerances are increased by 40%.
2. Dimensions are in millimetres.

Right: LDV

Table 4: Tolerances on coil width: EN 10131 : 1991

Nominal width		Normal tolerances		Special tolerances (S)	
		lower –	upper +	lower –	upper +
≥900	≤1200	0	4	0	2
>1200	≤1500	0	5	0	2
>1500	≤1815	0	6	0	3

Note: Dimensions are in millimetres.

Table 6: Flatness tolerances: EN 10131 : 1991

R_{eL}≥280N/mm²<360N/mm²

Tolerance class	Nominal width		Nominal thickness		
			<0.7	≥0.7<1.2	≥1.2
Normal	≥900	<1200	15	13	10
	≥1200	<1500	18	15	13
	≥1500	≤1815	22	20	19
Special (FS)	≥900	<1200	8	6	5
	≥1200	<1500	9	8	6
	≥1500	≤1815	12	10	9

Notes:

1. If sheet is ordered non skin-passed, only the normal tolerances are applicable.
2. The tolerances in this table represent maximum deviation from flatness.
3. For material with a specified minimum yield stength greater than or equal to 360N/mm², tolerances should be agreed upon at the enquiry stage.
4. Consult Corus about the availability of the *Special* flatness tolerance (FS).
5. Dimensions are in millimetres.

Table 5: Flatness tolerances: EN 10131 : 1991

R_{eL}<280N/mm²

Tolerance class	Nominal width		Nominal thickness		
			<0.7	≥0.7<1.2	≥1.2
Normal	≥900	<1200	12	10	8
	≥1200	<1500	15	12	10
	≥1500	≤1815	19	17	15
Special (FS)	≥900	<1200	5	4	3
	≥1200	<1500	6	5	4
	≥1500	≤1815	8	7	6

Notes:

1. If sheet is ordered non skin-passed, only the normal tolerances are applicable.
2. The tolerances in this table represent maximum deviation from flatness.
3. Consult Corus about the availability of the *Special* flatness tolerance (FS).
4. Dimensions are in millimetres.

Table 7: Roughness: EN 10130 : 1999

Grade	Symbol	R_a (µm) cut off 0.8mm
semi-bright	g	≤0.9
normal	m	0.6-1.9


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Steel for forming

Cold-rolled steel for forming and deep drawing is available in a range of qualities, each designed for particular applications.

Typical applications

- automotive components and body panels
- components for building
- domestic appliances
- electrical goods
- office furniture
- radiators
- tubes

Standards

Cold-rolled steel for forming complies with European standard EN 10130 : 1999 shown in table 8 below. Former national standards and nearest related grades are also shown in the table.

Mechanical properties

The values shown for the mechanical properties in table 9 on page 14 are for skin-passed material and are for test pieces taken transverse to the rolling direction.

Chemical composition

Cold-rolled steel for forming meets the requirements of the cast analysis in the standard, as shown in table 10 on page 14.

Annealing

Cold-rolled strip steels for forming are available as continuously annealed products or batch annealed products.

Dimensions

The width and thickness limits are shown in tables 11 and 12 on pages 14 and 15.

Table 8: Standards

European	National			
EN 10130 : 1999	**UK**	**France**	**Germany**	**Italy**
Grade	BS 1449 part 1	NFA 36-401	DIN 1623 part 1	UNI 5866
DC01	CR4	C	St 12	FeP01
DC03	CR2/3	E	St 13	FeP02
DC04	CR1/2	ES	St 14	FeP04
DC05	–	SES	St 15	–
DC06	–	IF	IF 18 (SEW095)	–

Left: Bisley Office Furniture, Woking, Surrey

Table 9: Mechanical properties: EN 10130 : 1999

Grade	R_{eL} (N/mm²)	R_m (N/mm²)	A_{80} (%)	r_{90}	$\bar{r}$	n_{90}	$\bar{n}$
	Max	Min-max	Min	Min	Min	Min	Min
DC01	280	270-410	28	–	–	–	–
DC03	240	270-370	34	1.3	–	–	–
DC04	210	270-350	38	1.6	–	0.180	–
DC05	180	270-330	40	1.9	–	0.210	–
DC06	180	270-350	38	–	1.8	–	0.220

Notes:

1. For thicknesses greater than 0.5mm and less than or equal to 0.7mm, maximum yield strength is increased by 20N/mm² and minimum elongation after fracture is decreased by 2 units.
2. For thicknesses less than or equal to 0.5mm, maximum yield strength is increased by 40N/mm² and minimum elongation after fracture is decreased by 4 units.
3. The values shown for r and n are for thicknesses greater than or equal to 0.5mm.
4. For thicknesses greater than 2mm, r_{90} and $\bar{r}$ are decreased by 0.2 units.
5. For design purposes, the minimum yield strength for DC01, DC03, DC04 and DC05 is 140N/mm².
6. For design purposes, the minimum yield strength for DC06 is 120N/mm².

Table 10: Chemical composition: EN 10130 : 1999

Grade	C	Mn	P	S	Ti
	Max	Max	Max	Max	Max
DC01	0.12	0.60	0.045	0.045	–
DC03	0.10	0.45	0.035	0.035	–
DC04	0.08	0.40	0.030	0.030	–
DC05	0.06	0.35	0.025	0.025	–
DC06	0.02	0.25	0.020	0.020	0.30

Note: Values are in weight percentages.

Table 11: Dimensions: EN 10130 : 1999: Continuously annealed

Thickness		Width			
		DC01	DC03 DC04	DC05	DC06
>	≤	Max	Max	Max	Max
0.380	0.400	1260	–	–	–
0.400	0.430	1330	–	–	–
0.430	0.500	1390	–	–	–
0.500	0.575	1532	–	–	–
0.575	0.600	1532	1385	–	–
0.600	0.650	1532	1532	1580	1580
0.650	0.700	1632	1632	1650	1650
0.700	0.750	1672	1672	1680	1680
0.750	0.850	1815	1815	1680	1680
0.850	0.950	1815	1815	1680	1680
0.950	1.200	1815	1815	1650	1650
1.200	1.600	1815	1815	1525	–
1.600	2.000	1532	–	–	–

Notes:

1. The minimum width is 900mm.
2. Dimensions are in millimetres.

Table 12: Dimensions: EN 10130 : 1999: Batch annealed

Thickness		Width			
		DC01	DC03 DC04	DC05	DC06
>	≤	Max	Max	Max	Max
0.350	0.380	1250	1250	1250	–
0.380	0.400	1260	1250	1250	–
0.400	0.430	1345	1275	1275	–
0.430	0.450	1390	1275	1275	–
0.450	0.500	1390	1300	1300	–
0.500	0.525	1525	1350	1350	–
0.525	0.550	1525	1400	1400	–
0.550	0.575	1525	1475	1475	–
0.575	0.580	1525	1525	1525	–
0.580	0.600	1525	1525	1525	1425
0.600	2.000	1525	1525	1525	1525
2.000	2.500	1350	1350	1350	–
2.500	2.900	1300	1300	1300	–
2.900	3.000	1295	1295	1250	–

Notes:

1. The minimum width is 710mm.
2. Dimensions are in millimetres.

High-strength steel

High-strength steel allows the user to increase the strength of the finished component or reduce the steel thickness, or both.

Cold-rolled high-strength steel is available in Corus' own Tenform grades and to EN 10268 : 1999.

Tenform CXK is cold-rolled high-strength low-alloy steel which combines high strength with improved formability for less difficult cold-formed applications that require steels with good surface finish and impact resistance.

Tenform CMN combines high strength with improved formability for difficult cold-forming applications.

Typical applications

- automotive components
- precision welded tube

Standards

Tenform CXK, Tenform CMN and steels from EN 10268 : 1999 are available in the grades shown in table 13 below.

Other high-strength steels

Consult Corus about the availability of other high-strength steels.

Mechanical properties

The values shown for the mechanical properties in tables 14 (below) and 15 (opposite) are for skin-passed material and are for test pieces taken in the rolling direction.

Chemical composition

Tenform CXK and Tenform CMN meet the cast analyses shown in table 16 (opposite). Steels from EN 10268 : 1999 meet the cast analyses shown in table 17 (opposite).

Dimensions

The width and thickness limits are shown in table 18 (opposite). The minimum width of all grades is 900mm.

Table 13: Standards

Tenform CXK	Tenform CMN	EN 10268 : 1999
Grade		
–	–	H240LA
–	–	H280LA
CXK300	CMN300	H320LA
CXK350	–	H360LA

Table 14: Mechanical properties: Tenform CXK and CMN

Grade	R_p (N/mm²)	R_m (N/mm²)	A_{80} (%)
	Min-max	Min-max	Min
CXK300	300-450	400-550	22
CXK350	350-500	430-580	20
CMN300	280-360	440-500	26

Table 15: Mechanical properties: EN 10268 : 1999

Grade	R_p (N/mm²)	R_m (N/mm²)	A_{80} (%)
	Min-max	Min	Min
H240LA	240-310	340	27
H280LA	280-360	370	24
H320LA	320-410	400	22
H360LA	360-460	430	20

Table 16: Chemical composition: Tenform CXK and CMN

Grade	C	Mn	Si	P	S	Nb+V+Ti
	Max	Max	Max	Max	Max	Max
CXK300	0.10	1.20	0.50	0.025	0.020	0.30
CXK350	0.10	1.20	0.50	0.025	0.020	0.30
CMN300	0.18	1.00	0.03	0.025	0.020	–

Note: Values are in weight percentages.

Table 17: Chemical composition: EN 10268 : 1999

Grade	C	Mn	Si	P	S	Nb	Ti
	Max	Max	Max	Max	Max	Max	Max
H240LA	0.10	0.60	0.50	0.025	0.025	0.090	0.15
H280LA	0.10	0.80	0.50	0.025	0.025	0.090	0.15
H320LA	0.10	1.00	0.50	0.025	0.025	0.090	0.15
H360LA	0.10	1.40	0.50	0.025	0.025	0.090	0.15

Note: Values are in weight percentages.

Table 18: Dimensions : Tenform CXK, Tenform CMN and EN 10268 : 1999

Thickness		Width			
		CXK300 CXK350	CMN300	H240LA	H280LA, H320LA H360LA
>	≤	Max	Max	Max	Max
0.60	0.70	1300	–	–	1300
0.70	0.75	1300	1370	1360	1300
0.75	0.90	1300	1370	1360	1300
0.90	1.00	1300	1370	1360	1300
1.00	1.10	1300	1400	1500	1300
1.10	1.25	1300	1400	1500	1300
1.25	1.40	1300	1400	1500	1300
1.40	1.50	1300	1400	–	1300
1.50	1.60	1300	1400	–	1300

Notes:

1. The minimum width is 900mm.
2. Dimensions are in millimetres.

Structural steel

Cold-rolled structural steel has guaranteed minimum strength and good welding properties, making it suitable for a broad range of applications.

Typical applications

- tubing
- domestic appliances
- office furniture
- warehouse shelving

Standards

Cold-rolled structural steel complies with the standards shown in table 19 below. Other national standards and nearest related grades are also shown in the table.

Mechanical properties

The values shown for the mechanical properties in table 20 below are for skin-passed material and are for test pieces taken transverse to the rolling direction.

Chemical composition

Cold-rolled structural steel meets the requirements of the cast analysis as shown below in table 21.

Dimensions

The width and thickness limits are shown in table 22 below. The minimum width is 900mm.

Table 19: Standards

Corus	National	
	UK	Germany
Grade	BS 1449 : 1991	DIN 1623-2 : 1986
CA200	CR34/20	–
CA240	CR37/23	St37-2G
–	–	RRSt37-3G
CA260	–	–

Table 20: Mechanical properties

Grade	R_p (N/mm²)	R_m (N/mm²)	A_{80} (%)
	Min-max	Min-max	Min
CA200	200-260	320-380	30
CA240	240-300	340-400	28
CA260	260-340	350-450	24

Table 21: Chemical composition

Grade	C	Mn	P	S
	Max	Max	Max	Max
CA200	0.120	0.60	0.045	0.045
CA240	0.120	0.60	0.045	0.045
CA260	0.120	0.60	0.045	0.045

Note: Values are in weight percentages.

Table 22: Dimensions

Thickness		Width		
		CA200	CA240	CA260
>	≤	Max	Max	Max
0.38	0.40	1260	1260	–
0.40	0.43	1330	1330	–
0.43	0.50	1390	1390	–
0.50	0.60	1532	1532	–
0.60	0.65	1532	1532	–
0.65	0.70	1632	1632	–
0.70	0.75	1672	1672	1360
0.75	1.00	1815	1815	1360
1.00	1.40	1815	1815	1500
1.40	1.60	1815	1815	–
1.60	2.00	1550	–	–

Note: Dimensions are in millimetres.

Right: Link 51 (Storage Products), Telford, Shropshire


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Inspection, packing and transport

Corus provides inspection documents, packing and transport to meet the needs of its customers.

Inspection documents

Corus can provide inspection documents to EN 10204, including those below.

2.1 Certificate of compliance with order

2.2 Test report with cast analysis only or with mechanical properties and cast analysis

3.1B Inspection certificate (Corus representative)

3.1C Inspection (purchaser's representative)

Packing

Packing can be adapted to the customer's requirements, method of transport and destination. Standard packing is shown below.

Plain banded
One circumferential band and a minimum of two radial bands. This pack can be supplied with edge protection.

Paper wrapped
One circumferential band and four radial bands, plus bore protection and crane protection.

Film wrapped
Machine-wrapped with one circumferential band, plus bore protection and crane protection.

Unit load
One circumferential band and four radial bands. The coil is paper or film wrapped with full edge and bore protection and a scuff pad on the bottom of the coil.

Fully protected
The coil is secured with one circumferential band and paper or film wrapped. It is then fully metal-wrapped and secured with three circumferential bands and six radial bands.

Products bear an ODETTE transport label for scanning (EDI).

Transport

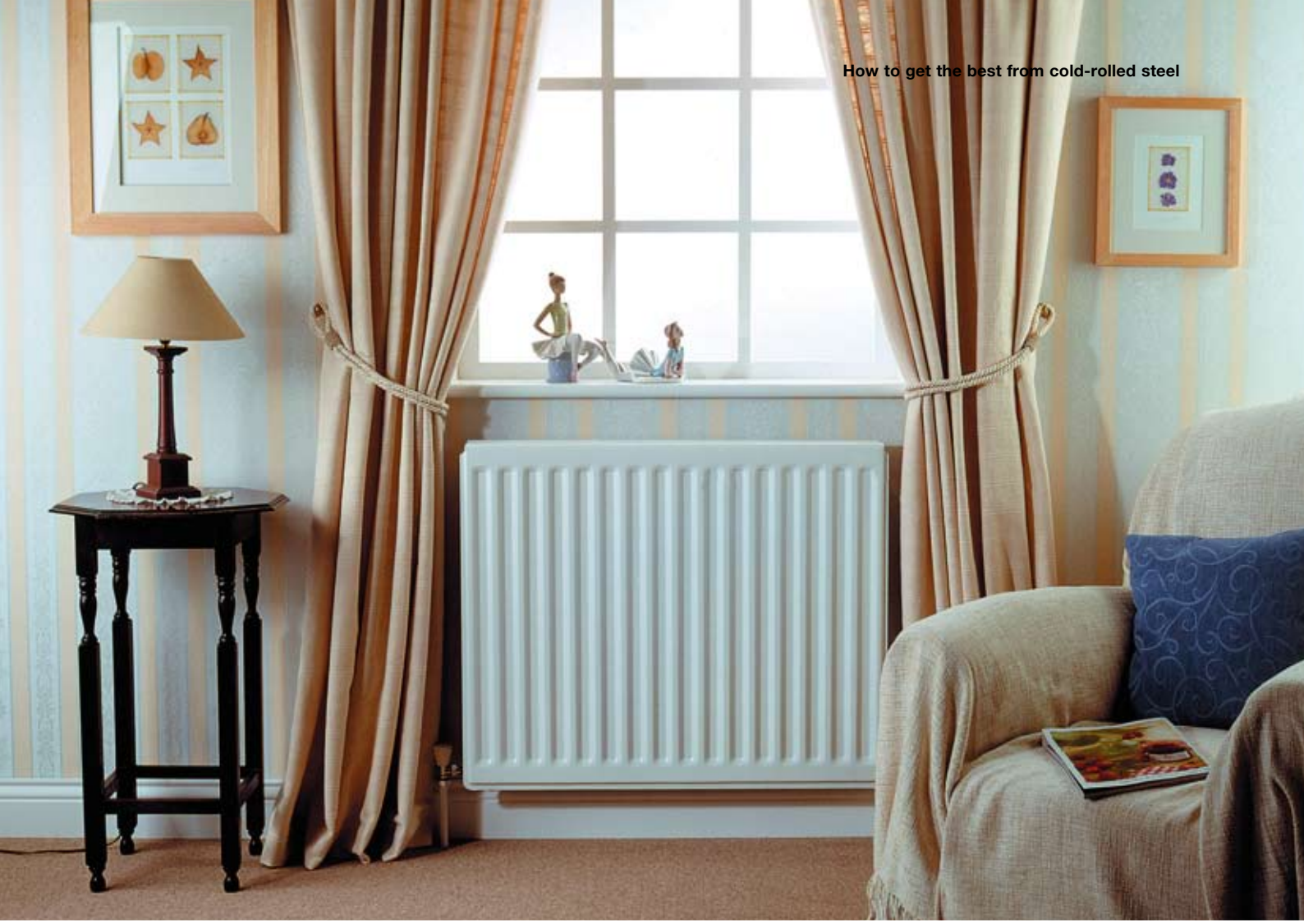
Corus is highly experienced in arranging appropriate transport of its products, including the necessary documentation.

If an order weighs less than 100 tonnes, the total weight for that order must be a multiple of the feasible coil weight. The weight tolerances for any item on an order are shown below.

50 tonnes and over: ±10%
20 tonnes to under 50 tonnes: ±15%
Under 20 tonnes: ±20%

Above right: Quinn Radiators, Leigh, Lancashire
Left: Indesit Company UK Ltd

How to get the best from cold-rolled steel



The best products will perform even better if the methods used to fabricate them account for their special properties. The guidelines shown on the following pages contain some important information about using cold-rolled steels. Corus has the experience and knowledge to help customers achieve the best possible results. Enquiries about using these steels should be directed to the Customer Technical Services department, whose details are on page 30.

Left: Blagden Packaging UK, Manchester
Above: Myson Radiators, Gateshead, Tyne & Wear

Forming and fabricating

Common processes such as cutting, blanking, brake forming, roll forming, spinning, crimping and lock forming are easy with cold-rolled steels, provided the proper grade of steel is chosen.

Press forming

Formability

The performance of cold-rolled steel is determined by its thickness and its metallurgical properties.

DC03, DC04, DC05 and DC06, in ascending order of forming capability, meet the requirements of the more demanding forming methods such as stretching or deep drawing (see 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.

The most formable cold-rolled steel grades, DC05 and DC06, combine the greatest ductility with the highest resistance to thinning. Difficult pressing operations involving combined stretch-forming and deep drawing are achievable with the special deep drawing quality, DC05, and particularly with the extra deep drawing quality, DC06.

Corus has also developed a new generation of high-strength formable cold-rolled steels that allow complex structural members to be produced.

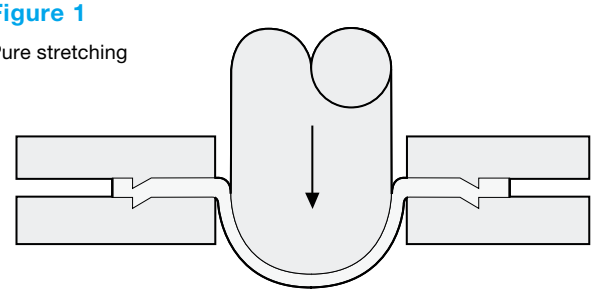
The selection of the correct grade of steel for a particular forming operation is normally based on the judgment and wide experience of the supplier, in consultation with the end user. Corus has the expertise to give such advice for any type of pressing.

Springback

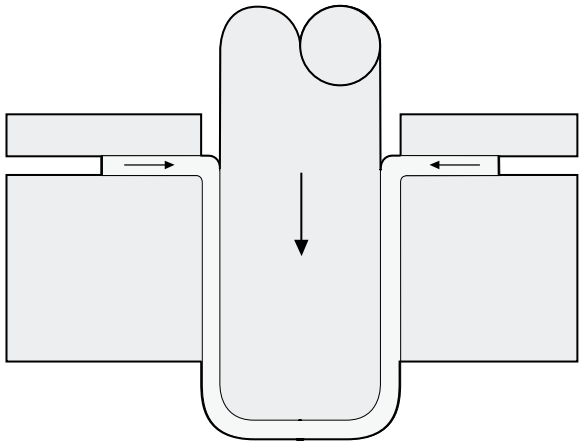
The degree of springback is largely a function of material thickness and its yield stress. The increasing use of high-strength steels and ultra-high-strength steels in fabrication leads to an increase in the levels of springback, owing to the increase in material yield stress and decrease in thickness. This must be taken into account when designing press tools for high-strength components.

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.

Hydroforming

Hydroforming is a forming technology that uses fluid pressure to deform the sheet steel into the desired shape 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 greater 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 continuously 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.

Tailor welded blanks

Using cold-rolled steel in the automotive industry to construct lightweight vehicles can save material and energy, which reduces emissions and the call upon resources, whilst maintaining vehicle safety and rigidity.

One way of reducing weight 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 can be combined in a single component to focus strength and formability where they are needed most.

Cutting

Rake angle

It is important that cutting blades on guillotines are set at the correct 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 cold-rolled steel. Corus can help customers choose a lubricant that meets their particular forming and fabricating requirements.

Mechanical fixing

There are many varieties of commercially available fasteners and fastening methods for joining cold-rolled steels. They include innovative assembly techniques that use the sheet itself as the joining medium.

Welding and adhesive bonding

Cold-rolled steels can be readily welded using resistance, laser and conventional fusion welding techniques. Satisfactory weld quality can be obtained at high-volume production rates.

Resistance spot welding

Guidelines for resistance spot welding of uncoated and coated sheet steel are defined in ISO 14373.

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 and t is the thickness of the sheet in contact with the electrode, both measured in millimetres.

The use of a weld size smaller than that given by the equation above will result in lower weld strength. This must be taken into account in any design calculations. 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 diameter.

For 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 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 distance between their centres, should be at least 3d (preferably greater) when welding together single sheets whose thicknesses are each 3mm or less.

Cold-rolled strip steels are also suitable for resistance seam and projection welding.

Left: Silverline Office Equipment Ltd, Mildenhall, Suffolk

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 TWBs. However, Nd:YAG laser light can be transmitted through fibre optics, making it more attractive for three-dimensional construction.

Brazing

Brazed joints can be produced using a number of heat sources including torch 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.

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.

Adhesive bonding

Cold-rolled steel can be bonded using a wide range of adhesive types. The choice of adhesive depends on the end application.

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.

Good durability depends on the type of adhesive and the surface condition of the steel. To promote long-term bond strength, the morphology of surfaces should allow a keying action. Surfaces should also be degreased before they are bonded.

Painting

The main requirements for painting are shown below.

1. The surface must be clean and free of oil, grease and other contaminants.

2. The surface must be pre-treated or suitably primed, or both, to maintain paint adhesion in service.

3. Undercoats and topcoats must be chosen to withstand the environment in which the material will be exposed and also to meet the life requirement.

4. 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).

Health and safety

The products in this brochure are covered by *Product health and safety data sheet no. 2* and *no. 16a.*

Above Left: Toyota
Above: Quinn Radiators, Leigh, Lancashire

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