TATA STEEL

TATA

Health and safety

Code of practice

Coil banding

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1 Scope and application

This code of practice sets out the Tata Steel Europe requirements to ensure steel (and aluminium) coils are banded / packaged sufficiently in order to minimise the risk of harm during handling, storage and transportation of the coils. It does not cover packaging requirements for ensuring product quality / environmental protection.

This document applies to Tata Steel Europe hubs / units / sites, joint ventures and all 3rd party contractors that undertake processing of coils on behalf of Tata Steel Europe.

This document covers all production coil sizes (wide, narrow, slit); all surface coatings; all steel grades ***with the exception of product development coils and ultra-high yield stress coils above 800 MPa*** (specific risk assessments must be conducted for these coils). This document applies to bore horizontal and bore vertical coils; and to hot wound coils (wound above 575°C) and cold wound coils (wound below 575°C).

This document specifies:

- the minimum banding requirements that are deemed necessary to ensure coils remain safe / stable during handling, storage and transportation and to ensure any stored energy in the coils is safely contained;
- the need for correct selection of banding materials and jointing methods;
- the requirement for adequate maintenance of banding equipment;
- the requirement for checking (and where necessary testing) of banding joints.

This document also provides information on stored energy in coils, known as 'spring back', and provides instruction on how spring back coils must be labelled and how they should be handled to minimise the risk of harm.

Tata Steel Europe health and safety standards and codes of practice are mandatory on all sites, including joint ventures where the business is operated by Tata Steel Europe.

If this Code of Practice creates a higher obligation than that required by local law or regulation, it should be followed as long as full compliance with the law or regulation is also achieved. In the unlikely scenario that a local relevant law or regulation requires a higher standard to be followed, that law or regulation should be followed and this should also be communicated to Group Health, Safety and Environment.

Codes of practice are part of the health and safety management system. Requirements and responsibilities for deployment as described in 'Governance and Accountabilities' and/or the Health and Safety Management System Framework equally apply.

Special note*: This code of practice will be formally reviewed 6 months after its first issue to assess the impact of implementation and to incorporate any new learnings.*

2 Roles, responsibilities and competence

2.1 Roles and responsibilities

Tata Steel Europe hubs / units / sites must identify and allocate roles and responsibilities and define competence requirements to ensure the effective implementation of this code of practice.

Note that certain competencies may lie within Tata Steel Europe Group technical functions, therefore hubs, units / sites should clearly define where such competencies are deferred to central functions.

Roles, responsibilities and competencies should be defined for all persons required to:

- conduct risk assessments for Tata Steel Europe steel coil types produced / processed by the hub / unit / site;
- set coil banding / packaging standards;
- specify, select and procure banding / packaging materials and equipment;
- undertake banding / packaging operations;
- determine inspection and testing processes to ensure banding / packaging integrity;
- determine and undertake maintenance activities on banding / packaging equipment to ensure on-going effectiveness of tooling (including band tension and joint integrity);
- communicate coil banding and packaging requirements and risks through the supply chain and to the customer.

Key groups of people who may be involved in this include:

- Tata Steel Europe site operations managers – responsible for banding / packaging operations;
- Tata Steel Europe technical / engineering managers / research and development personnel who are deemed competent to set coil banding / packaging standards;
- Tata Steel Europe and contractor personnel who operate banding / packaging equipment and tooling;
- Tata Steel Europe managers responsible for third party processors, and managers of those contracted facilities;
- Tata Steel Europe logistics contract owners responsible for off-site warehousing;
- maintenance engineers responsible for equipment integrity;
- commercial managers responsible for end customers' requirements and communication;
- procurement managers responsible for banding / packaging materials / equipment.

2.2 Competence

Persons involved in banding / packaging operations and equipment maintenance, and others handling coils, shall be provided with relevant training in:

- the risks associated with different coil product types;
- the risks associated with the removal of banding;
- what a ***spring back**** coil is and how these coils release their energy;
- coil banding / packaging standards;
- quality requirements for banding / packaging materials;
- quality requirements for banding joints and testing of joints;
- operational procedures / parameters to ensure correct fitting and jointing of bands;
- safe working procedures for banding / packaging operations including the need for any specific personal protective equipment to prevent injuries to eyes, face, hands and arms where a risk has been identified in the risk assessment;
- the requirements of this code of practice.

3 Risk assessment and forces acting on coil banding

3.1 Risk assessment

Each Tata Steel Europe hub / unit / site will establish and implement a process to assess the risks associated with the stability** of all coil types that are produced / processed either at, or sub-contracted by, that business location. Reference should be made to TSE group technical experts as necessary and the risk assessments should follow the format laid out in Appendix 1, covering the following:

- stored energy in the coil due to steel grade, gauge, dimensions, surface coating, coiling temperature and cold rewinding (see Section 3.2);
- induced forces in banding / packaging from handling by crane, forklift truck etc.;
- induced forces in banding / packaging from storage / stacking of coils;
- induced forces on bore bands during transportation of coils:
  - consideration should be given to the modality of transport (road, rail, inland waterways, sea, air);
  - consideration should be given to forces from vehicle braking or cornering that may initiate telescoping of a coil;
- potential damage to banding / packaging during handling and storage of the coils;
- risk associated with removal / renewal of packaging / banding.

* *A spring back coil is defined as having enough energy to cause the tail end to spring with significant force when containment of the energy is removed. The tail-end can spring completely over the coil, or when the coil is free to move (e.g. hanging in a crane), the energy might cause the coil to unwind violently. 2 kJoules of stored energy has been taken as the meaningful definition of a spring back coil. See also Appendix 4.*

*** The word 'stability' in this context means in relation to the banding applied to make the coil safe.*

3.2 Forces acting on circumferential coil banding – spring back energy

Stored energy / spring back forces may be present in coils due to a combination of the following factors:

- steel grade / yield stress / hardness code (spring back energy increases with increases in yield stress of the steel);
- coiling temperature (coils that are wound below 575°C will exhibit much higher spring back forces than coils that are wound above this temperature due a process known as *creep,* allowing hot wound coils to form a permanent set to their shape);
- batch annealing will similarly reduce / eliminate spring back energy in a coil;
- gauge / steel thickness (thicker gauges have greater spring back energy);
- coil width (wider coils have greater spring back energy than narrow coils);
- coil diameter (smaller outer diameters generate higher spring back forces);
- surface coating on the coil (e.g. oiled coils will generate higher spring back forces than dry coils due to lower internal friction coefficients);
- poor winding tensions;
- pre-set or residual curvature applied to, or remaining in, the coil tail.

The latter point will be specific to a particular process route or coiling machine and reference should be made to Group technical experts if more information is required.

4 Banding / packaging materials

Tata Steel Europe hubs / units / sites must establish processes to ensure banding / packaging materials are suitable for the coil types in question and meet the specification required for the intended applications.

4.1 Steel strapping

Steel strapping comes in a variety of widths, thicknesses and steel grades and with different surface finishes for corrosion protection. The choice of strapping size and grade will depend on the application. There must be a sufficient number of bands of the chosen size, grade and jointing method to ensure the aggregate strapping force is sufficient to maintain the coil in a stable and safe condition.

Typical strap widths used on coils range from 16 mm to 31.8 mm, with thicknesses from 0.5 mm to 1.27 mm. Different manufacturers offer different options and care must be taken to ensure the correct combination of width, thickness and grade is used.

Most strapping manufacturers offer several grades of steel strapping and reference should be made to the European Standard EN 13246 – *Packaging – Specification for tensional steel strapping.* Note that some manufacturers will meet the minimum requirements of the European Standard, whilst others will produce banding that exceeds the minimum requirements. Table 1 overleaf identifies the types of tensional steel strapping that should be used for coil banding.

Table 1 – Types of tensional steel strapping (ref. EN 13246)

Type ref EN 13246	Description	Comments
1	Cold rolled bright steel Low tensile stress 600 – 650 MPa	**NOT to be used on steel coils.**
2.1	Cold rolled and tempered Medium tensile stress 700 – 750 MPa	**NOT to be used on spring back coils.** Standard packaging quality – may be used to secure packaging material only.
2.2	Cold rolled and tempered High tensile stress 900 MPa Low elongation 0.5%	**NOT to be used on steel coils.** Elongation is too low leading to strap failure during coil handling.
3.1	Cold rolled heat treated steel Medium tensile stress 750 MPa Very **H**igh **E**longation 12% Often referred to as **HE** strapping.	**Recommended for low / medium risk coils** (see Appendices 3 and 4). High elongation makes the strap more resistant to failure during coil handling.
3.2	Cold rolled heat treated steel **H**igh **T**ensile stress 925 MPa High elongation 6% Often referred to as **HT** strapping.	**Recommended for high risk coils** (see Appendix 4). High tensile strength required for coils with high spring back energy. Note: some manufacturers supply HT strapping with improved elongation i.e. 8 – 12%. This is considered to be best practice.
3.3	Cold rolled heat treated steel Very high tensile stress 1250 MPa Medium elongation 3%	Should be considered for coils with yield stresses above 800 MPa. The lower elongation makes the strap more prone to failure during handling operations.

Appendix 2 summarises the typical tensile strengths (breaking forces) for different grades and sizes of strapping.

4.2 Steel banding joints

Steel banding joints are the weakest part of the strapping system. Due consideration should be given to the jointing method and type used when determining the number of bands required to ensure coil stability and safety.

Steel strapping can be joined in a number of ways:

- using seals fitted over the strap overlap that are then either notched or crimped;
- creating a sealless joint by punching a number of ‘keys’ through the strap overlap;
- spot welding the two ends of the strap together.

4.2.1 Basic seal joints

(i) Down notch joint

(ii) Reverse notch joint

Notch joints create a mechanical lock by splitting the steel seal and splitting the edges of each of the strap ends and bending the tabs down (or up).

(iii) Crimp joint

The strength of a crimp joint comes from the deformation of the seal creating frictional forces in the joint as opposed to forming a mechanical lock as in the notch type joint. **Crimp joints must NOT be used on spring back coils**. Note: crimp joints should not be used on strapping that has a corrosion protection coating because the frictional forces in the joint will be too low (unless special grit-impregnated seals are used).

Seal joints can have either single or double notches / crimps:

Single notch joint – Do NOT use on spring back coils

Double notch joint

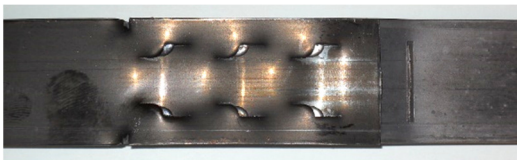
Single notch joints must NOT be used on spring back coils. Single notch joints have a typical minimum breaking strength of 45% of the strap breaking strength, whereas double notch joints will typically be between 65% and 75% of the strap breaking strength. Single notch joints should therefore only by used for securing packaging materials to coils, or on very low risk coils.

Seals vary in size and quality and care must be taken to ensure that seals are compatible with:

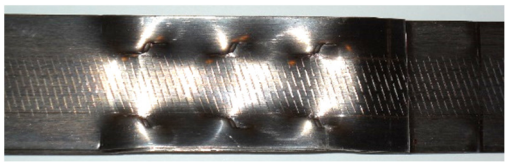
- the steel strapping size and quality;
- the tooling used to form the joint.

4.2.2 Sealless joints

Sealless joints are formed by punching though the overlapping ends of the strap and forming a mechanical joint. Sealless joints are typically formed with 2, 3 or 4 pairs of punches forming 'clinches', and when properly formed they should lock in both directions.



3 punch sealless joint
(Signode system front side)



3 punch sealless joint
(Titan system front side)

Typical strength of sealless joints vary from 60% of the strap breaking strength for 2 pairs of punches to 85% for 4 pairs of punches.

A minimum of 3 pairs of clinches per joint is required for spring back coils.

4.2.3 Spot welded joints

Steel strapping can also be joined by spot welding with either 1, 2 or 3 welds per joint.

Spot welded joint with 2 welds

Spot welded joint with 3 welds

Spot welded joints are required to have a minimum breaking strength of 75% of the strap breaking strength (ref ASTM D3953-15). The number of welds to achieve this should be determined by the equipment manufacturer.

Note: Bands used to secure Spring back coils must never be joined with a single spot weld.

4.2.4 Joint strength - general

In general, according to the European Standard for the selection and use of tensional strapping (EN 13891:2003) all joints formed in steel strapping should have a minimum breaking strength of 65% of the strap breaking strength. Therefore, single notch joints, or 2 clinch sealless joints should not be used on spring back coils (unless it is just for holding packaging material on the coil).

Suitable reference should be made to the supplier / manufacturer of the strapping and jointing equipment to establish the design strengths of the materials and tools used.

4.2.5 Position of the joint

Position of the joint needs to be identified at a place where the risk of damage or deformation is minimised. Consideration should be given to contact points when the coils are stored, stacked and transported. See Section 7.3.

4.3 Plastic strapping

Extruded and oriented polyester (Polyethylene-terephthalate - PET) strapping offers an alternative to steel strapping for some applications. It may be used to hold packaging material to coils and may be used as circumferential banding on **very low risk** coils (see Appendix 4). PET strapping has a typical yield stress of 430 N/mm^2 and a typical joint strength to 80% of the strap breaking force.

Plastic strapping must NOT be used to secure spring back coils.

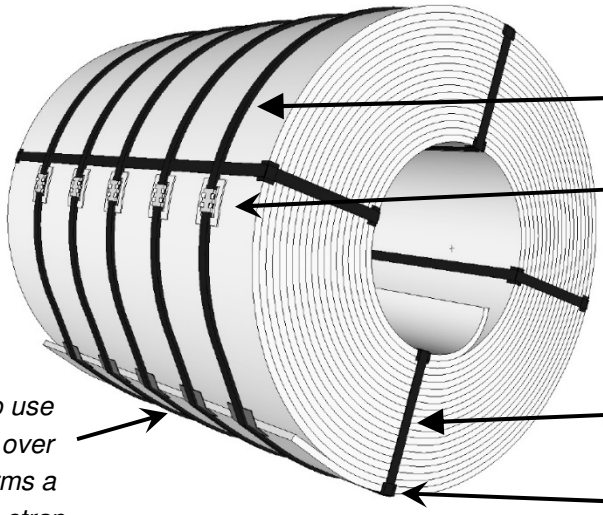
4.4 Film wrapping

Film wrapping may be used for environmental protection but is not considered to be part of the coil securing system.

5 Minimum banding / packaging requirements

Tata Steel Europe hubs / units / sites must establish procedures to ensure the necessary quantity and correct specification of banding / packaging materials are applied to coils at all stages of the manufacturing, processing and distribution routes to ensure the coils remain in a stable condition at all times. Bands may be required around the circumference of the coil to prevent the coil from unwinding, and bands may be required through the bore of the coil to prevent telescoping. Banding procedures should cover any risk of spring back coils becoming unstable during the banding process itself - see Section 7.3.

Appendices 3 and 4 provide matrices detailing the minimum circumferential banding requirements for coils with different steel grades, gauges and dimensions that are hot and cold wound respectively. Appendix 5 details the minimum number of bore bands to be fitted depending on transport modality and coil surface treatment.



Wide coil with circumferential bands and bore bands showing best practice additions

6 Banding equipment

6.1 Specification and selection

Banding equipment and joint tooling comes in a variety of forms:

- purely manual hand tool (not powered)
  NOT to be used on spring back coils;

Not for spring back coils

- hand tooling - pneumatically powered;
- hand tooling - electrically powered (mains or battery);
- fully automated systems.

The equipment and tooling must be compatible with the banding (and if applicable seal) specifications.

Changing suppliers of banding consumables may compromise the integrity of banding joints and formal management of change processes must be adopted (see Section 7.4) if consumables are not sourced from the original equipment manufacturer.

6.2 Maintenance and operational control

The nature of the banding process (application of the band, tensioning the band and joining the band) results in wear to the equipment and tooling. For example, the jaws used to form notches or crimps, and the punches used to form sealless clinches, will become blunt with use; and the teeth used to grip the bands during the tensioning operation will also become blunt and ineffective.

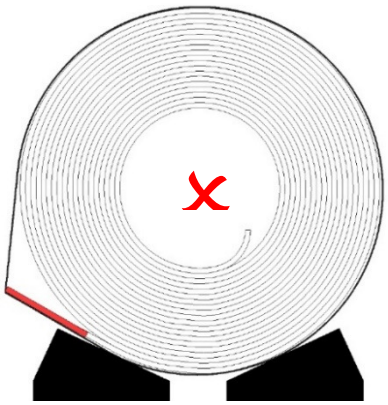
6.2.1 Tata Steel hubs / units / sites must ensure appropriate maintenance checks are carried out on all jointing equipment and tooling based on usage. Records should be kept to confirm that checks are undertaken at the prescribed frequency. Maintenance should only be carried out by competent personnel and with reference to the manufacturers' recommendations.

6.2.2 Systems shall be established to ensure operational parameters (such as air pressure / flow, battery charge, and tool settings) are maintained to guarantee the necessary banding tension and joint strength according to manufacturers' specifications.

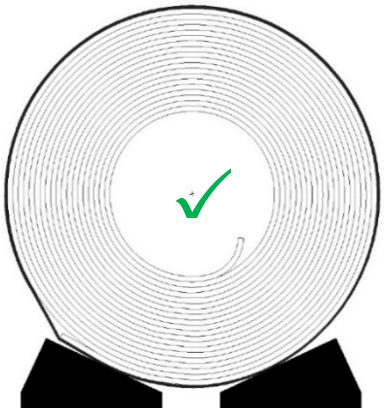
7 Ensuring banding / packaging integrity

7.1 Initial application

7.1.1 In spring back coils, the length / geometry of the tail of the coil can significantly weaken the banding. Therefore, care must be taken to ensure the tail follows the radius of the coil as far as is reasonably practical. For example, this can be achieved by rotating the coil to ensure its weight compresses the tail to the coil:



Coil tail too long, overstressing bands



Coil rotated to compress the tail around the coil before banding

7.1.2 Banding tension: for guidance the ideal tension in a steel band when the joint is made is between 30% and 50% of the breaking strength of the strap. Over-tensioning can weaken the band and under-tensioning can result in loose bands after the coil has been handled. Reference should be made to manufacturers' specifications and procedures should be in place to ensure jointing equipment and tooling is operated to achieve the correct level of tension.

7.1.3 Operators of banding and jointing tools must be trained and competent to do so.

7.1.4 Visual standards should be provided at all banding and packing stations to enable operators to visually check the integrity of bands and joints including:

- the correct number and orientation of the bands for differing coil sizes;
- the condition and quality of the strapping materials;
- the condition and quality of the joints.

7.1.5 Circumferential bands should be fitted before bore bands.

7.1.6 A final check should be performed before packaging is applied to the coil to ensure the correct number of bands have been applied to a coil.

7.1.7 Procedures shall be established for defect reporting and tool quarantine / repair to ensure coils are not despatched with sub-standard banding / joints.

Note: any defective bands must be replaced and **the defective bands must be removed** before despatch.

7.2 Periodic testing of banding joints

As well as visual checks under 7.1.4, procedures must be established to physically test and record banding joint strength and integrity. The frequency of these tests shall be appropriate to usage and the consequences of failure of joints. For example, high usage, safety critical banding joints (e.g. on spring back coils) may require sampling and testing initially once per shift as a minimum.

If the tests show sub-standard joints have been formed then procedures should be in place to check the joints on coils that may have been affected and to rectify any joints that are found to be suspect. This may require coils to be tracked through the supply chain, including through to the end customer.

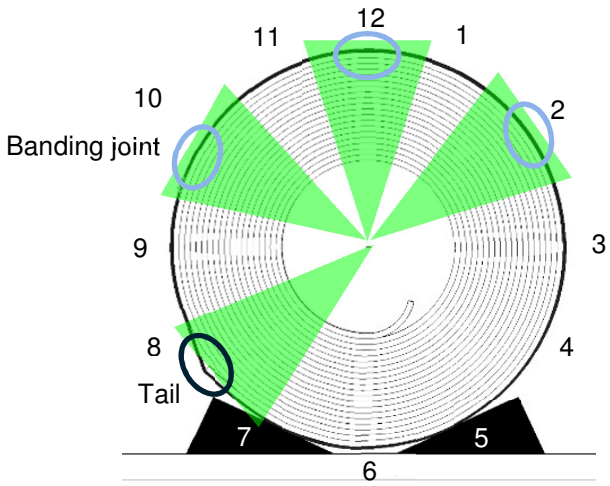
7.3 Throughout the manufacturing process and supply chain

7.3.1 All of the above processes / procedures shall be applied to coils at each stage of their life-cycle from initial hot rolling, through re-rolling and processing. This includes locations on Tata Steel sites and at external processors / warehouses.

7.3.2 Banding requirements may change through the life-cycle of a coil. For example a coil that is initially wound hot may need more circumferential bands after it has been re-rolled cold due to increases in the spring back forces. Tata Steel hubs / units / sites must establish procedures to ensure banding requirements are established, communicated and adhered to at every stage.

7.3.3 Banding, especially the joints, can be damaged during handling and storage. Consideration should be given to the positioning of the banding joints to avoid contact with the ground, chocks / cradles and adjacent coils.

7.3.4 The ideal position of the joint in a circumferential band is at either 10 o'clock, 12 o'clock or 2 o'clock to avoid contact when stacking (see below):



7.3.5 When storing coils, the safest position for the tail of the coil is between 7 and 8 o'clock (or 4 and 5 if viewed from the other side). In this position, the tail cannot spring outwards if bands are cut.

7.4 Management of change

Tata Steel hubs / units / sites must ensure formal management of change processes are used if changes are made to:

- coil banding specifications (number, orientation, material grade, size, joint type etc.)
- banding consumable suppliers / manufacturers;
- banding equipment (including operating procedures, operating parameters, and maintenance schedules);
- band joint inspection and testing regimes.

8 Externally purchased coils

8.1 Procurement

The specification of coils that are purchased externally to Tata Steel Europe should include reference to this code of practice for the banding requirements. As a minimum the number and specification of the banding should meet with the requirements of this code of practice for the type, grade and size of coils being purchased.

8.2 Receipt and inspection

Upon receipt of externally purchased coils, Tata Steel hubs / units / sites should have procedures in place to verify that the correct number and type of bands are fitted to ensure the safety / stability of the coil during handling and storage.

9 Banding removal

Bore bands should be removed before circumferential bands. Note: bore bands provide very little restraint against coil spring back forces.

Circumferential bands should be removed at the latest possible stage of coil preparation. Circumferential bands should only be removed when coils are positioned so that the free end cannot spring or fall in such a way that it may cause harm or damage. Removal should ideally be done automatically by a processing machine.

If banding is removed manually, the outer bands should be cut last and from a position that does not place the operator directly in front of the coil.

Banding should never be removed from a suspended coil (e.g. from an overhead crane or on a forklift pole).

10 Communication

Tata Steel hubs / units / sites must ensure risks associated with coil stability / safety, and the associated banding / packaging requirements are communicated to all parties who may be at risk throughout the supply chain up to and including the end customer.

10.1 Marking of hot spring back coils

Tata Steel hot strip mills that produce coils with spring back characteristics (see Appendices 3 and 4 for definition) should have systems in place to identify those coils with visible markings. An example of such a spray painted mark is shown below:

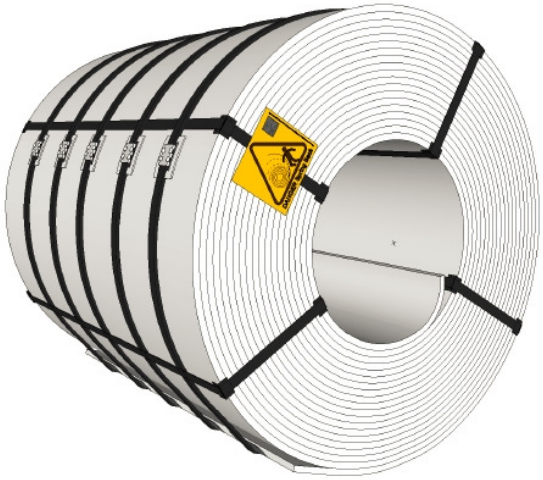
Spring back warning mark for hot wound coils

Note: Coils wound above 575°C will generally not exhibit spring back properties due to plastic deformation and stress relaxation at elevated temperatures.

10.2 Labelling of cold spring back coils

Where a cold-wound coil presents a spring back risk (see Appendix 4) the following label shall be applied to the banding on the naked coil and to the outer packaging if the packaging covers the original label:

Spring back warning label with QR code and URL to provide safety information about spring back coils for customers etc.

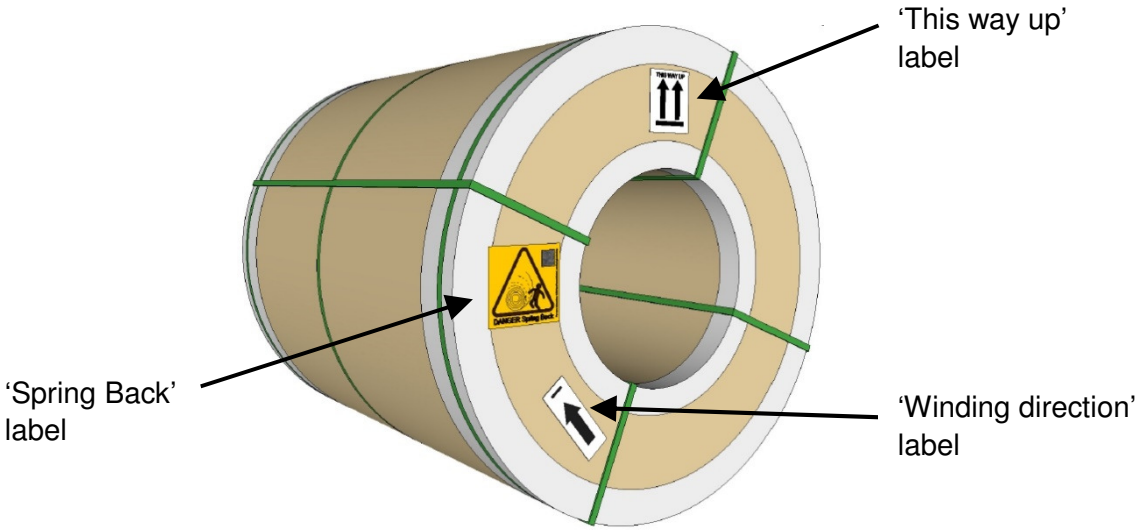


Note: For quality reasons, labels will be provided with narrow adhesive strips that should be applied to the banding, not to the coil surface. Labels should be applied to both ends of the coil.

Furthermore, if the coil is fully encased in packaging material, labels should be applied to indicate:

- the winding direction;
- ‘This way up’ to present the coil tail between 4 and 5 o’clock or 7 and 8 o’clock.

These labels will enable operators to position the coil in a safe orientation if / when bands or the packaging materials are removed.



Fully packaged coil with 'Spring Back', 'This way up' and 'Winding Direction' labels.

11 Monitoring compliance with this code of practice

It is the responsibility of Tata Steel Europe operations managers to ensure that local compliance with this code of practice is verified through the implementation of effective and robust monitoring and auditing processes.

12 Audit and review

Managers should have a process in place to identify, collate and evaluate measures of performance that relate to the deployment and efficacy of this code of practice in their area of responsibility.

Each hub / unit / site should ensure this code of practice is scheduled in their internal audit program, at a minimum three year frequency. Any learning from:

- banding related incident / accident investigations;
- new knowledge / technology / legislation;
- results of audits;

should be fed back to Group Health, Safety and Environment.

Units should review the outcomes of audits and performance measures at their health and safety fora and make recommendations for improvement where targets, aspirations and plans have not been achieved.

Users of this code of practice are encouraged to feed back any comments or experiences in the application of this document to assist in the process of continuous improvement. Feedback should be given to Group Health, Safety and Environment.

This code of practice will be reviewed by Group Health, Safety and Environment every three years and at any point in time if obliged by any feedback mentioned above.

Reference documents

The following European and American standards provide useful information relating to packaging banding:

- EN 13246:2001 Packaging – Specification for tensional steel strapping;
- EN 13394:2001 Packaging – Specification for non-metallic tensional strapping;
- EN 13891:2003 Tensional strapping – Guide to selection and use of tensional strapping;
- ASTM D 3953 – 15 Standard specification for strapping, flat steel and seals;
- VDI 3319 – Packaging guideline for steel coils and slit strip;
- UCI International union of railways - Loading guidelines 2014
- IMO/ILO/UNECE Code of Practice for Packing of Cargo Transport Units (CTU Code) 2014
- Definition of spring back hazard (reference source TSE R&D No. 172116);
- Training toolbox for spring back coils (see TSE H&S intranet information page);
- Customer recommendations at http://tatasteeleurope.com/springbacksafety.

Appendices

Appendix 1 – Risk assessment for coil stability

Appendix 2 – Typical strap and joint strengths

Appendix 3 – Circumferential banding requirements for hot-wound coils

Appendix 4 – Circumferential banding requirements for cold-wound coils

Appendix 5 – Bore bands required for different transport modalities

Appendix 1 – Risk assessment for coil stability

An Excel spreadsheet, requiring the following inputs, is available on the Tata Steel H&S intranet site to assess the risk of coil instability:

Coil Properties	Steel temperature when the coil is wound?	Greater than 575 ºC	Less than 575 ºC	Both Hot and Cold		
	Maximum yield stress of coils?	300 MPa	400 MPa	600 MPa	800 MPa	Greater than 800 MPa
	Maximum coil gauge / thickness ?	Less than 1 mm	2.5 mm	4 mm	6 mm	Greater than 6 mm
	Maximum coil width processed in the area.	600 mm	1200 mm	1600 mm	Greater than 1600 mm	
	Surface treatment of coils	Dry only	Pickled only	Pickled and Oiled	Galv/Tinplate/Painted	Both dry and coated
Handling	Orientation of coils after processing	Wide coil - bore horizontal	Wide coil - in a cradle bore horizontal	Wide coil - Eye-to-the-sky (ETTS)	Slit coil - bore horizontal	Slit coil - bore vertical
	Method of handling coils	Overhead crane with C hook	Overhead crane with coil tongs	Overhead crane with magnets	Pole truck	Forklift truck
	Are coils kept completely separated from all personnel at all times?	Yes	No			
	Is the tail of the coil <u>always</u> trapped at the 4 o'clock or 7 o'clock position?	Yes tails are always trapped	No tails may be in any position	Facilities are available to rotate coils	Not applicable - ETTS	
	Are coils rolled on the floor?	Yes coils may be rolled	No coils are never rolled			
Storage	How are coils stored in the location?	Bore horizontal - Single layer in cradles	Bore horizontal - Double layer in stillages	Bore horizontal - Double layer secured with wedges	Bore horizontal - 3 high	Stored Eye-to-the-sky (ETTS)
	Are the banding joints <u>always</u> in the 10 o'clock or 2 o'clock position?	Yes joints are always at 10 / 2 o'clock?	No joints may be in any position	Facilities are available to rotate coils	Not applicable - ETTS	
	Are the securing bands in contact with the floor?	Never	Sometimes	Yes	Not applicable - ETTS	
Transport	How are the coils transported by road?	Bore horizontal in a well trailers	Bore horizontal in cradles eye-to-the-side	ETTS on plastic / wooden skids	Slit coils ETTS in stacks	Not Applicable
	How are coils transported by rail?	Bore horizontal eye-to-the side in coil wagons	Bore horizontal eye-to-the front/rear in coil wagons	ETTS on plastic / wooden skids in box wagons	'Huckepack' in well trailers	Not Applicable
	How are coils transported by ship?	Bore horizontal in ship's hold - sea crossings	ETTS stacked in ships hold.	Barge / inland waterway	In road trailers on ferries	Not Applicable
	Containerised coils - orientation and modality	Bore horizontal in cradles eye-to-the-side road only	Bore horizontal in cradles eye-to-the-side sea / rail	Bore horizontal in cradles eye-to-the-front road only	Bore horizontal in cradles eye-to-the-front sea / rail	ETTS - any modality
Banding removal	Are circumferential bands removed manually?	Yes	No			
	Are bore bands removed before circumferential bands?	Yes	No	Not Applicable		
	Can <u>all</u> circumferential bands be removed automatically in a machine?	Yes	No			

Appendix 2 – Typical strap and joint strengths

Strapping strength assumptions based on EN 13246

		Min. Tensile Stress MPa
Plastic	**PET**	**430**
Steel	High Elongation / medium tensile strapping	750
Steel	High Tensile / medium elongation strapping	925

Strap Width (mm)	19.0		25.0		31.8		
Strap Thickness (mm)	0.63	0.80	0.80	1.00	0.60	0.80	1.00
	Theoretical Strap Tensile Strength (kN)						
PET plastic strapping	**5.1**	**6.5**	**8.6**	**10.8**	**8.2**	**10.9**	**13.7**
Medium tensile steel strapping	9.0	11.4	15.0	18.8	14.3	19.1	23.9
High tensile steel strapping	11.1	14.1	18.5	23.1	17.6	23.5	29.4

Typical Joint Strength as % of strap breaking strength

Plastic	**Plastic fused joint**	**80%**
Steel	Single notch seal	45%
Steel	Double notch seal	70%
Steel	2 punch sealless	60%
Steel	3 punch sealless	75%
Steel	4 punch sealless	85%
Steel	Spot welded - 2 spots	75%
Steel	Spot welded - 3 spots	85%

Note: These are typical values only and reference should be made to the manufacturer of the materials and equipment.

Appendix 3 – Circumferential banding requirements for hot-wound coils

- applicable to coils that are wound when the steel temperature is above 575°C

Special Note: *In order to comply fully with Appendix 3 business units may require significant investment in banding machines. Therefore, during the initial 6 month implementation phase of this code of practice, and in preparation for the formal review of this document, business units should undertake a detailed impact analysis and submit the findings to Group Health, Safety and Environment before major changes to operating practices are instigated.*

Tables A and B overleaf specify the number of circumferential steel bands that should be fitted to coils that are wound at a temperature above 575°C. Steel that is wound above this temperature will effectively deform plastically and retain its new shape through a process known as creep. Such coils will therefore not exhibit significant spring back characteristics whilst they are in their original coiled state.

There are two tables overleaf:

- Table A specifies the banding requirements for on-site movements only;
- Table B specifies the banding requirements for coils despatched externally.

The difference between the two tables is based on the additional risk of damage to the banding due to off-site handling, transport and storage. The numbers of bands specified in Table A is sufficient to safely contain the stored energy in the coils and to cope with internal handling, transportation and storage conditions.

Both tables are based on using strapping with either of the following specifications:

- 31.8 x 1.0 mm high elongation (HE) steel strapping with yield stress of 750 MPa (i.e. a breaking strength of 23.9 kN), or
- 31.8 x 0.8 mm high tensile (HT) steel strapping with yield stress of 925 MPa (i.e. a breaking strength of 23.5 kN)

If different strapping is used then a calculation must be done to determine the numbers of bands needed to secure the coils, and/or guidance sought from Group technical experts.

The tables are based on strapping joints that provide at least 70% of the tensile strength of the straps, i.e.:

- double notch seal joints, or
- 3 or 4 punch sealless joints, or
- 2 or 3 spot welded joints.

Rail transport

The International Union of Railways (UIC) Loading Guidelines for dry hot rolled coils require a minimum of **2 circumferential bands** with a minimum breaking strength of 14kN. These conditions are met by the banding in Table B.

Note: Coils wound above 575°C, up to 800 MPa yield stress and up to 16 mm gauge thickness are not classed as Spring Back coils.

Table A: ON-SITE movements only HOT wound coils i.e. coils wound above 575°C

Table B: OFF-SITE movements for HOT wound coils i.e. coils wound above 575°C

Number of circumferential bands

- based on 31.8 mm x 0.8 mm HT steel strapping 23.5kN tensile strength

Key: 1 band | 2 bands

Risk Rating: LOW

Yield Stress aim up to: **300** MPa

Max Gauge	Max Coil Width (mm) 900	1200	1500	1800	2100
<= 4.0	1	1	1	1	1
<= 6.0	1	1	1	1	1
<= 8.0	1	1	1	1	1
<= 10	1	1	1	1	1
<= 12	1	1	1	1	1
<= 16	1	1	1	1	1

Yield Stress aim up to: **400** **MPa**

Max Gauge	Max Coil Width (mm) 900	1200	1500	1800	2100
<= 4.0	1	1	1	1	1
<= 6.0	1	1	1	1	1
<= 8.0	1	1	1	1	1
<= 10	1	1	1	1	1
<= 12	1	1	1	1	1
<= 16	1	1	1	2	2

Yield Stress aim up to: 600 MPa

Max Gauge	Max Coil Width (mm) 900	1200	1500	1800	2100
<= 4.0	1	1	1	1	1
<= 6.0	1	1	1	1	1
<= 8.0	1	1	1	1	1
<= 10	1	1	1	1	1
<= 12	1	1	1	1	1
<= 16	1	1	2	2	2

Yield Stress aim up to: 800 MPa

Max Gauge	Max Coil Width (mm) 900	1200	1500	1800	2100
<= 4.0	1	1	1	1	1
<= 6.0	1	1	1	1	1
<= 8.0	1	1	1	1	1
<= 10	1	1	1	1	1
<= 12	1	1	2	2	2
<= 16	2	2	2	2	2

Key: 1 band | 2 bands | 3 bands

Risk Rating: LOW | LOW

Yield Stress aim up to: **300** MPa

Max Gauge	Max Coil Width (mm) 900	1200	1500	1800	2100
<= 4.0	2	2	2	2	2
<= 6.0	2	2	2	2	2
<= 8.0	2	2	2	2	2
<= 10	2	2	2	2	2
<= 12	2	2	2	2	2
<= 16	2	2	2	2	2

Yield Stress aim up to: **400** **MPa**

Max Gauge	Max Coil Width (mm) 900	1200	1500	1800	2100
<= 4.0	2	2	2	2	2
<= 6.0	2	2	2	2	2
<= 8.0	2	2	2	2	2
<= 10	2	2	2	2	2
<= 12	2	2	2	2	2
<= 16	2	2	2	3	3

Yield Stress aim up to: 600 MPa

Max Gauge	Max Coil Width (mm) 900	1200	1500	1800	2100
<= 4.0	2	2	2	2	2
<= 6.0	2	2	2	2	2
<= 8.0	2	2	2	2	2
<= 10	2	2	2	2	2
<= 12	2	2	2	2	2
<= 16	2	2	3	3	3

Yield Stress aim up to: 800 MPa

Max Gauge	Max Coil Width (mm) 900	1200	1500	1800	2100
<= 4.0	2	2	2	2	2
<= 6.0	2	2	2	2	2
<= 8.0	2	2	2	2	2
<= 10	2	2	2	2	2
<= 12	2	2	3	3	3
<= 16	3	3	3	3	3

Important note: Coils over 16 mm thickness and / or over 800 MPa yield stress should be assessed as special cases by technical experts.

Appendix 4 – Circumferential banding requirements for cold-wound coils

- applicable to coils that are wound when the steel temperature is below 575°C

Table C overleaf specifies the minimum number of circumferential steel bands that should be fitted to coils that are wound at a temperature below 575°C. The table specifies the required number of bands based on the yield stress of the coil material; the gauge thickness of the coil; and, the width of the coil.

Table C should be used in the absence of detailed analysis for specific coiling machines. Table C is based on coil winding machines that do not have the ability to put in a pre-set in the coil tail. If details of specific winding machines are known, TSE Group Research and Development function may be consulted to provide more detailed analysis of banding requirements for specific lines.

The banding matrices are based on strapping Spring Back coils with either:

- 31.8 x 1.0 mm high elongation (HE) steel strapping with yield stress of 750 MPa (i.e. a breaking strength of 23.9 kN); or
- 31.8 x 0.8 mm high tensile (HT) steel strapping with yield stress of 925 MPa (i.e. a breaking strength of 23.5 kN).

If different strapping is used then a calculation must be done to determine the numbers of bands needed to secure the coils. For example replacing one 31.8 x 0.8 mm HT strap with two 19 x 0.8 mm HT straps is acceptable:

One 31.8 x 0.8 mm HT band = 23.5 kN breaking force (see Appendix 2);

Two 19 x 0.8 mm HT = 2 x 14.1 kN = 28.2 kN total breaking force.

Alternatively, guidance should be sought from TSE Group technical experts.

Non-Spring Back coils, including all batch annealed coils, may be banded with 19 x 0.63 mm HT bands or higher strength (unless they are to go by rail).

Risk ratings are based on the calculated maximum stored energy in coils with outside diameters between 1000 and 2200 mm:

- Very Low risk: up to 0.1 kJoules
- Low Risk: between 0.1 and 2 kJoules
- Medium Risk: between 2 and 18 kJoules Classed as **Spring Back**
- High Risk: above 18 kJoules Classed as **Spring Back**

Very Low risk coils do not require high strength banding. Where Table C shows a value of 0/1 bands, this should be interpreted as meaning any form of closure can be used including: adhesive tape; cling film; shrink wrapping; plastic strapping; narrow / thinner steel strapping.

Low risk coils that are despatched off-site should have a minimum of 2 circumferential bands for the reasons stated in Appendix 3.

Rail transport

The International Union of Railways (UIC) Loading Guidelines for oiled coils (by inference oiled hot rolled coils and all cold rolled coils including galvanized coils), require a minimum of **2 circumferential bands** (and 3 bore bands) of at least 14 kN breaking strength to be fitted.

Coils with Medium or High risk ratings are classed as **Spring Back** (based on 2kJ of stored energy).

Table C: Coils wound below 575°C

Number of circumferential bands – for Spring Back coils these numbers are based on using steel strapping with a minimum of 23.5kN tensile strength.

Key:	0/1 band	1 band	2 bands	**2/3** bands	**4** bands	**5** bands	**6** bands	**7** bands	**8** bands
Risk Rating:	**Very LOW**	**LOW**		**MEDIUM**		**HIGH**			

Yield Stress aim up to: **300** MPa

Gauge (mm)	Max Coil Width (mm) 100	150	300	600	900	1200	1500	1800	2100
<= 1.0	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1
<= 1.5	0/1	0/1	0/1	0/1	1	1	1	1	1
<= 2.5	1	1	1	2	2	2	2	3	3
<= 4.0	1	1	2	2	2	3	3	3	3
<= 6.0	1	1	2	2	3	3	3	3	3
<= 8.0	1	2	2	3	3	3	3	3	3
<= 10	2	2	2	3	3	3	3	4	4
<= 12	2	2	3	3	3	4	4	4	4
<= 16	2	2	3	3	4	4	4	5	5

Yield Stress aim up to: **400** **MPa**

Gauge (mm)	Max Coil Width (mm) 100	150	300	600	900	1200	1500	1800	2100
<= 1.0	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1
<= 1.5	0/1	0/1	0/1	0/1	1	1	1	1	1
<= 2.5	1	1	2	2	2	3	3	3	3
<= 4.0	1	2	2	3	3	3	3	4	4
<= 6.0	2	2	3	3	4	4	4	4	5
<= 8.0	2	2	3	3	4	4	4	5	5
<= 10	2	2	3	3	4	4	5	5	5
<= 12	2	2	3	4	4	4	5	5	5
<= 16	2	2	3	4	5	5	**6**	**6**	**6**

Yield Stress aim up to: 600 MPa

Gauge (mm)	Max Coil Width (mm) 100	150	300	600	900	1200	1500	1800	2100
<= 1.0	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1
<= 1.5	0/1	0/1	0/1	0/1	1	1	1	1	1
<= 2.5	1	1	2	2	2	3	3	3	3
<= 4.0	2	2	2	3	3	3	4	4	4
<= 6.0	2	2	3	4	4	4	5	5	5
<= 8.0	2	2	3	4	5	5	**6**	**6**	**6**
<= 10	2	2	3	5	5	**6**	**6**	**7**	**7**
<= 12	2	2	3	5	**6**	**6**	**7**	**7**	**7**
<= 16	2	2	4	**6**	**6**	**7**	**8**	**8**	**8**

Yield Stress aim up to: 800 MPa

Gauge (mm)	Max Coil Width (mm) 100	150	300	600	900	1200	1500	1800	2100
<= 1.0	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1
<= 1.5	0/1	0/1	0/1	0/1	1	1	1	1	1
<= 2.5	1	1	2	2	2	3	3	3	3
<= 4.0	2	2	3	3	3	4	4	4	4
<= 6.0	2	2	3	4	4	5	5	5	**6**
<= 8.0	2	2	3	5	5	**6**	**6**	**7**	**7**
<= 10	2	2	3	5	**6**	**7**	**7**	**8**	**8**
<= 12	2	2	3	**6**	**7**	**8**	**8**	**8**	**8**
<= 16	2	2	4	**6**	**7**	**8**	**8**	**8**	**8**

Appendix 5 – Bore bands required for different transport modalities

Bore bands are used to prevent coils from telescoping during transportation for quality and safety purposes. Tables D and E overleaf show the number of **bore** bands considered necessary for different modes of transport.

IMPORTANT NOTE: The number of CIRCUMFERENTIAL bands must be the higher number from either Tables B/C or Tables D/E depending on coil type and transport modality.

Rail transport

There are international rules for banding of steel coils that are transported by rail loaded bore horizontal on external rail networks that should be adhered to:

- Dry steel coils (uncoated) must have a minimum of 2 circumferential bands;
- Oiled / coated coils must have at least 2 circumferential bands and 3 bore bands;
- All bands must have a minimum breaking strength of 14 kN.

It is considered acceptable to substitute 3 bore bands of 14 kN with 4 bore bands of 10.5kN breaking strength.

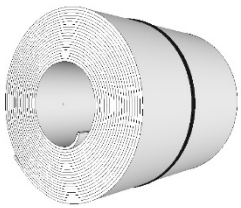
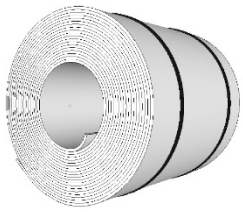
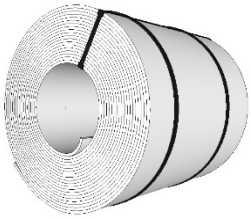
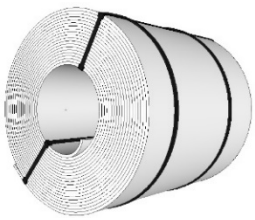
Table D overleaf shows the minimum number of bore bands that are needed for dry coils.

Table E overleaf shows the minimum number of bore bands that are needed for dry coils.

Note: Bore bands used for holding packaging material to the coil can be considered to be part of the coil safety banding to prevent telescoping during transportation.

However, the circumferential bands used to hold packaging to the coil are not to be considered as part of the coil safety banding as they will normally be removed prior to final handling and positioning of the coil at, for example, the customer' premises.

Table D – Minimum bore band requirements for Dry Hot Rolled Coils (HRC) only

Transport Modality	Source	Conditions / Comments	Banding
ON-SITE MOVEMENTS ONLY Or in BCA / BLA rail wagons only in the UK for inter-site transfers.	DB Schenker UK Rail Operations Manual.		1 circ. + 0 bore bands 
	Min. requirement for any off-site delivery of Hot Rolled Coil as per Appendix 3. Min. requirement of the UIC rail code for dry coils only.	Bore bands are not essential for road transport. Not compliant with DB Schenker rail loading standard in MLE	2 circs. + 0 bore bands 
	Min. requirement for DB Schenker/Tata MLE rail loading standards.	Bore band must have a minimum breaking strength of 14 kN for rail movement.	2 circs. + 1 bore band 
			2 circs. + 2 bore bands 

Key for modality:

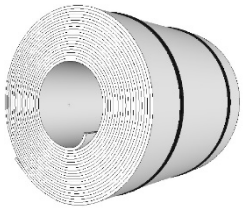
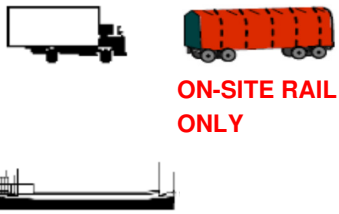
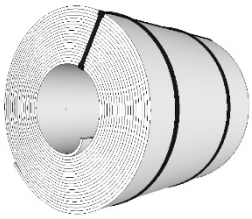
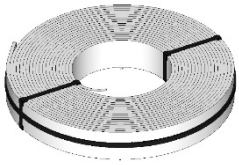
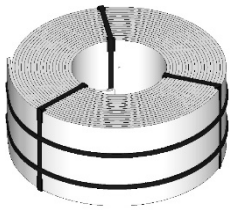
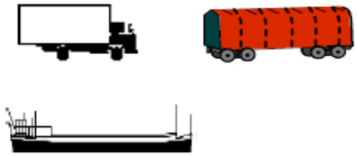
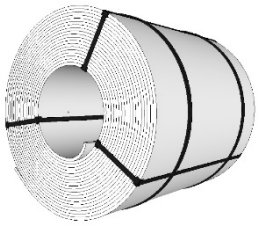
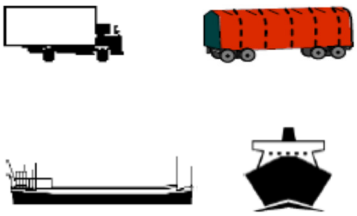
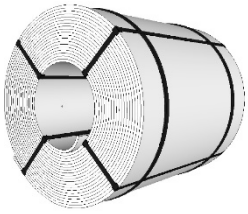

Road


Rail


Inland barge


Sea-going vessel

Table E – Minimum bore band requirements for oiled HRC and/or all Cold Rolled Coils

Transport Modality	Source	Conditions / Comments	Diagram
		Bore bands are not essential for road transport safety – the load restraint straps will prevent telescoping for safety purposes.	Circs.* + 0 bore bands 
			2 circs. + 1 bore band 
		Only for slit coil: less than 350 mm wide; and less than 4 mm gauge thickness; and less than 600 MPa	1 circ + 2 bore bands 
		Slit coils over 350 mm wide; or 4 mm gauge thickness (or greater); or 600 MPa yield stress (or greater)	2 circs. + 3 bore bands 
	Min. requirement of the UIC rail code for oiled / coated coils bore horizontal.	Min. 14 kN breaking strength straps for rail regulations.	2 circs. + 3 bore bands 
		Min. of 4 x 10.5 kN breaking strength straps for bore bands to match rail regulations of 3 x 14kN bands.	2 circs. + 4 bore bands 

* The number of CIRCUMFERENTIAL bands must be the higher number from either Tables B/C or those shown here for the transport modality.