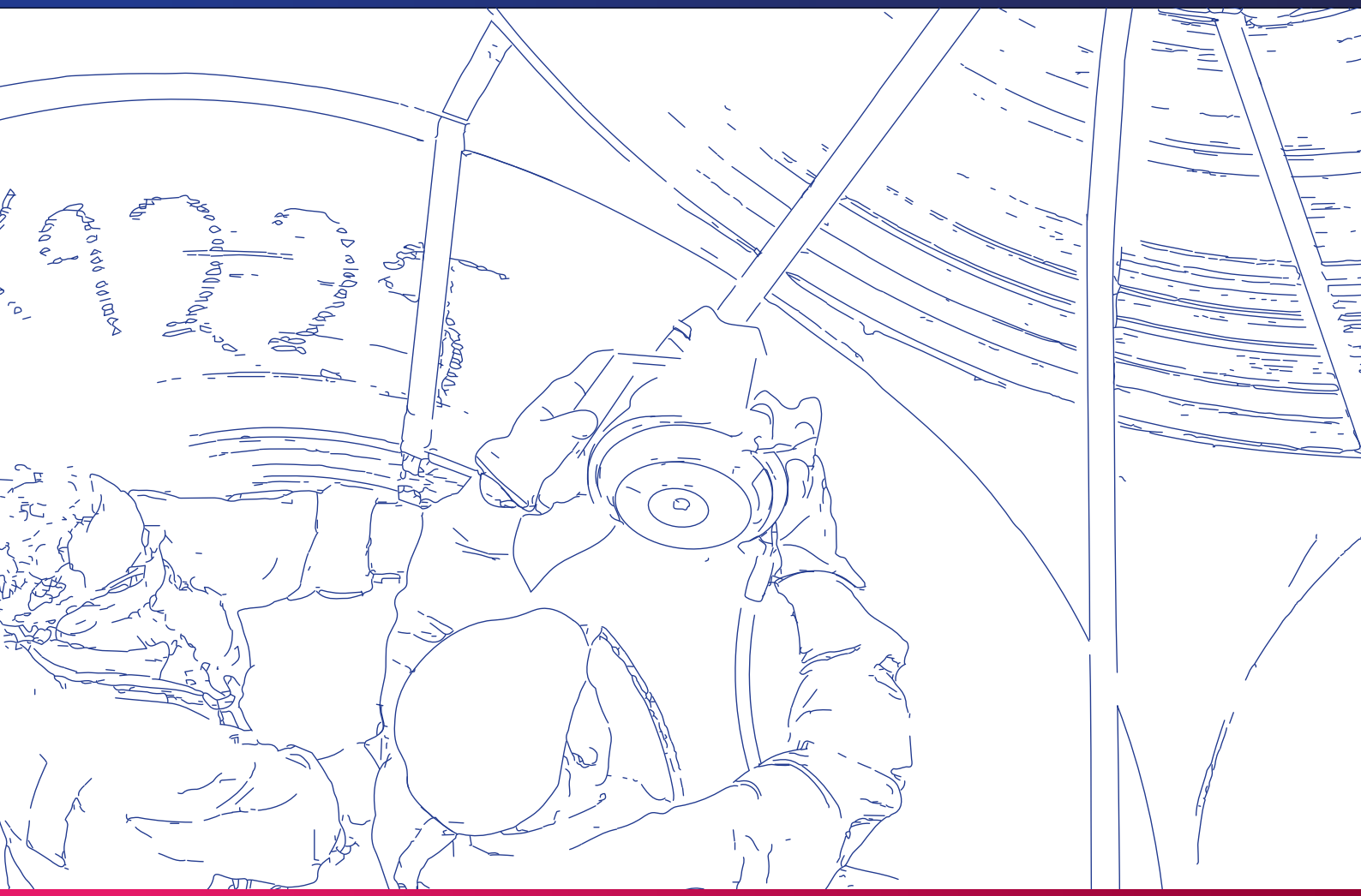
Standard Club

By your side

A Master's Guide to:

The Carriage of Steel Cargo



About this Guide

This is the third edition of Standard Club's guide to the carriage of steel cargo, first produced in 2009. This new version includes additional advice on the principles of stowage, weight distribution and California Block Stowage. The guide sets out to promote best practice and raise awareness of the risks of shipping steel cargo. It is written as a reference guide for the master, cargo officers and shore operations staff.

Steel is a high-value cargo, a cargo easily damaged by rough handling, water and moisture.

When carrying steel products by sea, it is essential to ensure that neither the steel nor the ship suffers damage. Its weight presents substantial challenges with stowage and securing. The ship must be fit to receive the cargo and the cargo must be safely stowed and secured. Incorrect stowage can lead to hull and cargo damage.

Cargo damage can occur for a number of different reasons in transit or before loading. Standard Club arranges preloading surveys to check the condition of finished steel before loading to ensure that bills of lading are correctly endorsed with full details of any such damage.

The guide to the carriage of Steel Cargo therefore focuses on correctly loading, stowing, caring for and securing steel cargoes. Its advice, if followed, will assist in the avoidance and prevention of steel cargo damage claims.

This guide was written in collaboration with Lloyd's Register, one of the world's leading providers of professional services for engineering and technology.

Captain Yves Vandenborn, Director of Loss Prevention

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01. Steel manufacture

Steel is manufactured from iron during a process in which most of the iron's carbon is removed, producing a tougher and more ductile material.

Steel is smelted from iron ore in a process involving heat, coke, limestone, oxygen and scrap steel. Manufacture takes place in a furnace, of which there are two types in common use: the basic oxygen furnace and the electric arc furnace.

After leaving the furnace, the hot steel passes through a secondary steel-making process to improve its quality, before it is cast into slabs, ingots, billets or blooms. The process of casting steel slabs, ingots, billets and blooms is known as continuous casting, because the process never stops. If the steel mill has rolling equipment, the hot metal may be rolled rather than cast.

Slabs, ingots, billets and blooms are often shipped by sea in transit to a rolling mill where they can be rolled into long products such as profiles, beams and channels. Steel slabs are rolled into plate.

There are two rolling processes – hot and cold rolling. Hot rolling takes place when the steel is red hot and cold rolling after cooling. During hot rolling, the steel product is formed. During cold rolling, the product is improved and made ready for sale.

Hot metal and reheated steel slabs can be hot rolled to form strip steel, a thin sheet of steel up to 2m wide. Strip steel can be coiled for storage and shipping. Steel that has been rolled when hot and coiled is known as a 'hot-rolled coil'.

Hot-rolled steel coils may be unwound for further rolling, only this time the metal will be cold and the process is called cold rolling. Cold rolling is the final step in steel manufacture – after cold rolling, the steel is ready for use. Cold-rolled thin sheet steel could be coiled again to create a 'cold-rolled coil'.

Cold rolling improves the steel's surface quality in readiness for sale.

Hot and cold-rolled steel coils are frequently shipped by sea. Even though some, but not all, hot-rolled coils will undergo a further manufacturing process, it is important for them to be delivered free from excessive rust and/or physical damage. Cold-rolled steel coils will not be further processed and when unwound can be used to make steel panels, such as car body parts. Cold-rolled steel coils need to be delivered to receivers in pristine condition.

Figure 1: Hot steel for forming the coil

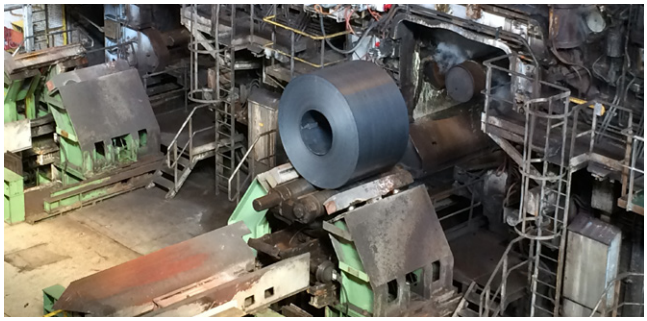

Figure 2: Hot rolled coil after rolling

02. Basic advice

The following checks and actions should always be taken when carrying steel:

Stowage

- Read your company's instructions on the safe carriage of steel, your ISM requirements and the advice in the cargo stowage and securing manual. Cross-reference with industry publications such as the *Code of Safe Practice for Cargo Stowage and Securing and Thomas' Stowage*. This guide may also form part of the ship's cargo manual.
- Find out the proposed loading plan in advance. Check whether the best, rather than the easiest, stow is proposed. If loading steel coils, check that key/locking coils are correctly positioned and tank top point loads are not exceeded. Estimate the loaded metacentric height (GM) by using the correct vertical centre of gravity for the loaded steel. Avoid very high GMs. Bear in mind the likely weather to be encountered during the voyage, as high GMs are associated with heavy/violent ship rolling.
- Enquire into the proposed method of stowing and securing cargo. Meet with the stevedore superintendent and/or supercargo to discuss the loading plan. Use this as an opportunity to point out any limitations with the ship or its equipment.
- Mark the holds' strong points, such as solid floors, on the tank top. Extend the marks up the hold sides. These are the best load-bearing positions. Marking them will make it easy to check whether cargo and dunnage are correctly positioned during loading.
- Avoid stowage in spaces without parallel sides. If this is unavoidable and frequent loadings are expected, arrange for the space to be permanently 'squared off' with a steel buttress or heavy-duty timber. Pay special attention to No. 1 hold.
- Avoid loading steel in the same compartment as chemicals, fertilisers, sulphur or other cargoes that could cause damage.

Dunnage

Apply dunnage to:

- spread the load. Always use sufficient strips of dunnage to avoid exceeding the tank top acceptable point load. As the height of a stow increases, so too does the requirement for additional strips of dunnage
- create frictional resistance. Steel has a very low coefficient of friction. Metal-to-metal contact should always be avoided
- avoid deformation of the cargo, especially when loading steel plate, coils and railway lines
- protect steel from moisture
- reduce possible movement within a stow, especially when carrying steel plate or slabs
- fill gaps, unsupported ends and breaks in block stowage.

- Laying dunnage is an important part of the safe and efficient carriage of steel. Use dunnage of sufficient thickness to enable efficient weight distribution and to facilitate cargo lashing/handling. One inch thick softwood dunnage is often used with steel coils. However, this thickness of dunnage is unlikely to give an even distribution of weight, and a point load should be assumed during calculation of loading limits and tank top strength. To avoid the risk of point loads, use a thicker dunnage (see Figure 13 on page 19). Ship's officers should ensure the correctly sized dunnage is laid properly. When placing dunnage between flat steel plate, keep the dunnage in a vertical line to avoid plate distortion. Use dunnage sized 60mm by 80mm.
- Use wooden wedges to fill gaps between dunnage and steel, and within the stowage.
- Use only dunnage *certified for ship use*, that is, dunnage with a plant quarantine stamp. In some ports, officials will want to inspect dunnage certificates. Avoid using dunnage that has previously been used with steel products, because the dunnage's cellular structure is likely to have altered. Recycle used dunnage in an environmentally acceptable way.

Loading

Coils should be stowed across the ship, on stout dunnage, with their axes fore and aft. Use wedges to safely locate coils during loading. Base coils should be loaded from the ship's side inwards to the centre and wedged, with the wedges placed below the coils on their in-board side. Once at sea, the ship's motion will cause the coils to settle as the weight of the key coils tightens the stow. Wedges placed either side of a coil will prevent this. However, when more than one key coil is used, and to locate the position of the key coils during loading, double wedging is necessary on either side of the centre supporting coil(s).

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Coils are secured with steel banding to each other in varying forms. Pneumatically tightened steel bands, which bind the coils to those stowed immediately below, are preferred.

Key coils are positioned so that their bottom edges are one-third of a coil's diameter below the top of the coils in the tier being locked, in a gap that is not greater than 60% of the key coil's diameter.

Wire coils should be stowed vertically, with their axes fore and aft, adjacent to each other in a similar configuration to the stowage of steel coils.

Plate should be stowed in the fore and aft direction, with dunnage running athwartships and between each tier. Stowage should be from one side of the ship to the other, leaving no voids, and the top layer secured with wire or chain bindings. When loading thin plate, stowage in subsequent tiers can be in alternate directions.

Long products, such as pipes, channels, angles, beams, flats, rounds and rebars, should be stowed in the lower holds in the fore and aft direction, with dunnage placed athwartships. Avoid mixing products of different types and lengths in the same stow. Place dunnage between the tiers. The top tier should be secured to the ship.

Semi-finished steel slabs should be stowed in the same manner as steel plate. California Steel Industries (CSI) recommends vertical stowage with tight lashing of top tiers (see page 26 – California block stowage).

- Arrange a preloading survey of all finished steel before loading. Do not confuse finished steel with project cargo.
- Avoid loading wet steel and wet dunnage. Wet steel has less friction. Both give off moisture.
- Ship's officers should monitor stevedores to ensure:
  - they use the correct equipment and do not damage the cargo. Steel wire slings or chains when used incorrectly can damage bundles of pipe, plate or steel coils
  - steel is not handled roughly
  - forklifts are fitted with proper lifting tines. Damage during lifting by a forklift is very common
  - stowage and securing is as per the cargo plan and the ship's cargo securing manual
  - cargo is not loaded wet or during periods of rain or left exposed in wet conditions
  - details of cargo damage are correctly recorded on the stowage plan and in the cargo log.
- Ship's officers should monitor the surveyor performing the preloading survey and be available to assist.

Cargo securing

Lashing arrangements that do not include a vertical component and do not connect to the ship's structure are of little value. However, in practice, steel is often lashed to itself with loop lashings. For example, steel coils loaded two tiers or more are secured to each other. Their key coils are secured with tight steel bands to the coils immediately below. Coiled wire has its top layer banded to the next layer down. Plate is held with horizontal wire bands across the top layer in an 'x' shape. Here, the objective is to create an immovable cap.

Cargo care

Steel cargoes are easily damaged by salt water. Before loading, test hatch covers for weathertightness and repair the covers if leakage is found. Test with ultrasonic hatch cover testing equipment. Examine hold and bilge wells and make sure they are dry. After loading and before closing hatch covers, clean drain channels and check that non-return valves are free. When closing hatch covers, apply cross-joint wedges before hatch skirt cleats. For further information on the maintenance of cleats and the closing of ship's hatch covers, see the club's publication *A Master's Guide to Hatch Cover Maintenance*, which is available on the club's website.

Additional protection, such as sealing foam and tape, can be applied along hatch cover cross-joints in exposed areas of the ship and especially on No. 1 hold if the ship does not have a forecastle. Ballast water should not be loaded in wing tanks when cargo holds are loaded with steel products, except when necessary for stability purposes, when load lines permit and when ballast tanks (including associated filling/ventilation/sounding pipes) are watertight. When testing steel surfaces for chlorides (salt) using silver nitrate, a resulting milky solution shows the presence of chlorides.

It does not necessarily show that sea water has entered the hold either through hatch covers or the hull.

During the voyage, control the dew point in the cargo hold by ventilation or by dehumidifying the air.

- Fit dehumidifiers in holds when steel is loaded in winter or in cold conditions for discharge or passage through areas in summer/warm conditions. Dehumidify holds as the outside air temperature rises. Particular care is needed when loading in humid tropical conditions, because cargo holds will contain damp humid air. Dry the air with dehumidifiers.
- Make sure dehumidifier cabling does not compromise the integrity of the hold or pose a fire hazard. Dehumidifiers drain directly to hold bilges, which should be pumped dry regularly. Keep records of bilge pumping operations.
- Take daily dew point temperatures of hold and outside air with a wet and dry bulb thermometer. Ventilate when the dew point of the outside air is less than the dew point of the hold air. This will normally occur when cargo is loaded in warmer conditions for delivery to a port, or passage through an area, with colder conditions.
- Keep detailed records of hold and outside air temperature, at the load port, during the voyage and at the discharge port. Record times of hold ventilation and of heating fuel in tanks adjacent to holds loaded with steel.

03. Steel commonly shipped by sea

Finished steel products

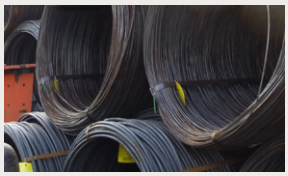
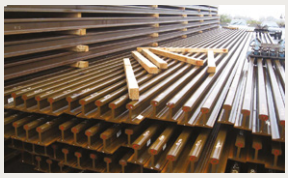
	Type	Description	Usual stow	Notes	Survey required
	**Cold-rolled coils**	Finished sheet steel in a transportation coil. 2 to 28 tonne weights	Athwartships – bottom stow	Coils will not be further processed but unwound and used	Yes
	**Hot-rolled coils**	Sheet steel being transported to a rolling mill in 2 to 30+ tonne weights	Athwartships – bottom stow	Coils usually unwound and cold rolled	Yes
	**Coiled wire rod**	Long steel bars formed by hot and cold rolling	Fore and aft	Can be damaged/ squashed by high stows. Can be left on the quay and loaded in the rain	Yes
	**Profiles**	Long steel bars formed by hot and cold rolling	Fore and aft	Used to reinforce steel structures	Yes
	**Channels**	Long steel bars formed by hot and cold rolling	Fore and aft	Used to reinforce steel structures	Yes
	**Angles/bulbs**	Long steel bars formed by hot and cold rolling	Fore and aft	Used to reinforce steel structures	Yes
	**Girders**	Long steel bars formed by hot and cold rolling	Fore and aft	Used to reinforce steel structures	Yes

Figure 3: Finished steel products

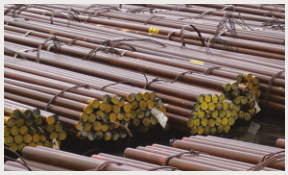
	Type	Description	Usual stow	Notes	Survey required
	**Plate**	Thick steel in finished form after cold rolling	Fore and aft or athwartships in bundles	Used in the manufacture of all sorts of steel structures	Yes
	**Reinforcing bars (rebars)**	Hot-rolled steel bar with a rough finish	Fore and aft	Used to reinforce concrete	No
	**Small-diameter pipes**	Finished steel loaded in bundles	Fore and aft – often pre-slung	Top tier lashed and secured	Yes
	**Large-diameter pipes**	Finished steel loaded singly or in bundles	Fore and aft	Ends prone to contact damage	Yes
	**Coated steel pipes**	Finished steel loaded in bundles or cradles	Fore and aft	High value. Easily damaged by rough handling	Yes
	**Sheet piling**	Used in construction industry	Fore and aft	Not usually further processed	No

Figure 4: Finished steel products

Other steel products

	Type	Description	Usual stow	Notes	Survey required
	**Ingot**	Raw steel before rolling	Fore and aft	Processed to make steel bars and plate	No
	**Slab**	Raw steel before rolling	Fore and aft	Processed to make steel bars	No
	**Bloom**	Raw steel before rolling	Fore and aft	Processed to make steel bars	No
	**Billet**	Raw steel before rolling	Fore and aft	Processed to make steel bars	No

Figure 5: Other steel products

04. Steel cargo surveys

Shipowners have an obligation to cargo receivers to deliver cargo in the same apparent condition as loaded (shipped).

Finished steel products can suffer physical damage or rusting during transit from the steel mill to the port, or during storage at the port.

Finished steel is most problematic because, at the discharge port, it is difficult to determine whether the damage occurred before loading or while on board. Consequently, it is essential to examine finished steel for defects before loading and to identify and record any damage or rusting. This information is needed to prove to cargo receivers that such damage occurred prior to shipment and not on board the ship.

P&I clubs arrange preloading surveys of finished steel as a means of preventing shipowners facing damage claims where damage occurred before loading. The club's rules require the survey as a condition of cover:

Unless the board otherwise determines, there shall be no recovery in respect of liabilities arising out of the carriage of finished steel products, unless the member has arranged for a preloading survey to be carried out by a club-approved surveyor at each port of shipment, and the bills of lading have been claused in accordance with the findings of the surveyor as to the condition of cargo at the time of loading.

Generally, clubs will only want to survey finished steel, that is, products that will not be processed in a steel mill before being used in a manufacturing process. For the purpose of a P&I club preloading survey:

Finished steel includes:

- hot or cold-rolled steel coils
- steel wire coils
- steel plate, bars, profiles, channels,
- angles and joists
- sheet steel
- steel pipes.

Finished steel excludes:

- steel billets, ingots, blooms and ore
- semi-finished steel slabs
- scrap steel
- steel rebars and D-bars*
- project cargo and/or flat-packed steel structures.

** Although reinforcing bars are 'finished' and do not undergo further processing at a mill, the club does not generally survey them.*

Survey procedure

Preloading steel surveys are usually undertaken by surveyors appointed by the P&I club. The surveyor has a number of duties, the most important is to examine cargo for damage and to advise the master on suitable clauses to endorse on the mate's receipts and bills of lading.

However, surveyors should also examine the ship's hatch covers, cargo holds and observe stowage, pointing out to the master any hatch cover defect that could give rise to leakage and any aspect of stowage that appears incorrect.

The surveyor should never take charge of stowage – this is the master's responsibility. However, if the master requires guidance and support in relation to stowage, the surveyor should be specifically instructed to advise on this issue, with the surveyor's fees to be for the member's account as this is an operational matter. The club can assist with identifying and instructing a suitable surveyor for stowage issues.

When examining steel cargo, surveyors will be checking:

- where the steel was manufactured, how the steel was transported from the steel mill to the port, where the steel was stored in the port prior to arriving at the berth and how the steel is protected from damage and the elements
- for physical damage, rusting, wetting and possible contamination with salt and/or chemicals. For example, steel stored close to the sea, or delivered by barge, can become contaminated with wind-carried salt.

At times, the steel itself cannot be examined because of its packaging. In which case, the surveyor will pay close attention to the condition of packaging and whether this is damaged, missing or wet.

Figure 6: Steel cargo loading

When examining stowage, surveyors will check that:

- steel is positioned correctly, on correctly sized and laid dunnage
- locking coils are positioned correctly
- stowage gaps and free ends are secured with dunnage
- lashings are applied correctly.

When examining hatch covers, surveyors will check:

- sealing gaskets and drain channels for damage
- that drain channels are clean
- cleats and wedges for missing springs and damaged compression washers
- that drain channel non-return valves are free.

The surveyor will want to:

- examine steel while it is in storage in the port, noting storage conditions
- examine each parcel of steel on the quay before loading. Otherwise, the examination will take place in a marshalling area
- note any exceptions with the steel, carefully describing the damage and identifying the damaged steel by reference to plate numbers and/or identification tags. Later, it will be necessary to endorse bills of lading and mate's receipts with details of the damage. Suggested wording is contained in this guide. At times, the surveyor will recommend not to load badly damaged cargo.

Occasionally, the surveyor will ask for assistance from the duty deck officer. This may be because:

- cargo is being loaded in more than one hold at the same time
- cargo is being loaded during a 24-hour period, but loading is erratic and intermittent
- the surveyor is checking other cargo and recording details of damage as loading continues.

The duty deck officer should always provide assistance.

When recording details of the cargo's condition, surveyors should always make detailed notes of any damage seen regardless of whether it is damaged packaging or very minor blemishes on the cargo. Everything needs to be accurately recorded by the surveyor. At times, the steel may appear to be in 'typical condition' for the type of cargo, even though there are minor blemishes. However, if the steel is in less than perfect condition, the true condition of the steel should be recorded by the surveyor and itemised in his report. The description needs to be precise because it may be necessary to prove to the receivers the exact items that were damaged, using the steel mill's identification marks or the shipper's docket, so that the receivers can verify that the items found damaged are the same as those noted by the surveyor. Never report, for example, '150 bundles of steel bar were loaded and 95 had minor rust/damage'. It is necessary to identify the 95 bundles.

Surveyors who come on board at the discharge port may represent receivers, in which case, their credentials should be checked and approved before allowing them access to cargo. Allow only surveyors whose credentials have been approved to take photographs of cargo.

There will be occasions when an independent tally of coils will be required. Ask the surveyor who is conducting the preloading survey whether they can assist.

Silver nitrate testing

Silver nitrate tests are performed as a means of detecting chlorides, in this case salt (sodium chloride). Silver nitrate is a clear solution, which goes milky white when mixed with chlorides.

This test is made whenever there is an allegation that steel has been damaged because of contact with salt water. If the test is positive, claimants are likely to pursue a cargo damage claim.

Test procedure

- The silver nitrate solution should be kept in a dark bottle fitted with a dropper.
- Before testing, check the area being tested for contamination.
- Squeeze a few drops of the silver nitrate solution onto the wet or rusty area, ensuring that the fluid does not come into contact with hands.
- Observe the result. The solution will change colour quickly and markedly when there is a strong presence of chlorides.
- Ensure that the dropper does not touch the wet or rusty steel or hands. This may affect future results.

Positive results show that chlorides are present on the steel. It does not show that sea water entered the hold either through hatch covers or the hull.

Chlorides can be present for other reasons, including:

- the hold was washed with salt water and not finally rinsed with fresh water.
- wind-blown salt accumulated in the hold and condensation caused salty water to drip onto the cargo
- salt was deposited on the steel before loading. Surveyors undertaking a preloading survey should check for salt contamination.

At the start of the voyage, it is important to ensure that hatch covers are weathertight, that the bilge system is tight, that holds are free from salt water residue or dry salt, and that any salt contamination found on the steel prior to loading is accurately recorded on the bill of lading.

If chlorides are found, it is important to advise the shippers as soon as possible. The bills of lading and mate's receipts will need to be endorsed, and shippers may wish to separate the affected cargo.

05. Bills of lading

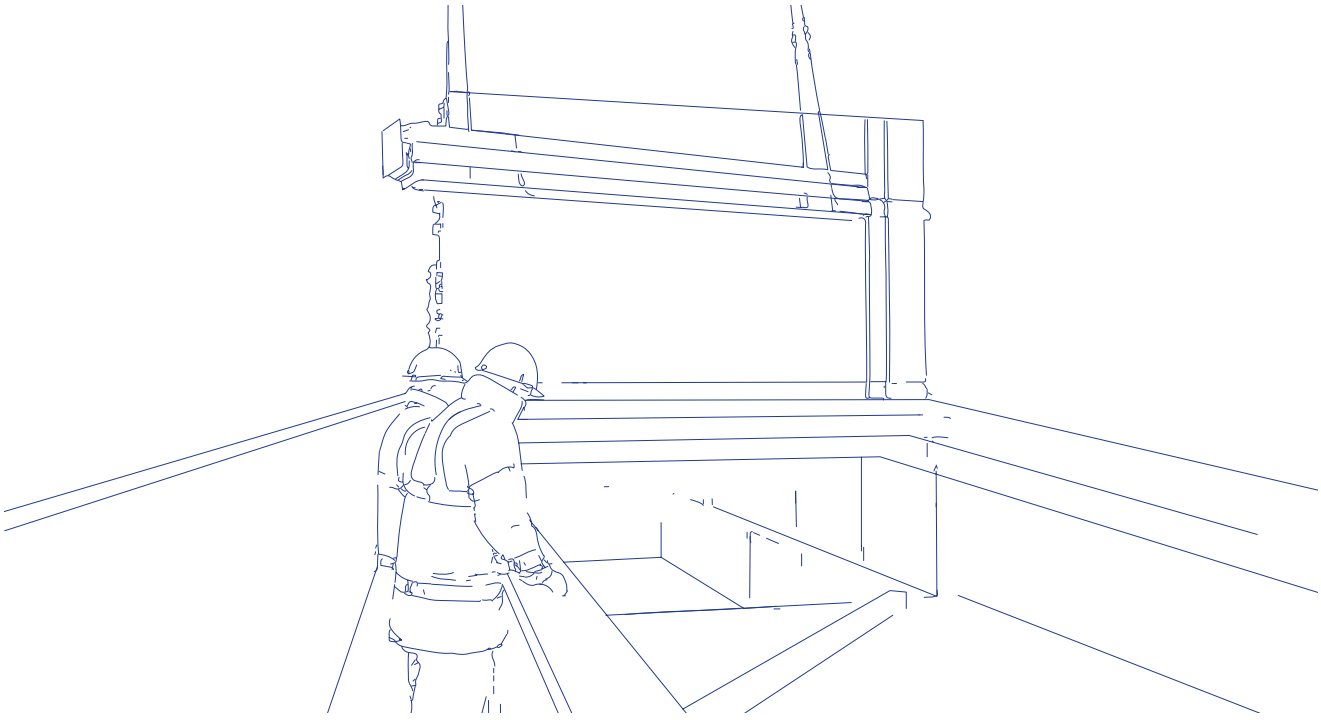
The bill of lading represents the cargo itself, and possession of the original bill indicates who is entitled to receive the cargo at the discharge port. A bill of lading is a record of the quantity of cargo on board and of its apparent order and condition at the time of shipment. As such, it is a vitally important document. Cargo damage or shortage claims can arise as a result of errors on a bill of lading.

The description of cargo on the bill has to accurately reflect the condition and quantity of cargo loaded. Any cargo defect or damage that may exist prior to loading needs to be accurately endorsed on the bills before they are signed. If the bills are not seen on board, a description of the damage should be endorsed on the mate's receipt.

Rusting is often described by reference to a percentage of the surface affected. This can be very difficult to quantify in practice. Rust percentages can vary from piece to piece, for example, one side of a beam may be totally rusty and the other side may not be rusty at all. The International Group of P&I Clubs standard clauses for steel can be broadly broken down into three categories:

- rust spotted – up to 15% of the visible surfaces affected by rust
- partly rusty – 15%-75% of the visible surfaces affected by rust
- rusty – over 75% of the visible surfaces affected by rust.

Use these categories if unable to estimate a percentage.



Clauses

The following or similar clauses should be used to describe damaged steel on bills of lading:

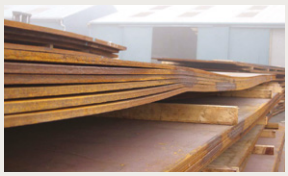
	Description
	Flat bound steel plate reference number xxxx rusted xx% of its surface and buckled along its edge
	Profile reference number xxxx – flanges/webs/corners/edges – bent/buckled/ distorted, along xxxx of its length
	Coil reference number xxxx – ripped/torn/distorted – along/in/around xxxx position
	Plate/bar/channel/profile reference number xxxx – dented/pitted in xx places and along xxx% of its edge
	Plate/bar/channel/profile/ coil – reference number xxxx – loaded in wet/damp/ rain/snow/ice conditions before shipment
	Plate/bar/channel/profile/ coil – rust spotted/partly rusty/rusty before shipment
	Plate/bar/channel/profile/ coil – rusted xxx% overall

Figure 7: Clauses

06. Steel coils and ship's strength

Carriage of a high-density cargo such as steel presents a challenge during ship design to ensure the ship's hull is sufficiently strong.

Class rules

Since 2006, many bulk carriers and some dry cargo ships have been built to common structural rules. The latest being Common Structural Rules for Bulk Carriers and Oil Tankers (CSR-H), 2017. The relevant sections which apply to loading steel coils are:

- steel coil loads in cargo holds of bulk carriers – part 1, chapter 4, section 6.4
- structures loaded by steel coils on wooden dunnage – part 2, chapter 1, section 4.

The common structural rules deal with loading on the ship's structure and the minimum scantling requirements to resist it. Through them, ships are designed for specific loading conditions, in which homogeneous (constant load per area t/m2) cargo loads are often assumed. The CSR sections referred to above contain a methodology to assess scantlings for steel coil loads. However, these scantlings are based on the assumption, in the case of loading steel coils, that the hold is loaded with coils of the same size and weight. These cargo loads as well as the wave loads contribute to the global bending, torsion and shear that the hull girder needs to withstand. The loading conditions will be in the ship's loading manual or computer, but these conditions are likely to reflect uniform loading of a similar sized and shaped cargo. In loading mixed steel of various sizes and shapes, particularly coils, is common. In which case, care is needed to avoid overloading the tank top.

Stowage

Coils are usually stowed athwartships and locked with one or more key coils. When carried more than one row high, the weight of top coils passes down to the ship's structure through the points where the coils touch. We assume that all the weight is passed vertically down to adjacent coils, when in fact, there is a tendency for key coils to push adjacent coils apart, creating a small horizontal force (see Figure 9). This horizontal force is resisted by the hold side or lower hopper and friction between the coils, dunnage and cargo hold. The vertical force is resisted by the tank top and double bottom. Double bottom structures are specially designed to withstand cargo load. Their plating and secondary stiffeners carry load to the primary structure. They are a grillage structure consisting of a longitudinal and transverse structure, with solid floors and transverse webs in lower hoppers.

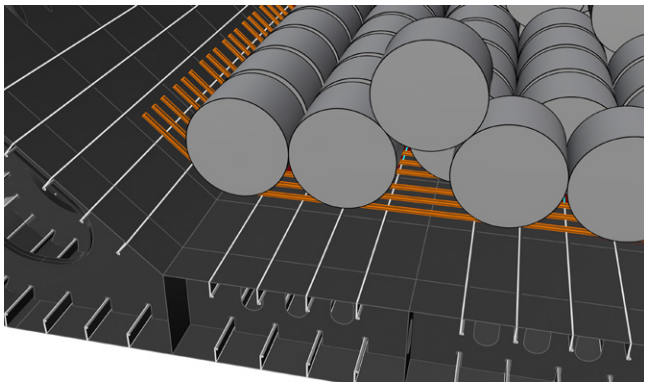


Figure 8: Double bottom structure and steel loading

Friction between coils is negligible. When calculating the vertical force, it is assumed that force is transferred perpendicular to a coil's surface along a line drawn centre to centre (see Figure 9).

Using this assumption, support forces in an arbitrary stack of coils can be calculated. Figure 10 shows two examples of a single coil supported by two coils on the bottom tier. On the left, the coils on the bottom have the same diameter and, hence, the weight of the top coil is shared equally between them. However, on the right, the majority of the weight of the top coil is supported by the smaller coil on the bottom tier, resulting in increased load passed to the inner bottom.

This approach can be followed to determine the loads on the inner bottom for irregular coil stacks, an example of which is visible in Figure 11.

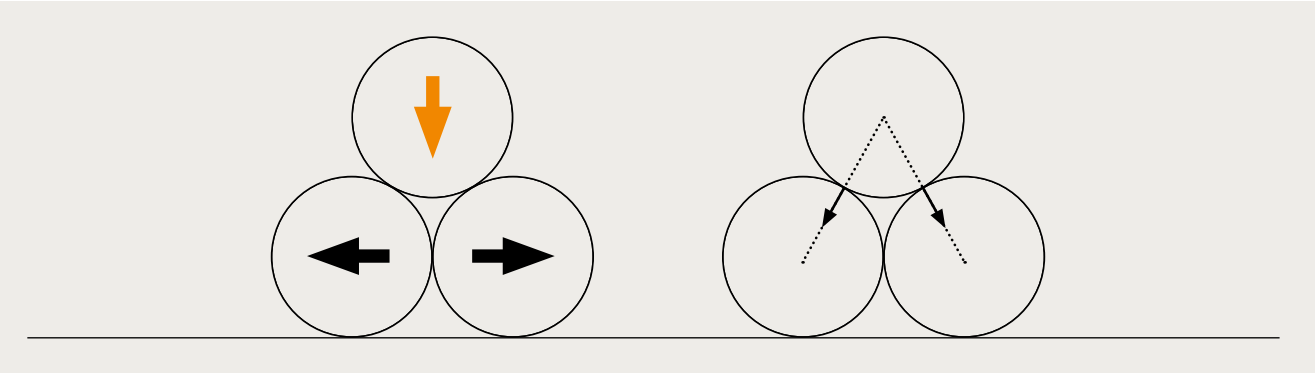


Figure 9: Supporting coils pushed out by top coil (left) and direction of force transfer (right)

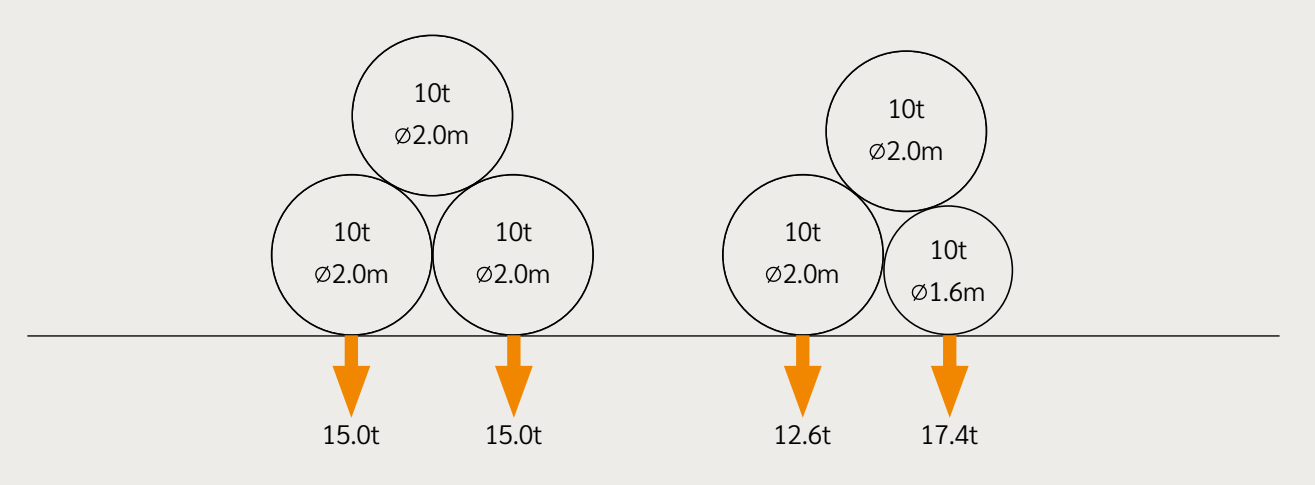


Figure 10: Example of weight transfer

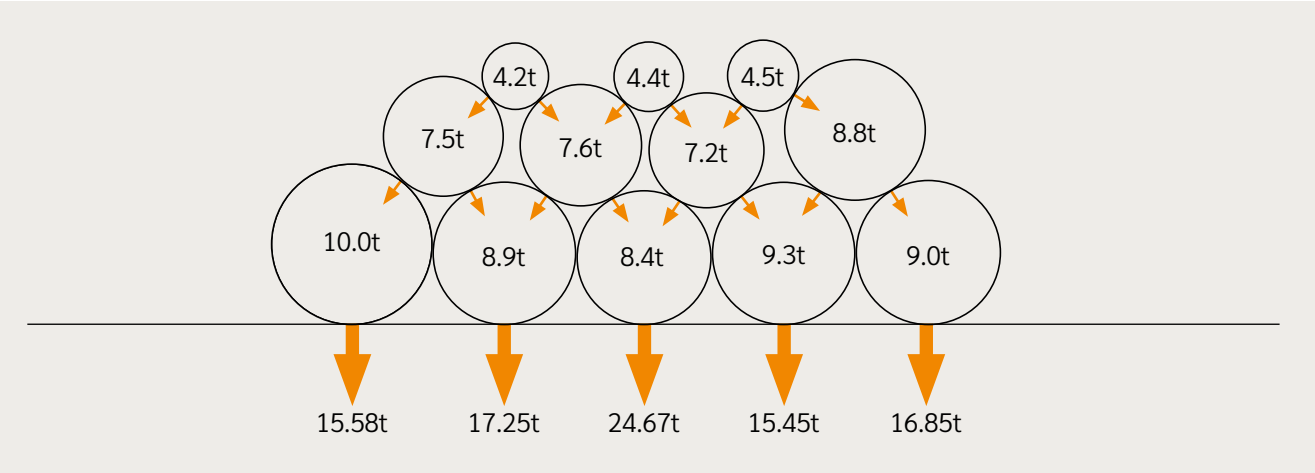


Figure 11: Load distribution in irregular coil stack

Inner bottom and hopper strength

The effects of the steel coil loading and the potential for point loading, compared to a homogeneous loading, can be visualised by finite element analysis.

If we consider single tier coil loading with two key coils per row, as shown in the diagram on the right, there are two possible loading distributions:

1. Loading as weight spread equally over the inner bottom such that a homogeneous pressure load is generated, as shown in Figure 12a.
2. Loading as weight spread unevenly over the inner bottom, such that there are point loads, as shown in Figure 12b.

In practice, actual loading is localised rather than homogeneous and, as such, uneven loading on the inner bottom is common.

In this example, the coils are placed on three pieces of approximately 6in by 1in dunnage, spread evenly. The resulting stresses in the ship's inner bottom are shown in the finite element analysis (right), with the bottom right diagram illustrating the stress from point loading associated with uneven cargo distribution.

A ship's inner bottom is designed for homogeneous loading and, for this reason, the avoidance of point loading is imperative. Dunnage is inserted between the steel cargo and the ship's hold structure. The dunnage protects the cargo during stowage and transport from damage, as well as providing support and friction between the cargo's load and the ship's hull. Increasing the number, width and thickness of dunnage will increase the spread of loading. However, the actual load distribution effect will be limited and an evenly distributed load is never achieved. Consequently, using the correct type and size of dunnage to reduce the risk of point loading cannot be over emphasized. Point loading is reduced by using dunnage thicker than 1in– thicker dunnage increases the load spread (see Figure 13 overleaf).

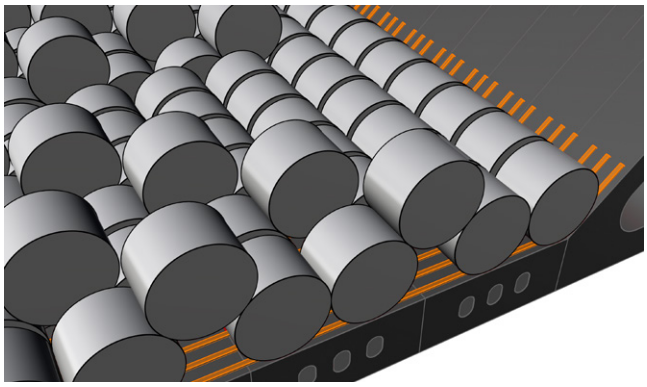


Figure 12: Steel coil loading condition

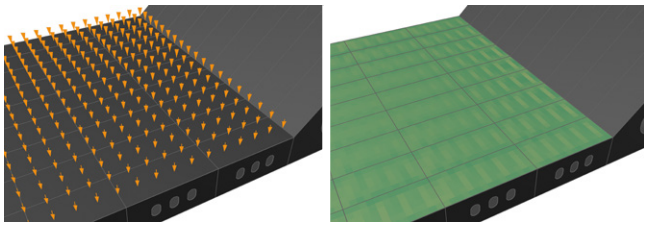


Figure 12a: Finite element analysis (homogeneous load)

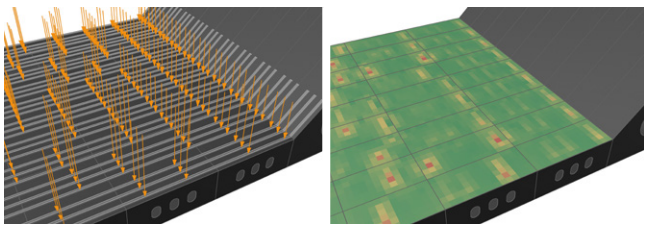


Figure 12b: Finite element analysis (point load)

The analysis above shows that assessing forces from a steel coil stow by assuming equivalent uniform loading is not advisable, as in reality, the loads are very concentrated, leading to higher stresses in the double bottom than would be expected. The CSR rules can be used for guidance during ship design for specific steel coil loading conditions. However, many of the ships used in the steel trade that carry coils have limited steel coil loading conditions in their loading manual. Calculation of conditions that reflect actual loading is essential to maintain the required level of safety.

To perform these calculations, the following need to be considered:

- coil size, shape and weight
- coil length and diameter
- spacing between coils and the position of key coils
- number of tiers being loaded
- loading position
- dunnage.

Specialist software is available for detailed assessment of hold loading. For example, Lloyd's Register's Steel Coil Tool 'LR CoilMatch' can be used in conjunction with the ship's loading instrument to accurately calculate hold loading and ensure that stowage is safe and within strength limitations. This software can be used to both verify loading during cargo planning and when the ship is alongside actually loading.

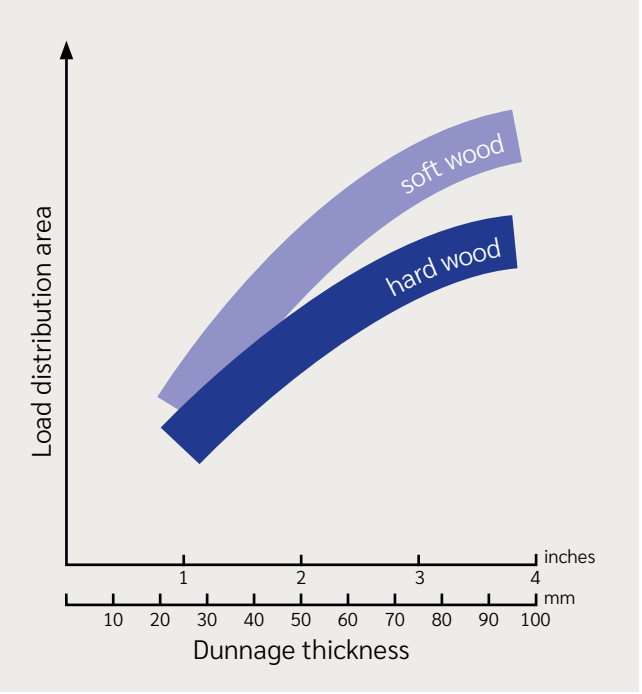


Figure 13: Effect of dunnage thickness on load spreading

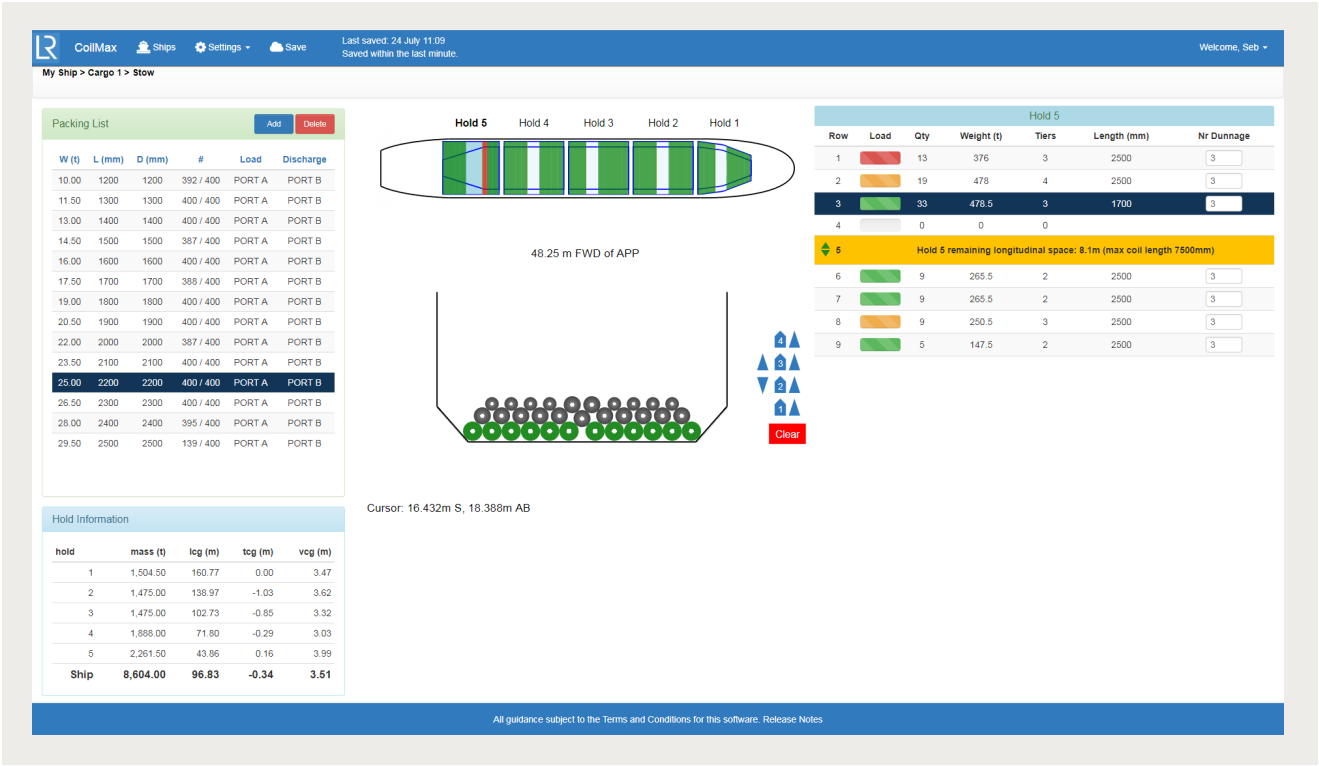


Figure 14: Screenshot provided by Lloyd's Register

07. Principles of stowage

Steel is shipped in a variety of shapes, sizes and weights. Consequently, it is difficult to stow in classic block stowage. Careful preparation of the hold is essential.

When loaded in a ship's hold, steel is placed on dunnage. Dunnage is placed between successive tiers of cargo and the side shell or lower hopper. Dunnage has two functions. To spread the steel's load uniformly in relation to the ship's structure and to provide frictional resistance. Insufficient or incorrectly applied dunnage can result in high point loads on the ship's tank top, possibly deforming it. It is important to use dunnage of the correct thickness, see Figure 13, page 19. When possible, lay dunnage on strong points. In Europe, dunnage is available in a mixture of imperial and metric sizes, with 8in by 1in planks used with steel coils, 60mm by 80mm planks used with steel plate and bars, and 6in by 4in planks used with heavy steel. Elsewhere in the world, dimensions are similarly either imperial or metric.

Steel is generally loaded in the fore and aft direction, with part cargoes loaded forward from aft. When loading coils, wedges are used below the coils, placed longways side down on the coils' in-board side. They locate a coil as it is stowed and prevent in-board athwartships movement. A key coil will always be used to lock a row of coils, with the key coil in subsequent rows placed in a different position. Key coils take up any gap that may occur between coils during ship movement.

Wedges are always placed on dunnage and never directly on the tank top.

Coils are stowed in rows or tiers. During loading, they are generally placed in the hatch square before stacking with a forklift. As each successive row or tier is completed, the coils are lashed before the next row or tier is loaded. A small gap is left between each successive row. The hold area used for landing coils and the stowage location have to be free from debris and/or raised objects. Landing a coil on a bulldog grip, ring bolt or shackle will cause considerable damage to the coil.

When lifting coils with a forklift, only forklifts with a coil-friendly tine, ie those fitted with a single central lifting arm, should be used. Even with this lifting arrangement, coils can be damaged.

A forklift carrying a large heavy coil will put a significant load on the tank top, so check and make sure the tank top strength is not exceeded. A forklift capable of lifting a 20-tonne coil will itself weigh much more than 20 tonnes.

Steel is lashed using wires, chains and steel bands. Pneumatically tightened steel bands are preferred for coils. When using wire lashings, suitable chafing pieces should be inserted between the lashing and the steel's edge. Insert dunnage between the lashing and the steel's sharp edges. Standing faces of coils are lashed (banded) back to the second row.

To allow access for lashing, coils are usually stowed with a 20cm to 30cm gap between rows and/or a transverse bulkhead.

The lashing procedure for coils involves securing the top coil to the coil immediately below, rather than securing the entire stow to the ship. By this method, the top coils act as a cap holding the remainder in place.

Profiles and plates are secured by a variety of methods, with the objective of preventing initial movement. With the exception of coils, lashings that do not ultimately connect to the ship's structure will be of little value. When assessing the value of lashings, it is necessary to consider how the cargo has been stowed, the potential for movement and how movement is prevented. Frictional resistance is the principal means by which movement is suppressed.

During loading, the ship's cargo officers must maintain a diligent watch and record cargo activities during the watch. Good records can prevent and reduce certain claims, and support any clauses made in the mate's receipts and bills of lading.

The watch officer should report to the master and note in the cargo record book:

- any cargo damage or broken bands on packaged cargo
- any stevedore damage to the ship
- the cargo condition
- departures from the stowage plan
- size and type of dunnage and how it was laid
- instructions given to stevedores and/or lashing gangs
- times when hatches were opened or closed
- stoppages due to weather
- movement of forklifts and other loading equipment in and out of the hold.

Photographs of cargo should always be taken.

Ports that specialise in steel have skilled stevedores and specialist equipment for stowage and securing. Greater vigilance is needed if loading or discharging in non-specialist ports.

Round products – coils

When coils are loaded horizontally in athwartship rows, locking the tier is essential. This is done by placing a coil to force those beneath it into a tighter stow. This coil is known as a key or locking coil. A key coil is most effective when placed at the centre of a row. However, it is important to avoid a continuous line of weight on the ship's tank top and, consequently, key coils placed in subsequent rows are staggered. Great care needs to be exercised when placing key coils. Figures 15 and 16 demonstrate how key coils should be placed.

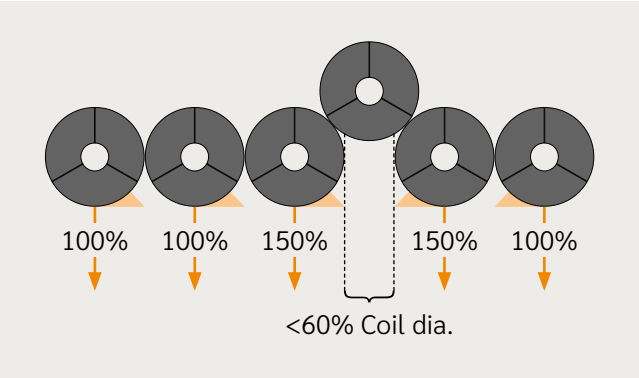


Figure 15: Single-tier key coil. 150% means 1.5 times the coil's weight

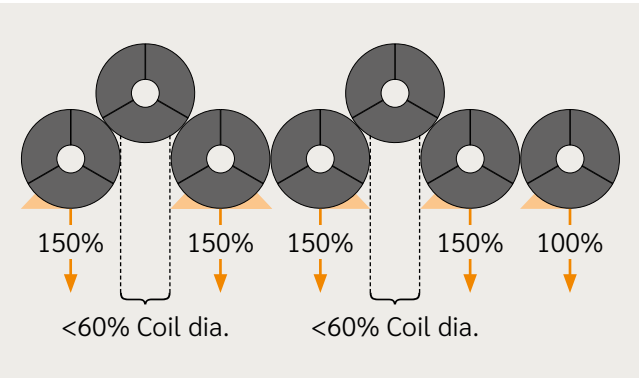


Figure 16: Single-tier two-key coils

Figure 17: Coils correctly stowed with dunnage, wedges and a key coil

Figure 18: Coils tightly stowed with centre line key coils and multiple key coils fore and aft

Key coils are placed so that the coil's bottom edge is one-third of its diameter below the top of the coil(s) being locked. This corresponds to the gap between the coils being locked of about half the key coil's diameter. However, if the gap is greater than 60% of the key coil's diameter, then the key coil could be damaged or crushed. In which case, the stowage will need to be altered by repositioning coils and placing timber between the ship's side and first coil – as shown in Figure 19. Although it is not considered good practice, two key coils can be fitted, provided they are kept separated and their weight does not fall on a coil common to both key coils.

When a key coil is placed above different-sized coils, as in Figure 20, the smaller coil takes the most weight. Care is necessary to avoid crush damage to the smaller coil.

Except when strength calculations restrict loading, steel coils should be loaded in a minimum of two tiers or layers.

Stevedores may attempt pyramid loading, a method that should be avoided, because excessive weight can be transferred to the ship's tank top and because it is difficult to lash pyramid coils.

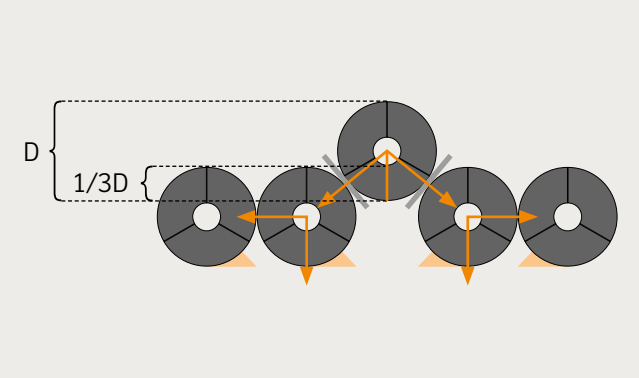


Figure 19: Single-tier one-key coil with supporting dunnage used when the key coil's gap is greater than 60% of the coil's diameter

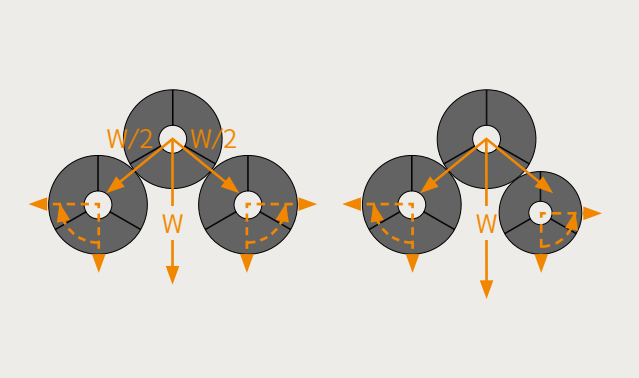


Figure 20: Single-tier one-key coil with different-sized coils. When different-sized coils are loaded and keyed together, the majority of the weight is on the smaller coil

Figure21: This key coil appears to exceed the 60% rule.

Figure 22 shows how 2.5 times the centre coil's weight is passed to the tank top in pyramid loading. In non-pyramid loading, only twice the coil's weight is passed to the tank top.

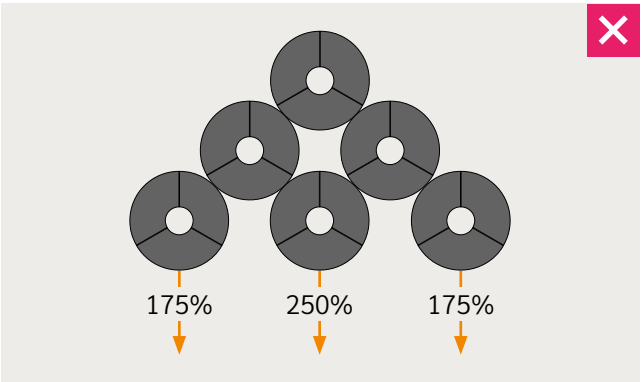


Figure 22: Pyramid loading – incorrect

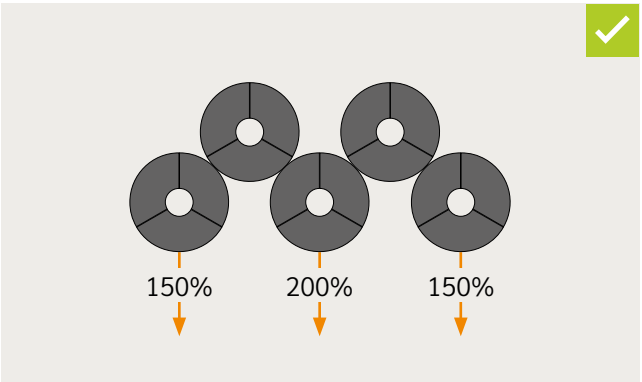


Figure 23: Pyramid loading – correct

When coils are loaded against the ship's shell, the cumulative weight of the stack will exert a 'pushing' force (L) when the ship heels, lists or rolls (see Figure 24 as an example for a box-shaped hold).

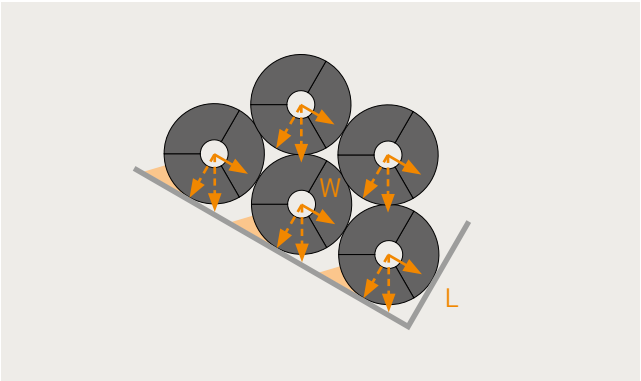


Figure 24: Weight from cargo can be transferred to the ship's shell

Figure 25: Cold rolled steel coil (CRSC) damage

Figure 26: Coiled wire rod correctly stowed in a square hold

When carrying these coils in conventional bulk carriers, the sloping angle, strength and load-bearing capacity of the hopper tank plates will need to be considered. As such, it is recommended that the dynamic stress conditions are checked against the allowable side shell strength in the ship's loading manual and/or computer.

Side dunnage can be used to protect the side shell or lower hopper and to reduce point loads.

A 50% rule can be applied when calculating weight passed down through a stow of similar-sized coils to the tank top. This process is demonstrated in Figure 27 below. It also shows why pyramid loading can give rise to excessive force on the ship's tank top.

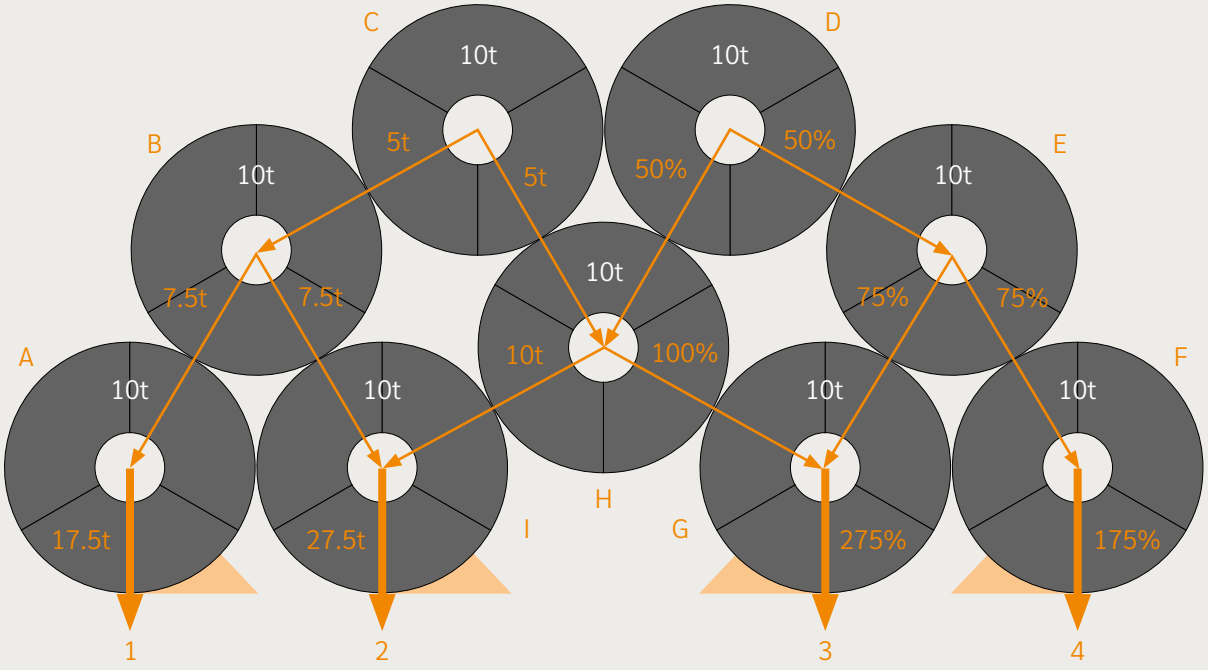
Small coils can be loaded vertically in tight block stowage, with each coil on top of another, but placed and secured on a strong pallet. This method of stowage does not require a key coil.

When carrying coils loaded vertically, extreme care is required to reduce the risk of cargo movement. To minimise gaps between coils, pallets need to touch. However, gaps will be present between the coils and scattered throughout the stowage. It is necessary to remove these gaps by hammering softwood wedges into them. There may also be standing faces/gaps at the end of the stowage, because the coils do not reach the ship's side or because the stowage is stepped. Use strong wooden shoring or dunnage bags to secure these gaps or anywhere that there is a risk of movement.

Imperfect and damaged coils

Damaged coils being returned to a steel mill are shipped as steel cargo rather than as scrap. Special care is necessary when loading and stowing them. Badly damaged coils should be stowed in the second or top tier and independently lashed or shored. Do not load cargo on top. Extra securing and additional chocking may be required to secure the stowage.

Damaged coils carried as cargo should have the damage accurately described on bills of lading and mates' receipts.



Point 1: **C**= 10tons transfers 5tons, **B** = 10tons + 5tons from **C** = 15tons and transfers 7.5 tons to **A**, **A** = 10tons + 7.5tons – **Point 1 = 17.5tons**

Point 2: **C**= 10tons transfers 5tons, **B** = 10tons + 5tons from **C** = 15tons and transfers 7.5tons to **I**, **C + D** transfers 5tons each to **H**, **H** = 10tons + transfer 10tons = 20tons, **H** transfers 10tons to **I**, **I** = 10tons + transfers 17.5tons – **Point 2 = 27.5 tons**

Point 3: **C** + **D** transfers 50% each to **H**, **H** = 200% and transfers 100% to **G**, **D** transfers 50% to **E**, **E** = 150% and transfers 75% to **G**, **G** = 100% + transfers 175% – **Point 3 = 275%**

Point 4: **D** transfers 50% to **E**, **E** = 100% + 50% = 150% and transfers 75% to **F**, **F** = 100% + 75% - **Point 4 = 175%**

Figure 27: 50% of the weight of a coil in an upper tier is assumed to pass to the coils below and to the tank top

Coiled wire rod

Coils of wire rod are stowed in a tight block stow, with their cores fore and aft on plywood sheets placed on wide dunnage. Direct contact between the coils and the ship's tank top should be avoided. Wire coils are wedged to avoid movement. Standing faces should be avoided, but if this is not possible, lash the coils back to a bulkhead by passing a wire through their core.

Care should be taken when lashing with chain because chain can damage steel. Damage can be prevented by placing dunnage at the point where the chain contacts the steel.

After loading, wire coils will settle and mesh together, and no further lashing is necessary, except for those coils that are not held in a block stow.

When cargo is locked together, care is needed during discharge to avoid damage. Inform stevedores at the discharge port of this requirement.

Flat products – plates and slabs

Steel plates are generally stowed with their longest axis fore and aft, on dunnage laid athwartships. Cargo is loaded from the hold's side to its centre. Dunnage is placed between adjacent plates to provide frictional resistance because the coefficient of friction between two flat steel plates is effectively zero.

Long plate is susceptible to waviness. Sufficient rows of 60mm by 80mm dunnage, placed vertically in line, are needed to prevent distortion. The higher or heavier the stow, the greater the number of pieces of dunnage required to support the plate and prevent buckling. In addition, dunnage has to be sufficiently thick to facilitate cargo handling and lashing.

Gaps between parcels of steel plate have to be chocked with strong timber. Any wooden structure built to support steel has to be self- supporting; otherwise, the structure could collapse if the cargo moves.

Figure 28: Steel plate is stowed fore and aft on arthwartship laid dunnage in a square-sided hold.

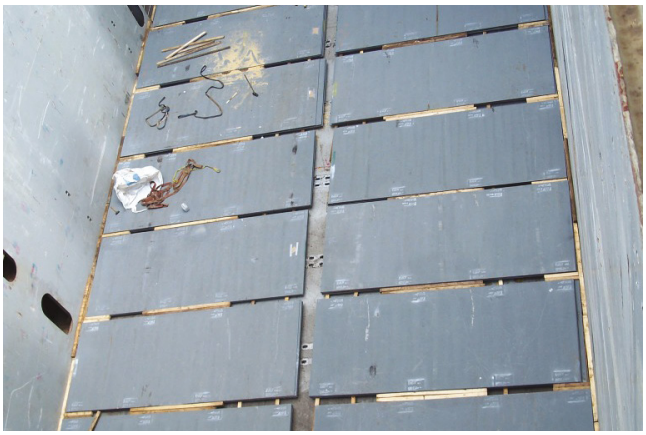


Figure 29: Plate on athwartships dunnage

Figure 30: At sea, when conditions allow, check 'chocking and tomming'. Remember that cargo holds should only be entered after following your company's cargo space entry procedures and only when sea conditions allow working on deck

California block stowage

This method of stowage has been in use for a number of years and is often requested when the cargo is destined for ports in California. It is popular and attractive to charterers because it significantly reduces the stevedoring costs, dunnage requirements and the time that it takes to load and discharge the cargo. However, a shift in the stow could potentially cause severe damage to the cargo and/or the vessel and could also cause significant problems with the vessel's stability.

As this method relies on frictional resistance, it can be used only for semi-finished slabs, i.e. steel with a very rough surface. When loaded, the slabs do not follow the hold's shape but are stacked flat in a vertical stow, one on top of the other, interspaced with dunnage. It is extremely important to keep the stack vertical. Dunnage is used at the sides and between columns to facilitate stacking. Typically, the slabs are loaded eight high, with the top three slabs lashed together to form a cap, which secures the top plates. There are no lashings to the ship's structure. It is normal to load the wings of a hold first, with slabs placed in the fore and aft direction. However, if the holds have deep wings, then stowage may remain in the hatch square.

Mariners have learned by experience that a tight stow, without spaces, is a stow that is unlikely to shift and a stow that is safe. So they are extremely sceptical about the California Steel Industry (CSI) method for stowage of semi-finished steel slabs, because the slabs are stowed vertically, without interlocking plates, without restraint to the ship's structure and with gaps between the ship's side and the cargo.

Given the concerns regarding the safety of the method, the cost saving argument does not appear to be a good enough reason to put the cargo, vessel, and crew at risk. As such, it is recommended to avoid usage of this method of stowage as far as practicable.

Long products – bars, profiles, angles, channels, beams and girders

Steel profiles should be loaded 'winged out' and stowed so that the ship's side provides support. When this is not possible, tightly stow the profiles and secure them with chains or wires leading to the ship's structure. Unlike coils, profiles should not be lashed to themselves but lashed to the ship's structure. During stowage, profiles can be interlocked with each other.

At times, long products are secured together with banding in an 'Olympic' style of lashing, with wires and bottle screws designed to lock the top tiers and prevent longitudinal movement. The bands are applied as the stow progresses and cargo is bundled together and interconnected.

Lay dunnage athwartships, not only to spread the load but to provide a friction pad and to aid drainage of any moisture.

Pipes

Loose pipes are generally stowed fore and aft, in a box-shaped hold, laid on dunnage placed athwartships and loaded from aft. If stowed in an irregular-shaped hold, such as No. 1 hold, 'square off' with wooden shoring before loading begins. Use wedges on the first tier of pipes. This helps with alignment and is safe.

Smaller pipes are loaded in bundles. Pieces of timber can be included within the bundles, placed horizontally between the pipes. Even though the pipes are separated by timber, the normal amount of dunnage should be applied and the usual care should be taken to lay dunnage on the tank top and to place dunnage between successive tiers of cargo.

When long pipes are stowed athwartships and their ends are adjacent to the side shell, dunnage should be placed vertically between the steel and the shell. This will stop steel that shifts from piercing the hull.

Additional securing and/or chocking should be applied when loading in the fore part of the ship.

Figure 31: First tier of nested I-beams stowed in the hatch square. Tightly stowed I-beams are secured with chains to deck fittings

Figure 32: Bundles of coated pipes are stowed with vertical chocking

08. Principles of securing

Steel is prevented from shifting by friction between the steel and dunnage. Lashings prevent initial movement.

Figure 33: Steel bands are pneumatically tightened

A variety of methods are used to secure steel. Here is some general guidance:

- Always consult the ship's cargo securing manual before applying lashings.
- Lashings are not designed for the most violent storms encountered at sea.
- The purpose of lashing cargo is to prevent initial movement. The majority of restraint comes from frictional resistance between the steel and dunnage.
- Smooth-surfaced steel and wet steel have almost no frictional resistance.
- It is only slabs stowed using the method known as California block stowage or steel coils that are secured to themselves; otherwise lashings should be secured to the ship's structure.
- Long products and plate may be intermediately lashed to themselves in order to bundle the steel together and produce a tighter stow.
- Lashings placed across the top of the stow are of no value. Lashings around a stow serve only to hold the steel in a block.
- Loosely fitted lashings serve no useful purpose.
- Steel wires and chain can cause damage if applied directly and if they touch the steel being lashed.
- Insert dunnage between steel and the lashings to increase friction and to prevent damage.

The disadvantage of lashing with wire and steel bands is that they cannot subsequently be tightened to compensate for dunnage compression, shrinkage or movement. However, this risk is minimised when bands are tightened pneumatically.

Friction

Friction is important as it prevents cargo movement during ship rolling. The table below shows the coefficient of friction for smooth plate. It is interesting to note that wet steel-to- steel surfaces are considered to have no friction at all.

Steel with a rough finish will have a higher value than the materials listed below.

Friction coefficient table for smooth plate

Materials in contact	Friction coefficient
Timber to timber wet or dry	0.4
Steel to timber or steel to rubber	0.4
Steel to steel, dry	0.1
Steel to steel, wet	0.0

Water or oil reduces friction. Slippery decks will contribute to cargo sliding, so it is important to keep decks clean and free from oil. Any leaks from winches, hatch motors and piping should be repaired. Check cargo for leaking oil and, wherever possible, deal with this as well.

The actual coefficient of friction is normally expressed as the angle of inclination from the horizontal at which movement between the two surfaces first occurs without application of external force, rather than the figure given in the table. The values shown in the table are valid for the static friction. In case of lashings, where the cargo may move little before the elongation of the lashings provides the desired restraint force, the dynamic friction applies, which is to be taken as 75% of the static friction.

Assuming that the coefficient of friction of dry steel-to-steel surfaces is 0.1, a static test shows the corresponding slippage angle is approximately 6°. In other words, when loose dry steel is stowed with metal-to-metal contact, without dunnage or lashing, it will shift when inclined to an angle of 6°. This angle is easily reached during ship motion. When steel is placed on dunnage, the same static test shows the angle is increased to 21° . Therefore, lots of dry dunnage should be used to avoid shifting. At sea, dynamic forces are present and the angle at which cargo can shift could be much lower.

These examples also ignore acceleration forces induced during ship rolling.

Figure35: Softwood dunnage

Figure 36: Hardwood dunnage

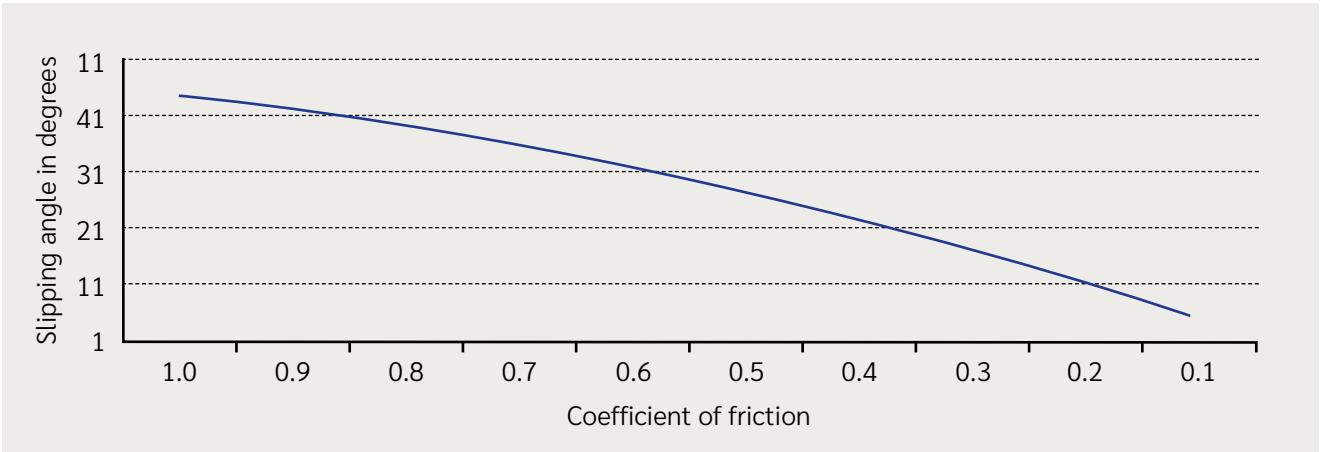


Figure 34: Graph to show the angle required for slippage at different coefficients of friction

09. Cargo officer's duties during steel cargo loading/discharge

A diligent cargo watch is important for the prevention of cargo damage and shortage claims, and structural damage to the ship.

Watch officers should ensure that:

- the hold is ready to receive cargo and stevedores understand the loading plan
- stevedores are using the right equipment so as not to damage cargo. Steel wire slings or chains when used incorrectly can damage bundles of pipes, plates or steel coils. Steel lifting rods, for example, are often used for safe lifting of heavy steel coils
- stevedores are not handling cargo roughly or stowing it badly and that dunnage of the correct type and size is applied correctly. A significant proportion of steel cargo damage can be attributed to the manner in which stevedores handle and stow cargo
- forklifts do not overload the tank top and are fitted with proper lifting or protective tines. Steel coils are frequently damaged by forklift tines

Figure 37: Forklift tines

- all damage to finished steel cargo is noted and presented by the master to the shipper's or receiver's agents, as quickly as possible. If the P&I club steel surveyor is attending, pass details of the damage to him as well
- assistance is provided to the appointed steel surveyor during a preloading survey and the survey is carried out in a diligent manner, with discrepancies reported to the master
- lashing and stowage are carried out as per the cargo plan. It is vitally important for the safe carriage of cargo and for ship safety that steel is loaded in the proper manner. If it is not, it should be reported to the master and owner/charterer immediately
- a log is kept of all activities, including:
  - details of any cargo damage
  - where and how the cargo was stored in the port and on the quay, ie was it stored raised from the ground on dunnage and protected from rain?
  - how cargo arrived at the berth. Did it arrive by rail/truck/ directly from the warehouse or was it shifted by a forklift truck?
  - weather: was it raining during loading/discharge? Was the steel wet?
  - whether stevedores were using the correct lifting equipment so as not to damage the cargo
  - whether stevedores used the dunnage correctly
  - the times when hatches were opened and closed, and the times of cargo operations
  - the condition of the cargo (take photographs).

10. Ship husbandry and steel cargo

Stability

The ship's stability will need to be calculated for the proposed loading to make sure the GM is acceptable.

Large quantities of steel stowed in the bottom of a hold will cause the ship's centre of gravity (KG) to reduce considerably, resulting in a high GM. This can make the ship 'stiff' and cause violent rolling in bad weather, something that can cause cargo to shift. If loading does result in an unacceptably high GM, and this cannot be corrected by ballast or moving weights, then an alternative stowage arrangement will be necessary.

Follow weather routing and as far as practicable try to avoid swell conditions, as these can cause heavy rolling and wavelengths equal to half the ship's length, which in turn can initiate parametric rolling in slender ships during pitching in head seas.

Corrosion and relative humidity

Atmospheric corrosion of steel starts when the relative humidity (RH) of air reaches 40%. The corrosion rate increases slowly until the RH reaches 60% and, thereafter, it increases rapidly. Other elements will cause corrosion such as salt, funnel gases, dust or other oxidising agents. These need to be removed from the hold by cleaning before loading. Dust can be hygroscopic, trapping moisture and making corrosion worse.

To prevent atmospheric-induced corrosion, it is essential for holds to be dry and hold air to have an RH below 40%. Other forms of corrosion can be prevented by thorough hold cleaning, freshwater washing and drying.

Any source of water such as wet dunnage, or water on the tank top or in bilges, must be removed prior to closing and securing hatch covers. When at sea, carefully monitor hold humidity and ventilate when the conditions dictate. In certain conditions, dehumidifying is essential to prevent sweat. Moisture may be present in other cargo loaded in the hold. In which case, care is needed to make sure steel is not loaded adjacent to hygroscopic cargo and, if such loading is unavoidable, additional attention should be paid to the hold's relative humidity and ventilation.

It is the ship's responsibility to ventilate properly or to dehumidify hold air. If steel is damaged by atmospheric corrosion, the receivers will claim damages. Making sure that cargo holds are clean and dry, and correctly following the ventilation procedure may not be sufficient to avoid atmospheric corrosion. Dehumidifying hold air will therefore also be necessary.

If loading in wet humid conditions cannot be avoided, avoid stowing wet steel adjacent to, or in the same compartment as, dry steel. Endorse the bills as 'wet before shipment'.

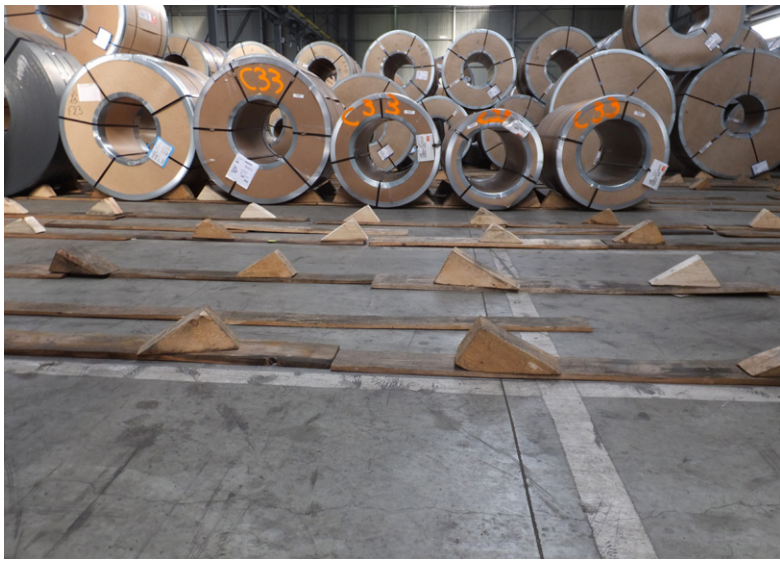


Figure 38: Coils prior to stowage correctly wedged

Hatch covers

Hatches leak for a variety of reasons, but mainly because of poor maintenance or failure to close them properly. Hatch covers are designed to a weathertight rather than to a watertight standard. This means water that passes the sealing gasket should not enter the hold. Drainage channels are arranged to prevent water from entering the hold by allowing it to drain away.

Steel is easily damaged if it comes into contact with salt water.

Prior to loading steel, close and seal hatch covers and test them for weathertightness.

Figure 39: Steel loading - work safely, wear personal protective equipment (PPE) and high visibility clothing

In addition, regularly check:

- sealing gaskets for physical damage, detachment or chafing
- quick acting cleats for the correct tension
- drainage channels for cleanliness, rust or other debris
- cross-joint wedges for damage and/or deficiency
- main securing cleats for damage
- hatch alignment and that metal-to- metal contact provides the correct gasket pressure
- hatch corner non-return valves for damage or deficiency
- hatch locating or pressure points for wear
- compression bars for damage.

Include hatch covers in the ship's system for planned maintenance and complete repairs if any of the above are found damaged or deficient.

In exposed locations, hatch covers can be further sealed by placing expanding foam in cross-joints and along the hatch skirt. Cross-joints can also be protected with bitumen- based tape.

The club's survey programme has shown that the principal cause of hatch cover leakage is poor panel alignment and, consequently, incorrect pressure on sealing gaskets. This usually occurs because of wear on metal-to-metal contact surfaces.

See the club's publication *A Master's Guide to Hatch Cover Maintenance*, which is available on the club's website.

11. Safety when working with steel

Steel is dangerous, and care is needed when working with or near steel.

Never:

- enter a cargo hold unaccompanied or without support
- enter a cargo hold without means to test the hold atmosphere for oxygen
- stand in the fall or swing zone of lifted steel
- enter a dark hold to examine steel without adequate lighting
- enter a cargo hold in bad weather
- tighten wire lashings to the wire's breaking point
- climb between stowed steel, especially steel coils
- walk on or between wet steel
- walk in the path of a coil that is not wedged – it could move

Always:

- respect the hazards associated with steel. Work safely and use proper walkways/safe means of access
- point out loose or poorly stowed steel to stevedores before they begin work
- stand well back and away from fall or swing zones while steel is being moved
- wear personal protective equipment
- wear high-visibility clothing

12. Appendix: Case study 1 – Damaged cargo and clean bills of lading

This case study is based on a claim presented by cargo insurers.

The cargo

A cargo of steel products was loaded for the Arabian Gulf. The cargo consisted of 600 bundles of black steel pipe and 2,000 steel coils.

The steel was delivered to the port by road and rail, and stored in a covered warehouse. When delivered to the ship, the steel was placed on open trailers.

Dunnage was placed between successive tiers of pipe and between the pipe and the ship's side. The coils were moved by forklift trucks, slung with wire ribbon slings and positioned in the ship's hold with a forklift. Dunnage was laid on the ship's tank top. It rained during loading and the cargo on the quay became wet. During prolonged periods of rain, exposed cargo on the quay and in trailers was covered with tarpaulins. However, wet cargo was eventually loaded with dry cargo.

The coils were surface rusted and bound with steel binding, some of which was bent, broken, rusted or missing. Some of the pipes were scratched.

The preloading survey

The P&I club arranged a preloading survey and instructed a surveyor to examine the steel for damage before loading and to assist the master with clausing the mate's receipts and bills of lading. During the survey, the surveyor also completed:

- a silver nitrate test in the ship's holds, which did not find evidence of chlorides
- a visual examination of the ship's hatch covers, coamings, compression bars, gaskets, drainage channels and cleats, and found them in good order
- a visual examination of access hatches and ventilation pipes, and found them in good order.

At the end of the survey, the surveyor issued a report and recommended that bills were endorsed with details of the damaged cargo and that loading had occurred during rain and that the steel was wet on shipment.

Figure 40: Steel coils arrive at the berth

Figure 41: Steel pipes arrive at the berth

Figure 42: Coils are loaded with ribbon slings

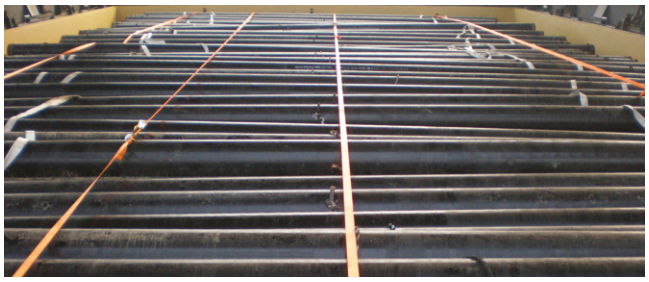


Figure 43: Pipes secured in the hold, but lashings are of little value

Figure 44: Pipes loaded on top of steel coils

Figure 45: Coils wedged in position

Figure 46: Coils being stowed by a forklift fitted with a single round tine

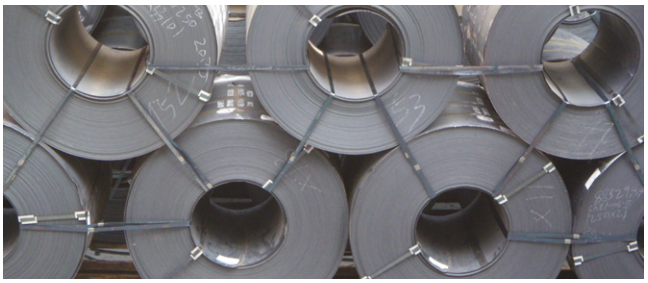


Figure 47: Coils stowed and lashed together with steel bands

Figure 48: Coils dropped straight into the hatch square. Note use of wire ribbon slings

Clauses and endorsements – wording for the bills of lading

Details of the damaged cargo needed to be endorsed on the mate's receipts/bills of lading and the surveyor attending for the club's preloading survey suggested that the master incorporate the following wording:

- 10% of the pipes nicked, dented and scored along the body of the pipe. A small number, less than 2%, end caps missing. All steel strapping bands showing signs of rust in varying degrees. About 2% of strapping bands missing, loose or adrift. Pipes pre-assembled in open hold square were wetted prior to loading
- 8% of coils showing signs of surface rust to varying degrees and extent. Approximately 10% of the coils' steel bands and wire ties were surface rusted, with 5% broken. 20% of the steel coils (no markings available) arrived on the quayside in the rain and were wet prior to loading.

The standard recommendations and wording for the clauses that accurately describe the damage and the damaged article (see page 15) were not used.

The master authorised the charterer's agent to sign bills on his behalf subject to:

- all bills of lading signed by the charterer's agents conformed with the quantities and description of the cargo actually loaded on board the vessel at this loading port and during her present call only
- all remarks endorsed on the mate's receipts must be endorsed in full on the bills of lading issued at this or any other transport bill of lading.

The master further made clear that the letter of authorisation was intended to complement the charterparty and must be applied in conjunction with the relevant provisions contained therein and that bills of lading signed by the charterer's agents without the above conditions being fulfilled would be considered to have been signed without the authority to do so.

The master further requested the charterer's agent to sign for receipt of the letter of authorisation and acknowledgement of its contents.

Bills of lading and endorsements

Bills of lading were issued clean by the charterer's agent even though the authority to sign bills granted by the master was subject to the bills being correctly endorsed with details of the cargo. The charterer's agent simply did not include the surveyor's remarks on the bills. The ship had sailed and the master was unaware that clean bills had been issued.

It is normal practice for the master to allow agents to sign and issue the bills of lading on his behalf, but more often than not, the appointed agent is the charterer's agent rather than the shipowner's agent. Consequently, the agent is inclined to act in the interest of the charterer rather than the shipowner. Bills are normally issued after the ship has sailed. When authority has been given to the charterer's agent to sign the bills, there is very little a ship's master can subsequently do to check that the cargo's description in the bills accurately reflects its condition.

The charterers came under commercial pressure from the shippers to issue clean bills, because of the terms of the letters of credit. However, this was not in the interests of the shipowner, because clean bills issued for damaged cargo render the shipowner liable for any cargo damage regardless of whether the damage occurred before or after loading. Issuing clean bills for damaged cargo may be a fraud against the receivers, which can invalidate P&I cover.

Letters of indemnity – LOIs

In commercial reality, the charterparty often contains an LOI clause – depending upon the type of charter. The shippers require clean bills for their sales contracts or letters of credit, and so there is considerable commercial pressure to have clean bills issued. In return for the issuance of a clean bill, a letter of indemnity is offered or agreed. On the face of it, the letter appears to indemnify the owner (or charterer) against the possible consequences of issuing a clean bill for damaged cargo. However, there are a number of pitfalls with this approach:

- issuing a bill of lading that does not reflect the true condition of the cargo is a crime in some countries as it could be construed as an act to defraud the receiver
- such a letter of indemnity is almost always legally unenforceable. Therefore, the value of the LOI is very much dependent upon the probity and reputation of the entity giving the LOI. For example, in a long-term charter, it would be reasonable to assume that the LOI given by the charterer may be honoured. In a contract of carriage or short voyage charter, this may not always be the case
- the shipowner may lose its P&I cover if it or the master knowingly issues or authorises issuance of a clean bill for damaged cargo.

At the discharge port

At the discharge port, joint surveys were carried out to assess the condition of the cargo. After detailed examination, the consignee concluded that the majority of coils were damaged. Many were entangled, bent or crushed, were considered unsuitable for their intended purpose and were rejected. The receiver alleged that as part of the next manufacturing process, the coils would be placed in an acid bath and then drawn out. However, due to the damage, the coils would be difficult to unwind.

The damage to the coils seen at the discharge port was in part caused by their poor condition, noted at the load port. At the load port, the club's surveyor had noted that some of the coils were distorted and sprung, and that retaining bands and ties were broken, adrift and rusting, but the bills were not claused to reflect the cargo's condition.

The claim

The receivers submitted a claim against the shipowner for 60 damaged coils, all of which were considered a total loss. Cargo interests demanded $80,000 in settlement for their loss.

Liability

Where the consignee is different from the shipper, a clean bill is irrefutable evidence of the apparent condition of the cargo at the time of loading. Since the bills issued here were owner's bills of lading, cargo interests had a direct action against the shipowner for breach of the contract of carriage. The shipowner can claim against charterers for reimbursement of any settlement reached with cargo interests, but such recovery action is not always successful because legal costs can be greater than the resulting award.

Comments and analysis

A clean bill is one that describes the cargo as being 'in apparent good order and condition', without containing adverse remarks. It can be evidence that the cargo was loaded in a good condition. If the bills are not claused with remarks indicating the true condition of the cargo, then the carrier is usually held liable to the receiver for the damage or impairment of the cargo.

As a consequence of the charterer's failure to endorse the bills of lading to record the cargo damage, the carrier (shipowner) was liable to cargo interests for the damage, even though the damage existed prior to loading.

To prevent claims arising from incorrect issue of clean bills, the following advice is given:

- masters should always be provided with a copy of the charterparty so that they are aware of the commercial agreement between the owners and charterers with respect to the issuance of bills of lading and letters of indemnity
- deck cargo officers should be diligent in their duties to observe and note damages to the cargo and make sure these are recorded in the cargo log and mate's receipts. They should not rely solely on cargo surveyors. All cargo damage seen should be brought to the master's and surveyor's attention
- wet cargo should not be loaded with dry cargo. Such cargo should stay on the quay until it is dry or, alternatively, bills should be cargo claused 'wet when loaded'
- always ensure that bills are claused to reflect the true description of the cargo, using descriptions similar to those set out in this guide
- when agents are authorised to issue bills on the master's behalf, this authorisation should be followed up by an email acknowledgement directly from the master to the agents with the wording agreed for the clausing to be included in the bills of lading
- masters should follow up after departure from the port and request confirmation that bills have been issued as per the master's instructions
- members should take a diligent interest in who issues bills of lading on their behalf and when they are issued. Procedures relating to issuance of bills of lading should form part of the ship's cargo procedures.

The mistakes made during loading resulted in a claim against the shipowner even though the ship had not caused the damage. Had the correct procedures been followed, as set out in this guide, the claim would have been avoided.

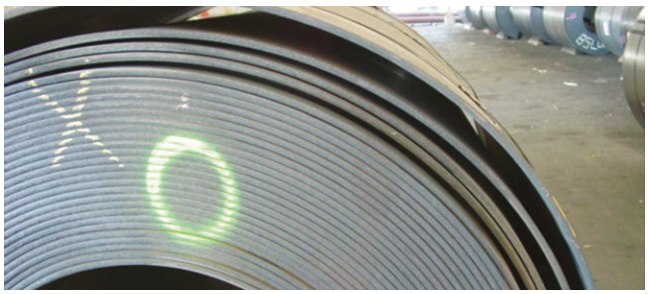


Figure 49: Condition of coils at discharge port – unwound

Figure 50: Condition of coils at discharge port – rusted

13. Appendix: Case study 2 – Poor dunnage

This study is based on a claim presented to the shipowner by cargo receivers.

A consignment of 2,400 steel pipes and 1,500 pipe casings was loaded at various Chinese ports for discharge in Antwerp. Each pipe weighed approximately 3.5 tonnes and each casing weighed between 0.5 and 1.2 tonnes. Wooden bulkheads were built in No. 2 hold to correct the ship's shape and to enable block stowage. Flat dunnage was laid athwartships over hold strong points for the pipes to sit on, but dunnage was not placed between the pipe ends and the hold's transverse bulkhead.

The P&I club's surveyor who attended for the preloading steel survey examined the cargo and suggested that bills be endorsed to reflect that:

- cargo had lain in the open without protection or covering
- cargo was rusty along its edges and surfaces
- cargo was slightly scratched along its edges and on its surfaces
- 89 pipes had their protecting end covers missing.

In spite of these recommendations, the bills of lading were signed clean.

During the voyage, heavy weather was encountered and a number of the wooden bulkheads in the No. 2 hold wings collapsed and allowed the pipes to move. Pipes located close to the hold's transverse steel bulkhead struck it and were damaged.

At the discharge port, the outturn surveyor remarked that 10% of the pipes had one or both ends bent or flattened. Their end covers were missing.

Comments and analysis

The principal cause of the damage was poor preparation of the hold prior to loading cargo and poor stowage during loading. In particular, insufficiently strong timbers had been used to square off the hull's shape in No. 2 lower hold and the wooden bulkhead was weak. In addition, during loading, dunnage had not been placed between the ends of the pipes and the hold's transverse bulkhead.

Stout dunnage should always be used to square off a hold's shape. Deck officers should supervise the construction of timber shoring to make sure it is correctly built and sufficiently strong. Although mariners may not always have experience in construction of timber shoring, they should check that the construction appears correct. Flimsy timber is unlikely to be sufficiently strong to withstand the forces associated with heavy ship pitching and rolling during a storm. If in doubt, advice should be sought.

Dunnage should always be placed vertically between the ship and cargo to prevent cargo movement and to protect the ship and cargo from damage.

Receivers were able to claim against the ship even though the damage occurred during bad weather. Had the wooden bulkheads been more robust, it is probable the damage, and the claim, would have been avoided.

Figure 51: Pipes loaded on top of coils need to be securely lashed to prevent movement. Dunnage has been placed between the pipes and the longitudinal bulkhead

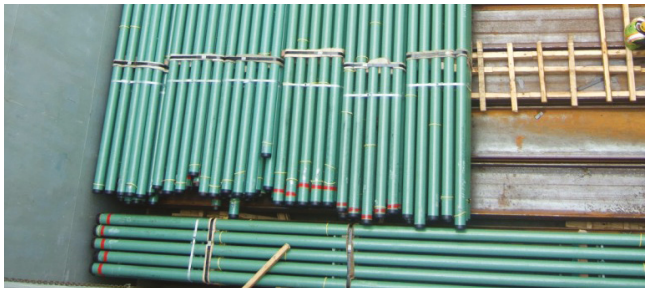


Figure 52: Pipes are stowed fore and aft, and athwartships. Dunnage has not been placed between the pipes stowed athwartships and the ship's side bulkhead

14. Loading checklist

Do:

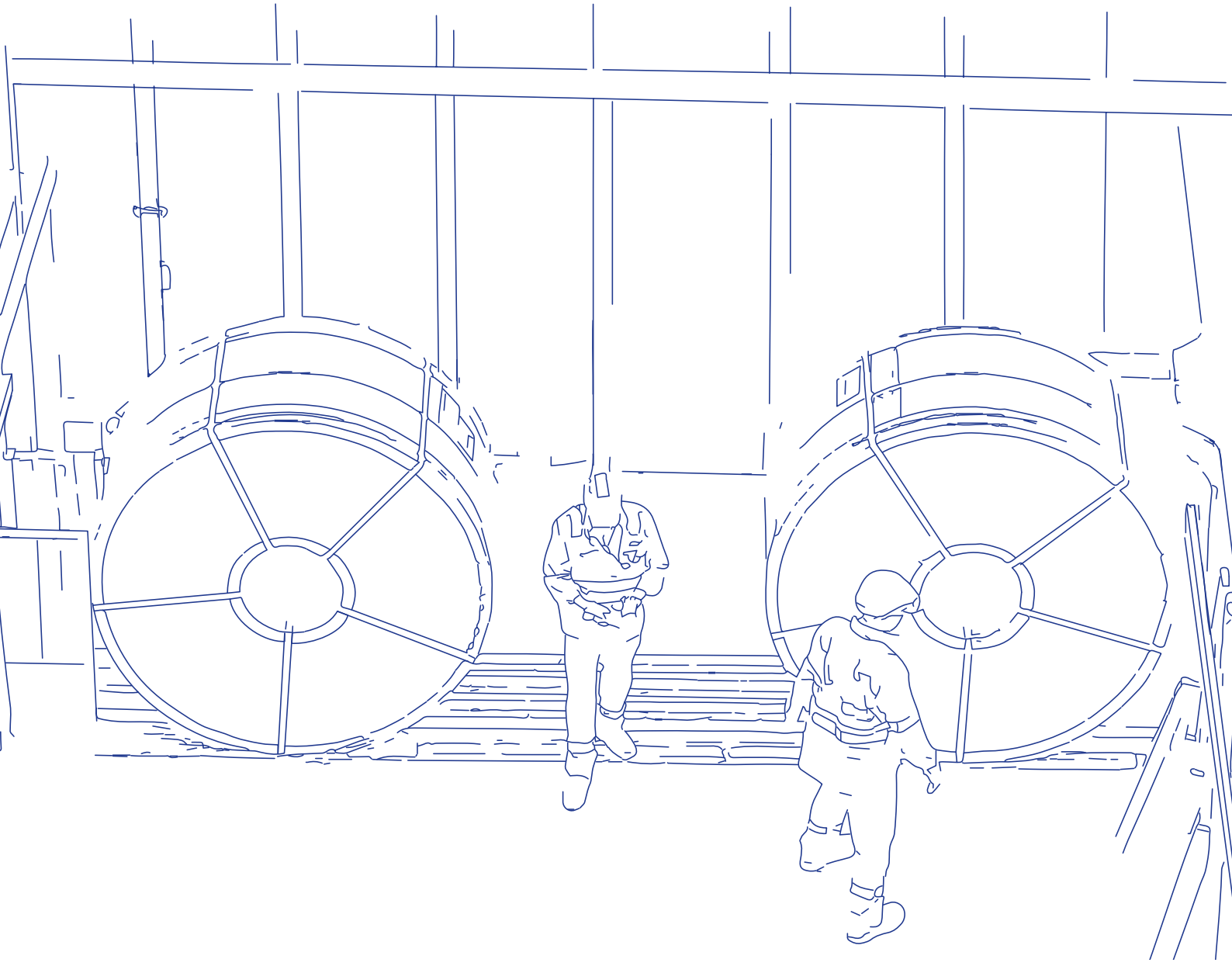
- Pre-plan steel stowage. Make sure steel is stowed on solid floors and, when applicable, key coils are positioned correctly. Coil widths and/or cargo dimensions may not always permit 'textbook' stowage.
- Mark the location of solid floors in the cargo space to enable easy reference during loading.
- Make sure cargo spaces are squared off by construction of a stout buttress or support. Use new timber and remember that No. 1 hold is most likely to be the hold where damage might occur.
- Wash holds with fresh water before loading, remove all debris and hard objects, fully dry the holds.
- When arranging stowage of steel coils, make sure the maximum tank top point load is never exceeded.
- Arrange for key coils to be placed in such a manner that the coil's bottom edge is one-third of its diameter below the top edge of the coil being locked. Stagger the position of key coils to avoid overloading the tank top.
- Make sure sufficient dry dunnage of the correct type and thickness is used.
- Use dunnage of uniform 2in thickness for coils. Remember, certain countries have import regulations that apply to ship's dunnage. Check the regulations before taking dunnage and use only approved dunnage, especially if discharging in North American ports.
- Record all pre-shipment damage on mate's receipts or bills of lading by carefully describing the damage found and clearly identifying the damaged article.
- Load steel dry, especially if steel is packaged (wrapped).
- If required to load wet steel, endorse the bills with 'wet before shipment'.
- Ensure hatch covers are weathertight before loading.
- Segregate steel that must be kept dry, and load it in a different hold from steel that can be loaded wet or products that contain moisture.
- Work with the surveyor to examine steel for preloading damage.
- Double-check any cargo found damaged. Make an effort to understand what the surveyor is looking for.
- Whenever surveyors visit to examine cargo, check their credentials to verify who they are acting for, before allowing access to the ship or cargo.
- Minimise the amount of cargo stowed with metal-to-metal contact. If this type of stowage is unavoidable, make sure the cargo is not wet. Wetness reduces frictional resistance and increases the danger of cargo shifting during ship rolling. Special care is needed when loading during rain showers.
- Try to avoid loading damaged cargo but accept that this may not be possible, in which case, stow this separately on top and endorse details of the damage on the bills of lading. Bent and buckled steel can be shipped for reprocessing, but the bills should not record the cargo as 'steel products'.
- Report to the P&I correspondent or ship's owners when problems are found with cargo or cargo stowage.
- Take daily dew point readings of hold and outside air, and ventilate or dehumidify when necessary. Keep detailed records of these measurements.
- Remember the voyage ventilation mantra, cold to hot, ventilate not. Hot to cold, ventilate bold.
- Calculate the ship's GM and, if possible, take measures to reduce high values.
- Follow weather routing and as far as practicable try to avoid swell conditions, as these can cause heavy rolling and wavelengths equal to half the ship's length, which in turn can initiate parametric rolling in slender ships during pitching in head seas.
- Remember that cargo has to be properly chocked and secured, and that only steel coils and semi-finished steel slabs stowed in California block stowage are lashed to themselves. All other steel is lashed to the ship.
- Point out any ship or cargo hazards or limitations to the stevedores.

Don't:

- Rely on stevedores to determine cargo stowage. They may opt for the easiest stowage rather than the best.
- Use the maximum allowable tank top loading weight to determine the number of steel coils that can be safely loaded. Steel coils produce a point load. The maximum allowable tank top loading weight assumes a homogeneous weight distribution.
- Be surprised if the textbook size and type of dunnage is not delivered to the ship. The dunnage supplied may be the best available, in which case, greater application of dunnage may be required.
- Use wet or 'green' timber for dunnage.
- Sign, or allow the ship's agents to sign, clean bills of lading or mate's receipts for damaged cargo.
- Allow coils to be loaded in a pyramid pattern.
- Load steel before evaluating the strength of the tank top against the proposed weight distribution.
- Ventilate when the relative humidity of ambient (outside) air is greater than that of the hold air or when the ambient air's dew point is greater than the temperature of the cargo. These conditions exist when cargo is cold, because it was loaded in winter (cold) conditions for discharge in, or passing through, summer (warm) conditions.
- Ventilate if unsure that ventilation conditions are correct.
- Stow steel products in the same compartment as cargo with different ventilation requirements.
- Load steel in holds that have previously carried oxidising agents or acidic compounds, until the holds have been thoroughly washed with fresh water and dried.
- Think that space remaining in the hold after loading steel needs to be filled with other cargo; it does not. When loading a full cargo of steel, the tank top maximum loading will be reached before the hold is full and often before the ship reaches her marks.

15. Conclusion

Standard Club's loss prevention programme focuses on best practices to prevent those claims that are avoidable. These usually result from crew error, poor crew training or not following proper procedures. In its continuing commitment to safety at sea and the prevention of accidents, casualties and pollution, the club issues a variety of publications on safety-related subjects. The Master's Guide series looks at key areas that cause incidents and gives members practical guidance to avoid them.



List of photos

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- Walter Vervloesem (FNI), Chairman IMCS Group, IMCS bvba, Belgium

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The Standard P&I Club

Standard Club is comprised of the entities listed below. To identify your insurer within Standard Club please refer to your policy documents for the relevant policy year or please contact us. To best serve customers, Standard Club uses international correspondents, which may be another entity within Standard Club.

The Standard Club Ltd, incorporated in Bermuda (No. 1837), authorised and regulated by the Bermuda Monetary Authority. Managers: Standard Club Management (Bermuda) Limited, incorporated in Bermuda (No. 56069). Registered addresses: Swan Building, 2nd Floor, 26 Victoria Street, Hamilton HM 12. The Standard Club Asia Ltd, is a company incorporated in Singapore with limited liability (No. 199703224R), authorised and regulated by the Monetary Authority of Singapore. Managers: Standard Club Management (Asia) PTE. Limited, incorporated in Singapore (No. 199703244C). Registered addresses: 140 Cecil Street, #16-03/04 PIL Building, Singapore 069540. The Standard Club Asia Ltd (Hong Kong Branch), registered in Hong Kong (No. F0024636), authorised and regulated by the Hong Kong Insurance Authority (F24636). Managers: Standard Club Management (Asia) PTE. Limited (Hong Kong Branch), registered in Hong Kong (No. F0024645). Registered addresses: Suite A, 29/F 633 Kings Road, Quarry Bay, Hong Kong. The Standard Club Ireland DAC, incorporated in Ireland (No. 631911), authorised and regulated by the Central Bank of Ireland (C182196). Managers: Standard Club Management (Europe) Limited, incorporated in Ireland (No. 630355), authorised and regulated by the Central Bank of Ireland (C184973). Registered addresses: Fitzwilliam Hall, Fitzwilliam Place, Dublin 2. The Standard Club Ireland DAC (UK Branch), registered in the UK (No. BR021960), deemed authorised by the Prudential Regulation Authority, subject to regulation by the Financial Conduct Authority and limited regulation by the Prudential Regulation Authority (FRN 833593). Managers: Standard Club Management (Europe) Limited (UK Branch), registered in the UK (No. BR021929), deemed authorised and regulated by the Financial Conduct Authority (FRN 848125). Registered addresses: The Minster Building, 21 Mincing Lane, London, EC3R 7AG. Details of the Temporary Permissions Regime, which allows EEA-based firms to operate in the UK for a limited period while seeking full authorisation, are available on the Financial Conduct Authority's website. The Standard Club UK Ltd, incorporated in the UK (No. 00017864), authorised and regulated by the Prudential Regulation Authority & Financial Conduct Authority (FRN 202805). Registered address: The Minster Building, 21 Mincing Lane, London, EC3R 7AG. The Shipowners' Mutual Strike Insurance Association Europe (The Strike Club), incorporated in Luxembourg (No. B50025), authorised and regulated by the Commissariat aux Assurances. Registered address: 74, rue de Merl - BP 2217 L-1022 Luxembourg. The Strike Club UK Branch, registered in the UK (No. BR019357), deemed authorised by the Prudential Regulation Authority, subject to regulation by the Financial Conduct Authority and limited regulation by the Prudential Regulation Authority (FRN 203102). Managers: Standard Club Management (Europe) Limited (UK Branch), registered in the UK (No. BR021929), deemed authorised and regulated by the Financial Conduct Authority (FRN 848125). Registered addresses: The Minster Building, 21 Mincing Lane, London, EC3R 7AG. Details of the Temporary Permissions Regime, which allows EEA-based firms to operate in the UK for a limited period while seeking full authorisation, are available on the Financial Conduct Authority's website. The following offices provide claims services for Standard Club: Standard Club Management (Americas), Inc., incorporated in the United States (Connecticut) (No. 4050326). Registered address: 180 Maiden Lane, Suite 6A, New York NY10038; Standard Club Management (Europe) Limited (Greek Branch), Law 27/1975 Branch Office, Status Building B, Areos 2A, 166 71 Vouliagmeni, Athens, Greece; and Standard Club Management (Bermuda) Limited (Japan Branch), registered in Japan (No: 0100-03-034516). Registered address: 6th Floor Takebashi Bldg, 2-1-8, Kanda Nishiki-cho, Chiyoda-ku, Tokyo 101-0054 Japan.

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