Cargo securing to prevent cargo damages on road, sea, rail and air

Presentation of the Presentation Material

Nils Andersson MariTerm AB
Caring Learning Material
Content

- PowerPoint Presentation
- Teacher’s Manual
- Student Book
- Quick Guide
- Cargo Calculator

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Cargo Material
PowerPoint Presentation

General/Road
(69 slides)

Sea
(33 slides)

In total ~150 slides

Rail
(30 slides)

Air
(20 slides)

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## Cargo Material
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Cargo Securing at Road Transport
Acting Forces

0,6 when risk of tipping

0,5
(0,6)

0,5

0,8

All the forces are expressed as part of weight of the cargo.
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# Cargo Material

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Legislation vary by country but the intention is the same – the cargo has to be secured to prevent accidents.

Legal responsibility for different parties comes from legislation.

By operating according to CEN or IMO regulations cargo securing fulfills the requirements in most national regulations.
Proper cargo securing is an important element in safe loading of packed goods on transport vehicles.

The European standard **EN-12195-1:2010** is the European reference document on cargo securing on road transport.

Sea transport has the IMO/ILO/UN ECE regulation.

Rail transport has created its own norms, but for intermodal transports the cargo securing that follows the principles of the EN-12195-1:2010 standard are accepted by the most intermodal rail transporters.

Air transport has also its own norms created by IATA.
Cargo Securing - General Liabilities - Regulations

Regulations in Finland

Road
- The Finnish Road Transport Act: 3.4.1981/267

Rail
- The Finnish Railway Act: 8.4.2011/304

Sea
- The Finnish Maritime Act: 15.7.1994/674
Cargo Securing - General
Liabilities - Regulations

Regulations in Sweden

Road
- The Swedish decree of traffic: SFS 1998:1276 3 kap. 80§
- The Swedish Transport Authority regulation TSVFS 1978:10 and VVFS 1998:95

Rail
- The Swedish Rail company regulation: SJF 601 (year 1985)

Sea
- The Swedish Transport Authority regulation: TSFS 2010:174
Regulations in Germany

Road
- StVO
  - §§ 22 and 23 StVO govern the responsibilities of the loader and the driver
  - VDI directive 2700a

Rail
- German Railway Act: AEG (Year 1951 / revised 1994)
- Trans-European Railway Interoperability Order: TEIV (Year 2007: revised 2012)

Sea
- Inland Waterway Vessel Act BinSchG (Year 1895; revised 2009)
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Forces acting on the cargo during transport are caused by different movements due to the mode of transport. The acting forces are:

- Deceleration
- Acceleration
- Centrifugal force
- Gravity
- Vibration

These forces may cause **sliding**, **tipping** and **wandering**.
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Cargo Material
PowerPoint Presentation - Layout

Cargo Securing at Road Transport
Acting Forces

0.6 when risk of tipping
0.5
0.8

All the forces are expressed as part of weight of the cargo.

Cargo Securing at Rail Transport
Acting Forces

- Longitudinal and horizontal forces
- Vertical
- Transverse horizontal forces
- Wagon oscillation (yaw) during transport
- Centripetal force
- Gravity
- Vibration

These forces may cause sliding, tipping and wandering for the cargo in CTU.

Cargo Securing at Sea Transport
Acting Forces

A vessel has the following six freedoms of motion:
- Roll
- Sway
- Pitch
- Surge
- Yaw
- Heave

Cargo Securing at Air transport
Acting forces in the air transport

During take-off, flight and landing forward, backward, sideways as well as upward forces occur and act cargo

These forces are:
- Acceleration
- Deceleration
- Yawing
- Lift

The first three are considered with 1.5 g, the last with 3 g.

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Cargo Securing - General
Basic Principles - Sliding

Sliding occurs when cargo securing and friction can’t hold the cargo in place.

For example hard and sudden braking or steep turning can create forces that make the cargo slide on the load carrier’s platform or even fall out.

Observe - the weight of the cargo has no influence on whether the package starts to slide or not!
Friction exists in the contact between two surfaces. Friction force resists the movement of the cargo on its surface. The higher the friction is the harder it is for the cargo to start sliding.

Video
http://www.cargosecuring.info
The stability of a cargo depends on the position of the centre of gravity, load carrying area and the dimension of the package.

Horizontal forces as a result of the change of CTU’s speed may cause the cargo to tilt or tip over.

The longer and wider the package is the harder it is to tip over. On the other hand the higher the centre of gravity is the easier the package tips over.
Every time cargo is transported it is exposed to vibration. Vibration can be caused by the load carrier’s engine, road surface/track, tires/wheels, suspension, superstructure etc.

If the vibration is strong, cargo can start to wander on the load carrier platform and it may cause problems.

Magnitude of vibration can be large which can create wandering phenomena.
# Cargo Material

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Cargo Securing - General
Securing Methods

Different securing methods:

- Blocking
- Locking
- Lashing
  - Top-over lashing
  - Loop lashing
  - Spring lashing
  - Straight/Cross lashing
Blocking

- Is the basic method of cargo securing.
- Uses the CTU’s structures in cooperation with a wide variety of devices.
- Eliminates the movement of the cargo so that sliding or tipping can’t occur.
Lashing methods

- Top-over lashing (Frictional lashing in standard)
- Direct lashing
  - Straight/Cross lashing (Slope lashing in standard)
  - Loop lashing
  - Spring lashing
- Round turn lashing
Top-over Lashing

Top-over lashing is used to prevent the cargo from sliding and tipping. The purpose of this securing method is to press the cargo against the load carrier with lashing equipment so that the friction force can keep the cargo in place.

The top-over lashing runs from side to side over the load. Lashing is most effective when the angle is between 75 and 90 degrees.
If the cargo requires more than one webbing, they should be evenly distributed over the length of the cargo.

Re-tightening is necessary during the transport because of acting forces that make the load move and loosen the lashing equipment.
Loop Lashing

Loop lashing is a kind of slope lashing. It prevents effectively sliding and tipping in transverse direction.

At least two pairs of loop lashings must be used per cargo unit if the cargo unit is not prevented from twisting.

Remember to take care of cargo securing forward and backward directions for instance by blocking.
**Spring Lashing**

A spring lashing is used mainly to prevent cargo movement and tipping in forward or backward directions.

Angle between the platform and webbing should be as low as possible and it must not exceed 45 degrees.
Cargo Securing - General
Securing Methods – Straight/Cross Lashing

Straight/Cross Lashing
Used typically with larger machinery and cargo to which you can attach the lashing directly.

Be aware when the lashings are attached crossways – if the cross occurs under the centre of gravity the lashing does not prevent the cargo from tipping.

Source: EN 12195-1:2010
Cargo Securing - General
Securing Methods – Round Turn Lashing

Round Turn Lashing
Round-turn lashing is mainly used to prevent tipping. The principle is to make several units to become one.

If the round-turn lashing is considerably long the effect of preventing tipping is small.
## Cargo Material
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<td>Different Cargo</td>
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</table>
Webbing is the most commonly used cargo securing equipment. It is easy to use and versatile so it can be used to secure many kinds of cargoes.

Because webbings are made from fibers they should be protected against sharp edges.

Webbings prolong under strain so they need to be retightened during the transport.
Cargo Securing - General
Securing/Lashing Equipment - Webbing

Example of marking of a webbing according to standard EN 12195-2

- Unit: 1 daN ≈ 1 kg
- Breaking load = 4000 kg
- LC = Lashing capacity = 1600 daN
- $S_{HF}$ = Standard hand force = 50 daN
- $S_{TF}$ = Standard tension force = 400 daN
Chains are typically used when transporting heavy cargo like electric transformers or earth movers.

The main differences between a web and a chain lashing are that under a normal load a chain lashing doesn’t stretch and it’s not so sensitive for sharp edges.
Cargo Securing - General
Securing/Lashing Equipment - Blocking

Blocking devices
• Beams
• Bars
• Braces
• Dunnage bags
• Wooden battens
• Wedges

Source: W.Strauch/containerhandbook.de
Cargo Securing - General
Securing/Lashing Equipment - Others

**Increasing Friction**
- Friction mat
- Tag washers

**Protective**
- Supporting edge profile
- Corner protection

**Other**
- Lashing cover
- Net
Cargo Securing - General
Inspection of Web and Chain Lashings

Web and chain lashings should be inspected before use!
Don’t use a web lashing if you notice:
• Edge damage
• Cuts
• Tear damage or knots
• Wear damage
• Dirt level and old age

Don’t use a chain lashing if you notice:
• Cracks in the surface
• Visual deformation i.e. prolongation
• Wear more than 10 % of the diameter
## Cargo Material
### PowerPoint Presentation - Outline

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Cargo securing to prevent cargo damages on road, sea, rail and air
Cargo Securing at Sea Transport

General

Almost all seafarers have been exposed to and are very well aware of:

- the impact and force of hard weather.
- if the cargo is not properly stowed and secured the consequences can be dramatic.
- the forces on the cargo can be large due to green sea on deck.
Cargo Securing at Sea Transport

Typical Factors for Sea Transport

Typical factors for a sea transport are:

- The side forces can be large due to rolling
- The motions on sea can decrease the impact of the gravity force
- Large acting forces can occur over a long period of time
- A lot of heavy cargo is handled by sea transports
- A lot of cargo is handled on the same vessel
Cargo Securing at Sea Transport

Consequences of Poor Cargo Securing

Insufficient cargo securing in one container can start a “chain reaction” which ends up in direct consequences like

- Loss of cargo and CTUs
- Damages to the vessel

and in worst case

- Loss of vessel
- Loss of lives

Photos of cargo shifting on Container vessel
Cargo Securing at Sea Transport
Consequences of Poor Cargo Securing

Beside the direct consequences like damages on cargo and ship, poor cargo securing can also lead to indirect consequences like:

- Economic consequences
- Damage to the Environment
- Badwill
Cargo Securing at Sea Transport

Typical Cargo Transport Units and Cargoes

• Vehicles and trailers
  - General cargo
  - Pulp and paper
  - Steel products

• Freight containers
  - General cargo
  - Pulp and paper
  - Steel products
  - Machinery

• Flat racks
  - Machinery
  - Vehicles
  - Project cargoes
Cargo Securing at Sea Transport

Cargo Transport Units – Vehicle/Trailers

Vehicles and trailers are used for sea transports in the North and Baltic Sea, and the Mediterranean.

Different types of superstructures:
- Open flat
- Cover/stake
- Box with or without side doors
- Curtainsiders
Cargo Securing at Sea Transport
Cargo Transport Units – Vehicle/Trailers

Strength Demand on Superstructure

Sideways Strength according to the European Standards
- EN 12642 L and
- EN 12642 XL
Cargo Securing at Sea Transport

Cargo Transport Units – Freight Container

Freight containers constructed according to the ISO standard

+ Firm structure which can block cargo in all directions
+ Built for transportation in unrestricted areas
- Difficult to load with EUR-pallets
Lashing points can be a “weak link”. According to the ISO standard:
- For general purpose containers, cargo securing devices are optional
- Anchor points: min. safe load of 1000 kg
- Lashing points: min. safe load of 500 kg
Cargo Securing at Sea Transport
Cargo Transport Units – Flat Racks

Flat racks are usually built within the frame of ISO standard with
- No roof or side walls
- End walls normally same strength as a freight container
- Collapsible end walls
- Internal height often less than for an equivalent freight container
- Lashing points normally designed for a safe load of at least 5 ton
Cargo Securing at Sea Transport

Liabilities

The master of a ship is responsible for the seaworthiness of his ship including the cargo securing

However, normally the master is not responsible for cargo breakage caused by insufficient securing of the cargo inside covered cargo transport units, unless bad cargo securing is suspected
Cargo Securing at Sea Transport
Liabilities – Dangerous Goods

Regulations for transport of DG at sea are found in the IMDG-code

The consignor is responsible to
- Classify and identify the dangerous cargo
- Pack, mark and label the cargo
- Follow the segregation provisions when loading a CTU
- Provide the consignment with the following documents:
  - Dangerous Goods Declaration
  - Container/Vehicle Packing Certificate
Cargo Securing at Sea Transport
Liabilities – Dangerous Goods

Container/Vehicle Packing Certificate (CPC)

Persons packing a container/vehicle shall certify:

- Drums securely stowed upright
- All goods is properly loaded and secured
- Properly marked/labelled/placard
- Correct segregation

CONTAINER/VEHICLE PACKING CERTIFICATE

DECLARATION
I hereby declare that the goods described below have been packed loaded into the container/vehicle identified below in accordance with 5.4.2 of the IMDG code.

MUST BE COMPLETED AND SIGNED FOR ALL CONTAINER / VEHICLE LOADS BY PERSON RESPONSIBLE FOR PACKING / LOADING

Name of company

Name status of declarant

Place and date

Signature of declarant

CARGING
cargosecuring.info
Cargo Securing at Sea Transport
Regulations and Standards

- Conventions: **SOLAS**
- Codes: **CSS-Code**
- Resolutions: **A.489, A.533, A.581**
- Circulars and guidelines: **IMO/ILO/UN ECE Guidelines for packing of cargo transport units**
- Rules and regulations of the Classification Society
- National regulations
- Cargo Securing Manual
Cargo Securing at Sea Transport
Regulations and Standards

The most important rules and regulations for cargo securing in or on CTUs are:

- IMO/ILO/UN ECE Guidelines for packing of cargo transport units (CTUs)
- IMO Model Course 3.18 “Safe packing of cargo transport units”
Cargo Securing at Sea Transport
Handling at the Port Terminal

The cargo securing on a Cargo Transport Unit (CTU) in an intermodal transport chain is only inspected at the port terminal if bad cargo securing is suspected.

The stevedores are performing cargo securing on a CTU only if the CTU is stowed at the port facility.

The cargo securing of the CTUs on the sea vessel is done by the stevedores and/or the crew onboard the ship.
Cargo Securing at Sea Transport

Acting Forces

A vessel has the following six freedoms of motion:

- Roll
- Sway
- Pitch
- Surge
- Yaw
- Heave
Cargo Securing at Sea Transport

Acting Forces

Acting forces according to the IMO Guidelines for packing of CTUs

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<th>Sea Area</th>
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<th>Backward</th>
<th>Sideways</th>
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<tr>
<td>A: Baltic Sea</td>
<td>0.3g (a)</td>
<td>0.3g (a)</td>
<td>0.5g</td>
</tr>
<tr>
<td>B: North Sea</td>
<td>0.3g (b)</td>
<td>0.3g (b)</td>
<td>0.7g</td>
</tr>
<tr>
<td>C: Unrestricted</td>
<td>0.4g (c)</td>
<td>0.4g (c)</td>
<td>0.8g</td>
</tr>
</tbody>
</table>

1g = 9.81 m/s²

Combined with static gravity force of 1.0g acting downwards and a dynamic variations of:

(a) ± 0.5g
(b) ± 0.7g
(c) ± 0.8g
Cargo Securing at Sea Transport
Securing in CTUs – Securing Methods

Securing methods of cargo in CTUs are

- Blocking
- Locking
- Top-over lashing
- Loop lashing
- Spring Lashing
- Straight/cross lashing
Cargo Securing at Sea Transport
Securing in Different Directions - Lengthways

If possible, block the cargo in lengthways directions against
- Firm structures of the CTU
- Boards
- Empty pallets
- Other cargo
- Threshold made of other packages
- H-bracing
- Wooden battens
Cargo Securing at Sea Transport
Securing in Different Directions - Lengthways

Examples of securing by blocking in lengthways direction
Cargo Securing at Sea Transport
Securing in Different Directions - Lengthways

If necessary use lashings in combination with blocking

Lashing methods:
- Top over lashing
- Spring lashing
- Straight/cross lashing
Cargo Securing at Sea Transport

Securing in Different Directions - Sideways

If possible, block the cargo in sideway directions against:

- Firm structures of the CTU
- Other cargo
- Empty pallets
- Dunnage bags
- Wooden battens
- Stanchions
Cargo Securing at Sea Transport
Securing in Different Directions - Sideways

Examples of securing by blocking in sideways direction
Cargo Securing at Sea Transport
Securing in Different Directions - Sideways

Use of dunnage bags in sideways direction
- Only in CTUs with firm side walls

Advantages:
- Follows the cargo well
- Form tight stowage

Note!
- Protect the bag from sharp edges
Cargo Securing at Sea Transport

Securing in Different Directions - Sideways

If necessary use lashings in combination with blocking

Lashing methods:
- Top over lashing
- Loop lashing
- Straight/cross lashing
The end section of a load in a CTU has to be secured by
- Wooden battens or
- Boards or
- Empty pallets

*Note* – the result of bad securing of the last section could be fatal!
Note – Don’t use dunnage bags directly against the container doors!
- Use wooden battens or
- Place the dunnage bags between the last and the second last section
Cargo Securing at Sea Transport

Load Distribution

In a container the distribution of cargo weight must be maximum 60% in one half of the container and minimum 40% in the second half.
Cargo Securing at Sea Transport

Securing Steel Products

Steel products are often heavy and secured by blocking, if necessary by lashing.

**Note:**
- Loop lashing is often more efficient than top-over lashing
- Steel coils shall be transported in firm cradles
- Protect web lashing from sharp edges by edge protectors
- Use friction sheet to increase the friction
Cargo Securing at Sea Transport
Securing Sawn Timber and Round Timber

Sawn timber
- Additional lashing required in sea Area B compared to a road transport
- Sawn timber has to be blocked in all directions when loaded in a freight container

Round timber
- Normally not transported in CTUs
- Special regulation for the securing on board the vessel
Cargo Securing at Sea Transport

Securing Pulp and Paper

Pulp and paper secured by blocking and if necessary by lashing

Note:

- Supporting edge beams protect the paper and make the lashings more sufficient
- Protect the paper from damages by use of edge protectors
- Low friction between wooden pallets and plastic film
- Pulp not rigid in form may require additional lashing
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Caring Learning Material
Teacher’s Manual

General/Road
(~ 85 pages)

Sea
(~ 50 pages)

Air
(~ 25 pages)

Rail
(~ 50 pages)

In total ~210 pages

CARING is partially financed by the Leonardo da Vinci programme of the European Union. In Finland the Centre for International Mobility CIMO administers and is responsible for implementing the Leonardo da Vinci Programme. This publication has been funded by the European Commission. The Commission accepts no responsibility for the contents of the publication.
Cargo Securing at Air Transport
Teacher’s Manual - Layout

Part
Slide No
Info text
Own notes

General
Apart from some "weather water survival" almost all seafarers have been exposed to hard weather.
If the cargo is not properly stowed and secured when the ship starts to roll and pitch in hard weather
it is obvious that the consequences can be dramatic.
In severe weather conditions, if necessary, the speed should be reduced and the course altered, such
proceedures may decrease the load of stress, pitch to cargo and the ship’s structure, by eliminating
debris movements and heavy exposures to green water ships.

Notice

2012-10-15
Page 1 (54)
Caring Presentation
Teacher’s Manual – Example

Cargo Securing at Sea Transport

[Slide 3 of 3]

Examples of cargo securing at sea: At anchor, in port, during voyage.

A vessel has the following six types of motions: translational and three linear:
roll, pitch, and yaw.

Applications and main points:
- All objects are subject to changes in form or direction, not just those moving horizontally. If you are standing on a ship, you are always moving with the ship's motion. The problem is not just your body moving with the ship, but also the object you are carrying. If you are holding a piece of paper, it will move with the ship, but it will also move with your body. The object's motion is the sum of the ship's motion and your body's motion.

A vessel is subject to accelerations as a result of the sea. The acceleration is given by the formula:

\[ \text{acceleration} = \frac{\text{force}}{\text{mass}} \]

where force is the result of the sea or wind, and mass is the mass of the object.
Caring Learning Material
Student Book

- Introduction
- Responsibilities
- CTUs
- Equipment
- Methods and principles
- How to use Quick Guide
- Loads

(≈ 50 pages)
Caring Learning Material
Student Book - Example

Calculating Number of Lashings

To know exactly how much a lashing can bear and secure often requires a number of rather complex calculations. It mainly depends on how simple we have these calculations, and present them to cables with this manual as 'Single-Cable-Sets' with pre-calculated values. To check the dimensions of the lashing you need, in most cases, be able to use this guide with pre-calculated values. You may, however, encounter special situations difficult to calculate. The calculated, the load-carrying capacity of the lashing equipment at your disposal may not correspond to the pre-calculated values. For each of these more advanced calculation methods are needed, which are often done by specialists in cargo securing in your firm or by consultants.

To calculate the number of lashings needed to prevent sliding and tipping, first look up how many lashings you need to prevent sliding. Secondly, you look up how many lashings you need to prevent tipping. The highest number of these shows how many lashings you, at least, have to use.

An example of a calculation of the number of top-over lashings needed to secure a wooden boxes with dimensions: Width 2 meters, Length 2 meters and height 2.5 meters. The wooden box weighs 3.5 tons and is placed on a wooden platform as shown in the picture. It is not lashed in any direction. In this example the cargo is homogeneous, meaning it has in center of gravity is in the middle. The number of top-over lashing is decided by use of the measurement and the figures in the table. Here the number of lashings to prevent sliding must be calculated.

Step 1 - According to the table below the friction factor for a wooden box on a wooden platform is 0.45.

<table>
<thead>
<tr>
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<th>Friction factor</th>
<th>Practical factor</th>
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<tbody>
<tr>
<td>Woven cord - cotton</td>
<td>0.45</td>
<td>0.22</td>
</tr>
<tr>
<td>Woven cord - manila hemp</td>
<td>0.45</td>
<td>0.25</td>
</tr>
<tr>
<td>Woven cord - steel wire</td>
<td>0.45</td>
<td>0.28</td>
</tr>
<tr>
<td>Woven cord - stainless steel</td>
<td>0.45</td>
<td>0.30</td>
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Caring Learning Material
Reference

- EN-12195-1:2010
- European Best Practice Guidelines on Cargo Securing for Road Transport
- IMO/ILO/UN ECE Guidelines for packing of cargo transport units
Thank you!

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