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SECURING MEASURES FOR ON BOARD GOODS (MOORING, ANCHORING, STACKING)

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Abstract: *Shipping operators require special care on securing goods and persons on board. Long journeys and harsh natural conditions very frequently lead to unwanted accidents. Hence, a well-established preventive behavior on board, proper anchoring and securing cargo in containers easy to handle, improves the chances for goods to reach the destination "unharmed".*
Unfortunately, there is a growing number of incidents and loss of cargo aboard ships lately. Losses in large vehicles, cars, machinery, steel pipes, steel structures, timber, freight containers, dangerous chemicals.
Goods must be stackable so that the ship moored and shipboard personnel should not be exposed to any risk. It is a first priority for mooring and safe stacking and good planning, execution and supervise on/off the loading and unloading. Lashing and stowage aboard ship are extremely important factors for the safety of life at sea. Inadequate mooring of goods led to many accidents and even loss of lives both during voyage and during loading and unloading operations.
Keywords: *shipping transport, lashing, stowage, mooring, anchoring.*

Legal framework and International regulations:

Regulations VI/5 and VII/6 of the 1974 SOLAS Convention require cargo units and cargo transport units to be loaded, stowed and secured throughout the voyage in accordance with the cargo securing manual (CSM) approved by the administration and drawn up to a standard at least equivalent to the guidelines developed by the International Maritime Organization (IMO).

The guidelines have been expanded to take into account the provisions of the Code of Safe Practice for Cargo Stowage and Securing (the CSS Code), the amendments to that Code, the Code of Safe Practice for Ships Carrying Timber Deck Cargoes, and the codes and guidelines for Ro-Ro vessels, grain cargoes, containers and container vessels, and ships carrying nuclear waste and similar radioactive products.

As from 1 January 1998, it is a mandatory regulation for all vessels, other than exempted vessels such as dedicated bulk solid, bulk liquid, and gas- carrying vessels, to have onboard an approved and up-to-date cargo securing manual. Some administrations may exempt certain cargo-carrying ships of less than 500 gross tons and certain very specialized ships, but such exemption should not be assumed in the absence of a formal exemption certificate.

It is a mandatory requirement for masters and ships' officers to be conversant with the CSS Code and the CSM Regulations, to understand their applications for the vessel in which they are serving, and to be capable of deploying correctly the hardware which goes with it. All securing of cargo units shall be completed before the ship leaves the berth. The CSM and its associated hardware are subject to port state control inspection. Violation of the CSM requirements may give rise to vessel detention and/or prosecution of the master and owners.

The CSS Code and CSM Regulations and their amendments contain much sound and well-tried advice, and should not be treated lightly.

The phrase "deck cargoes" refers to items and/or commodities carried on the weather-deck and/or hatch covers of a ship and there on exposed to sun, wind, rain, snow, ice and sea, so that the packaging must be fully resistant to, or the commodities themselves not be denatured by such exposure. Even in Ro-Ro vessels, many areas above the actual "hold" space can reasonably be considered as "on deck" even though not fully exposed to the on slaught of wind and sea. The combined effects of wind, sea and swell can be disastrous. Where damage and loss occur to cargo shipped on deck at anyone's risk and expense, the ship-owners, the master and his officers, and the charterers, must be in a position to demonstrate there was no negligence or lack of due diligence on their part.

Lashing system

All interests involved in the lashing and securing of deck cargoes should be arinmind that high expense in the purchase of lashing materials is no substitute for a simple design and a few basic calculations before lashing operations commence. Other than in Ro-Ro and purpose-built container operations where standardizationofgearandrapidloadingandturnaroundtimesrisedifferentproblems, shipmasters should be encouraged–on completion of lashing operations–to make notes of the materials used, to produce are presentatives ketch of the lashing system, to insist upon being provided with proof certificates of all lashing components involved, and to take illustrative e-photographs of the entire operation.

Mooring and safe stacking of goods depends on early planning, execution and supervision of the loading and unloading procedure. Lashing and stowage calculation should be based always on predictable hard weather conditions that may occur during voyage. Acting Forces on a cargo unit appear in longitudinal, transverse and vertical axis (see fig.1)

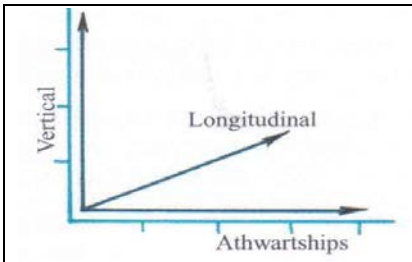

Fig.1

Shipboard transportation must always take into account the factors which act during transport of goods. Unfortunately, there is a growing adverse incident reports and loss of cargo aboard the ships. Losses like steel pipes, large vehicles, timber, cars, machinery, steel structures, freight containers, dangerous and polluting chemicals.

Main causes of accidents at the Sea

The causes of these accidents or losses are included in the following categories:

• ignoring recommended procedures and rules for loading and unloading of the goods.
• weather conditions;
• insufficient staff to complete the preparation work required before the ship leaves the port;
• goods separation not used in an efficient manner;
• using inappropriate (power and number) of binding methods;
• pass of binding material around some unprotected sharp edges;
• inadequate distribution of loaded cargo units;
• damage of transported goods may be caused by rust formed due to the action of condensation on some metal parts.
• Improper stacking of goods during transportation will lead to inevitable friction between different goods, or between them and the walls of the vessel.

After **stacking**, goods index fall into two categories:

- Heavy Goods (heavy machinery, industrial machinery)
- Light Goods (electronics, consumer goods, grains)

For naval transport efficiency is particularly important the knowledge of goods weight, volume and possibilities of stacking in the ship's stores. In charge, in terms of legal liability, for improper stacking is the owner and the captain of the ship. The work itself, even if it is done by specialized operators of the Port staff, will only run under the supervision and authority of the ship captain, as assigned by his specific contractual obligations to transport and deliver goods to the destination in corresponding terms quantitative and qualitative, as shown in the "Charter Party" or the bill of transportation. Maritime law rules states that stacking ways (methods) must be known before loading the ship, important obligations, in this case, returning both to the captain of the ship and to the charterer which is required to specify the nature of the goods, their physico-chemical properties and stacking index for a judicious analysis of the transported goods to fill the entire space of the storage area, ensuring the best product integrity. The owner of the ship, has responsibility to maintain the technical equipment available and to prevent damage of the loaded goods. In addition, knowledge of goods offered for shipping enables skipper to take appropriate measures for their boarding by weight, and rotation index stacking ports, to ensure high efficiency and profitability of entire transport activity.

This knowledge is related to:

- dimensions;
- tons (weight);
- features;
- destination;
- stacking index.

Those contributes to the loading / unloading plan, and provide the precise order of bringing the goods on board, which is made only on the captain's supervision, all loading operations will be conducted in a way that will not threaten the stability and safety of the ship.

Experienced charterers and ship-owners and other specialists in the shipping field, revealed that the volume occupied by the loaded cargo on board at the time, is influenced by the following elements:

• weight of the goods;
• uniform size and size of packages;
• geometric shape of store-rooms and deadweight of the ship;
• physico-chemical properties of goods;
• stowage factor;
• operators qualification.

Mooring materials

Mooring of the goods is the process of providing temporary position of goods by binding them to the hull, using specific means and methods to prevent the movement, damage, contamination or even loss of the goods during the voyage. Mooring oversized products is performed by qualified staff and will take account of the special object construction, and carry the manufacturer's instructions on the site of anchors and type of materials to be used. Materials used in the anchoring will have to meet conditions imposed by the gauge resistance freight carried.

Wire ropes - are constructed from galvanized steel wire products with a thickness of 0.2 to 0.4 mm, by twisting to the left, around hearts of jute or of vines forming the wire. The bundle of wires are six in number and are twisted in their turn to the right around another heart (the heart of the line), which may be hemp or jute tar. This heart is to protect the wires inside from moisture and oxidation, and to provide flexibility to keep the line of the rope oiled. Strap heart can be metal made. For wire ropes, which are used in wet or corrosive atmosphere, or for longer periods of time staying under water, are used metal ropes and galvanized wires with synthetic heart. Metal ropes (wires) it is recommended that to be made of round strand, flexible and not too large in diameter easy to handle. In some cases the ropes to be used as mooring links are provided already cut to specific lengths and provided with already-made special touch devices at one or both ends. To achieve the goal of good metal mooring ropes must be flexible and relatively small in diameter for the best efficiency.

The most common wire ropes are 16 mm diameter with a minimum breaking load of 7.75 force ton (1 ton = 9.80kN force). The breaking load is calculated force that wire ropes or other binding device fails to support after sliding or overturning the unit loads. Safety resistance must be 33% to 20% of the breaking strength according to the wire stretch to which it is exposed.

When a metal rope is used as mooring device it must be accompanied by the special loop using key rigging grip. There is only one way to achieve such a gripping loop:

• rigging key must be the correct size in diameter for wire use;

• a fair number of keys to be used (see tablefig.2);

• all keys must be caught in the same manner rigging vaulted from bearing weight of the yarn;

• distance between keys will be six times the diameter of the rope;

• end of the thread has to be fixed or cut, as so, not to be left free;

• key rigging must to be close tight and be fixed in to yarn;

metal rope diameter (mm)	minimum number of rigging keys
before and equal to 19	3
19 - 32	4
32 – 38	5
38 – 44	6
44 - 56	7

Fig.2

Chains - the advantage of using them is that, under normal loads, they don't elongate (see fig.3). They are widely used in mooring containers and vehicles. All the chains must have a high link end provided with a hook which can be taken on all sides of the binding. They shall extend only to the original tension, manually operated. The most important way is to use a secure container freight units for Ro-Ro ships and heavy lifting units. The chain will be made to the appropriate length the size and type of the corresponding connecting link and the ends will be suitable, if necessary(see fig.4). Of course chains can be used for connecting other types of goods, but are more difficult to handle than wire ropes and do not guarantee to tie round freight unit or attachment points when used. The biggest advantage is that the chains do not stretch and therefore can be fitted well and will remain close during the trip so that goods will not move.

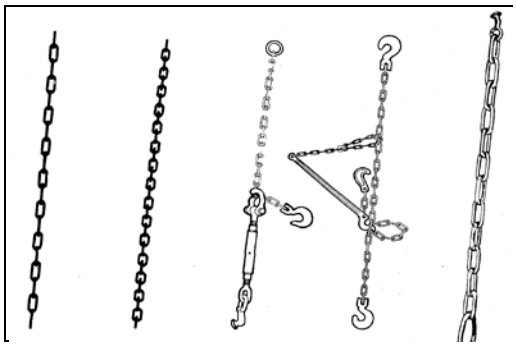

Fig.3 Chain link type's

Diameter (mm)	Link type	Loading capacity (force ton)
9 mm	short	5.20
10 mm		6.42
11 mm	short	7.85
13 mm		10.81
16mm	short	16.42
18mm		20.75
20 mm	short	25.65
22mm		31.00

Fig.4 Chain link properties

Synthetic hawser - should be use limited for light loads or low volume areas which are partially housed in the vessel. Synthetic ropes have characteristics that are not ideal for mooring. Stretch when are wet and shrinks back when dry. No safe when knotted or connected and damage when exposed to sunlight and seawater. Therefore it is sometimes difficult to establish and maintain a strong synthetic rope. In conclusion, their use should be limited to lighter cargo binding of small diameter ropes is only synthetic or in combination with other materials, such as wire ropes.

Webbing - are usually made of braided impregnated polyester fibers and therefore will stretch more than steel ropes. They are very easy to use, easy to bound and are manufactured in different sizes and with different tensile strengths. The most common use of them is binding machines and other types of cargo such as pipes, small vessels.

Choosing mooring equipment is very important and the chosen materials must be adequate. For example, metal chains and ropes should not be used to secure the rolls of paper material, because they will penetrate the paper and cause damage when merchandise is moving. Like webbing straps and steel bands are likely to be adequate for binding a machine of 200 tons, from the simple fact that it would require large number of them to do the job.

Mooring materials when not in use must be kept, in clean and dry storage area, away from chemicals or other items that could cause damage. Detachable parts like connecting rings must be greased. All mooring equipment must be completely checked at regular intervals and all damage, worn parts or other faults should be removed or put away for repairs. Whenever items are removed from the storage area and are put back into use, a close examination have to confirm that they are in satisfactory operating conditions. When new materials are brought on board they must be inspected to confirm that are the ones that have been ordered for replacement and are in mint condition. Cargo securing manual should be updated whenever lashing materials are replaced.

Packaging goods for shipping includes many materials used for protection, separation and support freight items.

- Wood in the form of flat plates and the entire range of sizes;
- Various types of reinforced and water resistant paper;
- Polythene sheets and other synthetic or natural fibers;
- Air bags of different sizes;

To protect the cargo from coming in contact with metal from the ship and condense water, packaging have many functions, in combination with storage and security they provide:

- help against cargo tilting in the form of dry timber or buttresses.
- spread along the entire cargo hatch, deck or floor of the tank.
- increase friction between cargo and under Articles hatch floor deck or tank that is folded.

Packaging and other lashing materials, are part of the ship's equipment and are not discarded at the end of the voyage, they should be stored in a clean, dry storage, away from any chemicals or other items that could cause damage. Frequently packaging materials should be examined to determine if they have been damaged and if found defective, they must be removed.

Friction force

Friction of two surfaces in contact are either static or sliding one over the other. The frictional force will act against any force which causes or may cause motion. That friction is related to the friction coefficient between the two surfaces. For a cargo package placed on the deck, friction force require to overcome the initial friction force can be calculated by multiplying the weight of the article and the coefficient of friction of the two surfaces.

$$F = \mu \times m \times g$$

where : F = Friction force

μ = friction coefficient

m = mass

Thus, the higher the friction coefficient of the surface, the greater will be the force required to slide cargo article along the deck. The magnitude of the friction coefficient is direct related to the nature of the two surfaces (see fig.5)

Contact materials	iron on iron
iron on iron (wet)	0.0
iron on iron (dry)	0.1
iron on wood	0.3
iron on rubber	0.3
wood on wood (dry or wet)	0.4

Fig.5

The friction coefficient between two surfaces is tangent angle of the contact surface and should be higher for the movement to take place between the two surfaces and may only occur as a result of gravity, without any action of external forces.
The friction coefficient between wood and iron is 0.3. The friction coefficient is independent of the object weight that is pressed against the surface and independent of the contact surface.
It is clear from CSS coefficients code if there were no lashing between the iron unit base oversized and the iron deck, the unit will slide at a much shallower angle. If the iron bridge is wet it looks like after table of CSS code that oversized unit should slide along the deck even when the ship is upright, the coefficient is 0.0. Oversized unit would not move just because the deck is wet, but once the ship starts moving, the friction coefficient can be considered zero and the dynamics of the situation against which we try to ensure merchandise. It is also clear that when lashing timber is mounted in the cargo items, they will slide along the deck at an angle greater than if they were wood at all. When a vessel is at sea and in roll and pitch angle to the horizontal deck will change everywhere, the connections between cargo and deck where items are stored are dynamic and act on the stored goods in all directions.
These additional external forces will do a unit of goods to slide to the deck at an angle less than the equivalent coefficient of friction of the two surfaces. Mooring, properly installed and tensioned can prevent slippage freight units along the deck. This is done by acting differently mooring components vertically downward and horizontally. Vertical components will actually increase the friction which will mean that for the move to take place, it takes a larger external force. Horizontal components will act in line with external forces, meaning that before the move to take place it takes a larger external force. Mooring components will also prevent the cargo unit to drop over the board.

CONCLUSIONS

Deck cargoes, because of their very location and the means by which they are secured, will be subjected to velocity and acceleration stresses greater, in most instances, than cargos to wed below decks. When two or more wave forms add up algebraically a high wave preceded by a deep trough may occur; this maybe referred to a san "episodic wave": a random large wave –notice ably of great erheight than its precursors or successors–which occurs when one or more wave trains fall in to phase with another so that a wave, or waves, of large amplitude is a reproduced giving rise to sudden steep and violent rolling and/or pitching of the ship. These are popularly–and incorrectly–referred to as "freak" waves; they are not "freak", however, because they can, and do, occur anywhere at any time in the open sea. The riskis wide spread and prevalent. The stowage, lashing, and securing of cargoes therefore require special attention as to method and to detail if unnecessary risks are to be avoided.

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