



## Purpose:

The e-learning module (ELM) is designed for theoretical training of navigators in accordance with Chapter II of the STCW Convention in the part concerning of stability of the ship.

The ELM is included in the "*Shiphandling basics*" library.

## What is an e-learning module?

E-learning module is the electronic textbook on one or more sections. Theoretical materials can be accompanied by drawings, diagrams, photos, animations and videos. There is a test for assessment of knowledge gained at the end of each section.

## Contents:

- Initial Transverse Stability
- Static stability curve
- Dynamic stability curve
- Stability criteria
- Ensuring longitudinal stability of the ship

## Target groups

Deck - Management  
Deck - Operational

## Ship types

Generic



## Regulations

### Table A-II/1 STCW Code

Competence:	Maintain seaworthiness of the ship
Knowledge, understanding and proficiency:	<i>Ship stability</i> Working knowledge and application of stability, trim stress tables, diagrams and stress calculating equipment.

### Table A-II/2 STCW Code

Competence:	Control trim, stability and stress
Knowledge, understanding and proficiency:	Understanding of fundamental principles of ship construction and the theories and factors affecting trim and stability and measures necessary to preserve trim and stability.

### Table A-II/3 STCW Code

Competence:	Maintain seaworthiness of the ship
Knowledge, understanding and proficiency:	<i>Ship stability</i> Working knowledge and application of stability, trim stress tables, diagrams and stress calculating equipment.



STABILITY OF THE SHIP  
Version: 05/2022

Section 1. Initial Transverse Stability


### Initial Transverse Stability.

Ship stability is the ability of a ship to float in an upright position and, if inclined under action of an external force, to return to this position after the external force has ceased acting, i.e., the ability of the ship to react to external forces.

The main characteristic of stability is the righting moment, which should be sufficient for the ship to resist withstand the static or dynamic (sudden) action of heeling and trimming moments arising from cargo displacement, under the effect of wind, waves, etc. The heeling (trimming) and righting moments act in opposite directions and are equal at the equilibrium position of the vessel.

There is transverse stability, corresponding to the inclination of the ship in the transverse plane (list of the vessel), and longitudinal stability (trim of the vessel).

Longitudinal stability of sea-going vessels is obviously assured and its violation is practically impossible, while the



Slide: 4/126

Back Next

STABILITY OF THE SHIP  
Version: 05/2022

Section 1. Initial Transverse Stability

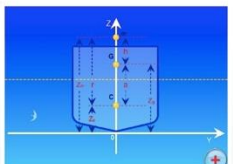
When the ship is inclined, her center of buoyancy (C) is the center of gravity of the volume of water displaced by the ship, i.e. the center of gravity of the underwater volume of the ship will move along a certain curve, called the C trajectory. At small inclination of the ship (not more than 12°), it is assumed that the C trajectory coincides with a straight line, which can be considered an arc of r radius centered at point m.

The r radius is called the differential metacentric radius of the ship, and its m center is the initial metacenter of the ship.

The distance between the initial metacenter m and the ship's center of gravity G is called the initial metacentric height (or simply the metacentric height) and is denoted by the letter h. The initial metacentric height is a measure of the ship's stability.

$$h = z_c + r - z_g \quad h = z_m - z_c \quad h = r - a$$

where a is elevation of G over C.



Initial Transverse Stability

Slide: 5/126

Back Next

STABILITY OF THE SHIP  
Version: 05/2022

Section 2. Static stability curve

### Static stability curve.

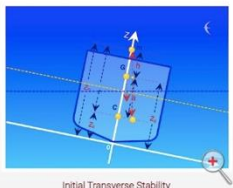
The stability of the ship at small angles of inclination ( $\theta$  less than 12°) of heel is called initial, in this case the righting moment depends linearly on the angle of heel.

Let's consider the equal volume inclinations of the ship in the transverse plane. In doing so, we will assume that:

- angle of inclination  $\theta$  is small (up to 12°);
- the section of the curve CCG of the CB trajectory is an arc of a circle lying in the plane of inclination;
- the line of action of the buoyancy force in the inclined position of the vessel passes through the initial metacenter m.

Under such assumptions, the total moment of the pair of forces (forces of weight and buoyancy) acts in the plane of inclination on the lever GK, which is called the static stability lever, and the moment itself is the righting moment and is denoted  $M_{st}$ .

This formula is called the metacentric transverse stability formula:

$$M_{st} = P h \theta$$


Initial Transverse Stability

Slide: 34/126

Back Next

STABILITY OF THE SHIP  
Version: 05/2022


Section 4. Stability criteria

The procedure for calculating the stability criteria is given in the "Rules for the Classification and Construction of Sea-Going Ships" Vol.1.

For ships sailing in winter in winter seasonal zones, in addition to the main load options, stability considering icing should be checked. In the calculation, account shall be taken of increase in displacement, height of the center of gravity and sail area due to icing. The stability calculation under icing shall be carried out for the worst loading condition as to stability.

For static stability curves, constructed with an icing allowances, the angle of vanishing stability must be at least 55°, and the maximum static stability lever for ships of an unlimited navigation area, must be at least 0.2 m at the list of at least 25°.

When checking stability under icing allowances, the mass of the ice is considered as an overload and is not included in the ship's deadweight. The mass of ice per square meter of



Slide: 72/126

Back Next

STABILITY OF THE SHIP  
Version: 05/2022

Section 5. Ensuring longitudinal stability of the ship

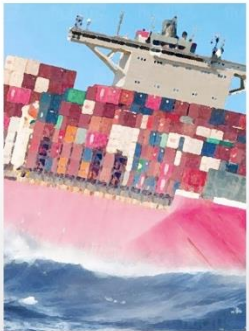
From the point of view of the overall longitudinal strength, the most unfavorable positions of the ship are when the ship's midship is located:

- at the wave crest (the buoyancy forces in this section increase, and decrease towards the ends. Hogging occurs);
- at the wave trough (the buoyancy forces decrease in the middle, and increase towards the ends. Sagging occurs).

The check of the ship's hull strength by the bending moment is carried out according to the Shear and Bending moment diagrams or Tables of Bending Moments and Shear Forces.

In addition to overall strength, local strength is distinguished, i.e. Permissible tank top strength on decks of holds, tween decks, main deck and hatch covers. Its value is given in the Ship's Stability Booklet.

Almost all merchant vessels have computer loading



Slide: 108/126

Back Next

STABILITY OF THE SHIP  
Version: 05/2022

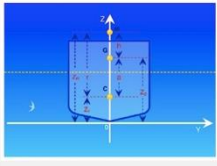
Test task

Indicate what letter denotes the RIGHTING LEVER?

Choose the correct answer

- G.
- C.
- $Z_c$
- $Z_m$
- r.
- $Z_g$
- l.
- m.
- h.

Attempts: 1



COMMENT

Slide: 46/126

Back Next