onBoardMED

TEACHER'S MANUAL

Course:

Effects of Ship Stability in Emergencies and Evacuations

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European Union European Regional Development Fund

TEACHER'S MANUAL

The purpose of the teacher's manual is to assist teachers in organizing and introducing the course. It is not the intention to present teachers with a rigid teaching package which they are expected to follow blindly. Instead, it is an introduction to the material produced in the OnBoard-Med –project.

LEARNING METHODS

Lecture (online, face to face, video)

There are several types of lectures, e.g. online in real time, face-to-face with target groups, or video lectures, which are created offline and presented at a suitable time.

Active lecture

Face-to-face lectures, with dialog between students and lecturers. Normally we use that learning method in theory lessons. Students and teacher will together discuss with open minds.

eLearning

E.g. pre-tasks via learning environment, Kahoot questions, and discussion between international students in discussion platform. Mobile phone or computer is required.

Exercise

Various types of tasks; oral, written, individual, group etc.

NAME OF THE COURSE AND ECTS

Effects of Ship Stability in Emergencies and Evacuations 8 ECTS (1 ECTS = 27 hours; 135 hours)

The course consists of three part courses: Basic Ship Stability (3 ECTS), Stability in Extreme Conditions (3 ECTS) and Loading Computers (2 ECTS)

OBJECTIVES

As the courses are dealing with major safety issues of ship use and design, the studies start with basics of stability, followed by more advanced topics. The objectives are:

After the Basic Ship Stability course (3 ECTS), the student possesses an understanding of ships' stability theory and rules on intact stability, and is able to perform the basic calculations

After the course in Stability in Extreme Conditions (3 ECTS), the student possesses an understanding of ships' stability theory in wind and waves, as well as basics of damaged stability and relevant rules, and is able to perform the basic calculations

After the course on Loading Computers (2 ECTS), the student understands the structure of a loading computer and is able to use it in loading tasks

CONTENTS

Basic Ship Stability (3 ECTS)

1. – 2. Ship's hull
3. Ship's displacement and deadweight
4. Ship's buoyancy
5. Centre of gravity
6. Ship's draft
7. – 9. Ship's initial stability
10. - 11. Ship's stability during large angles of heel
12. Ship's stability when carrying grain cargo
13. Ship's stability requirements and information to the captain

Stability in Extreme Conditions (3 ECTS)

14. Ship's stability during wind
15. – 16. Ship's damage stability
17. Division of ship’s hull into watertight compartments.
18. Ship's stability when grounding
19. – 21. Ship's stability in waves

Loading Computers (2 ECTS)

22. Loading computer

TARGET GROUP

Deck and engine officers and Naval Architects

IMPLEMENTATION AND WORKLOAD

LEARNING METHODS: Teacher assisted learning, slides, problem/solutions, videos, tutorials

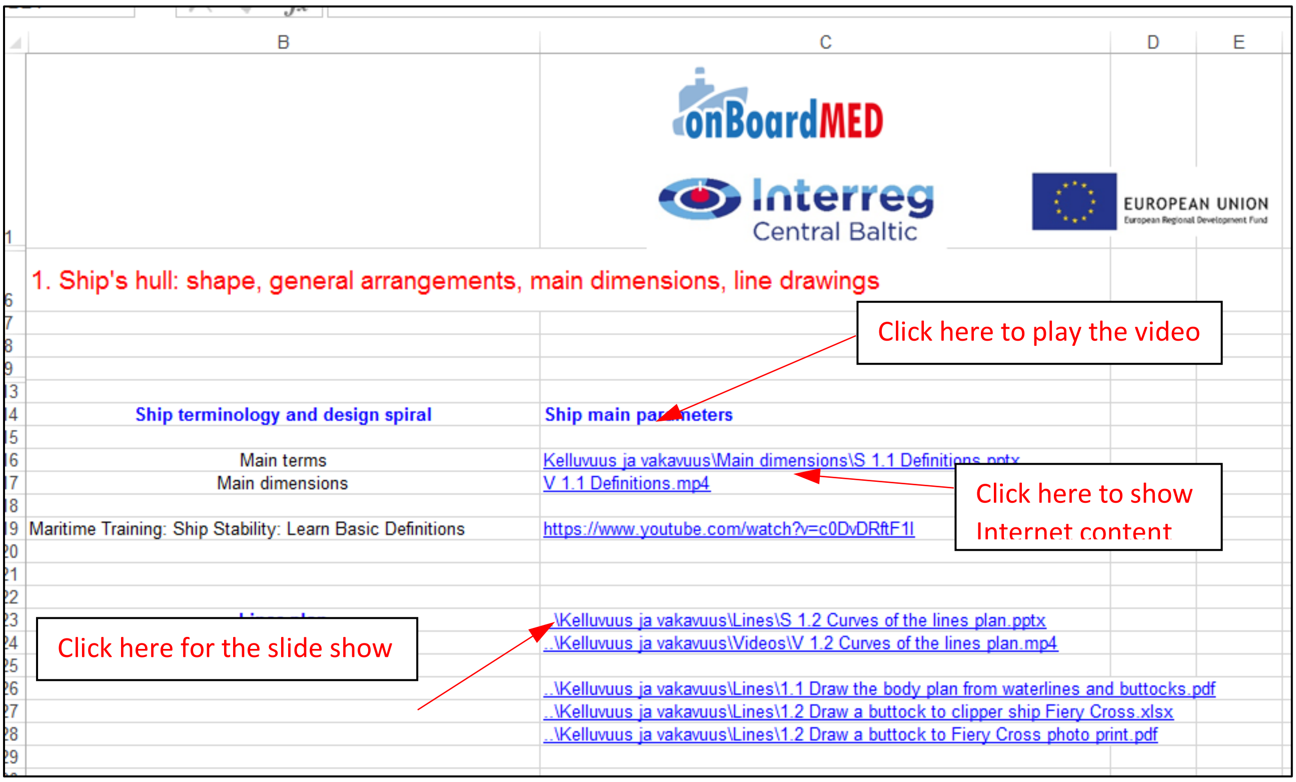
- Basic Ship Stability (3 ECTS) course: 30 hours in class or e-learning, 48 hours of calculation task assignments
- Stability in Extreme Conditions (3 ECTS) course: 30 hours in class or e-learning, 48 hours of calculation task assignments
- Loading Computers (2 ECTS) course: 20 hours in class or e-learning, 32 hours of loading exercises
- Practicing for the Final Exams; hours depend on ability and ambition of the student

ASSESSMENT

Examinations at the end of each course (0-5), assessment of exercises

COURSE MASTER

There is a **COURSE MASTER** Excel- file, where all course materials are linked in logical order. **It is the heart of the course!** See illustration below for topic 1. By clicking the link, the respective slide, video, problem etc. opens to the screen. The Course Master file can be used by the teacher in classroom, as well as by the students in their distance learning.



SUMMARY

Ship Stability in Emergencies and Evacuations 8 ECTS		
12 weeks total, about 16 h of student work per week		
Basic Ship Stability (3 ECTS)	Starting week no:	Learning methods
1. Ship's hull: shape, general arrangements, main dimensions, line drawings.	1	Teacher assisted learning, slides, problem/solutions, videos
2. Ship's hull: coefficients of fineness, approximate calculations of ship's' hull parameters.	1	Teacher assisted learning, slides, problem/solutions, videos
3. Ship's displacement and deadweight: terminology, its determination using loading scale, TPC.	1	Teacher assisted learning, slides, problem/solutions, videos
4. Ship's buoyancy: Archimedes principle, centre of buoyancy, centre of gravity, conditions of equilibrium.	1	Teacher assisted learning, slides, problem/solutions, videos
5. Centre of gravity: determination of ship centre of gravity, its movement when moving or loading cargo.	2	Teacher assisted learning, slides, problem/solutions, videos
6. Ship's draft: change of draft when loading small and large cargo, change of draft due to water density alterations (FWA), determination of draft using loading scale, reserved buoyancy, load line.	2	Teacher assisted learning, slides, problem/solutions, videos
7. Ship's initial stability: metacentre, metacentric height and radius, GZ lever, its determination, angle of loll.	3	Teacher assisted learning, slides, problem/solutions, videos
8. Ship's initial stability: the effect of movement of solid cargo on ships initial stability, the effect on stability of suspended cargo and free surface of a liquid cargo.	3	Teacher assisted learning, slides, problem/solutions, videos
9. Ship's initial stability: the effect of cargo loading and unloading on ships stability, neutral planes, loading of heavy cargo, inclining test.	3	Teacher assisted learning, slides, problem/solutions, videos
10. Ship's stability during large angles of heel: GZ curve, its construction, effect of ships parameters and icing on GZ curve.	5	Teacher assisted learning, slides, problem/solutions, videos
11. Ship's stability during large angles of heel: dynamic stability, diagram for dynamic stability.	6	Teacher assisted learning, slides, problem/solutions, videos
12. Ship's stability when carrying grain cargo.	6	Teacher assisted learning, slides, problem/solutions, videos
13. Ship's stability requirements and information to the captain.	6	Teacher assisted learning, slides, problem/solutions, videos

Stability in Extreme Conditions (3 ECTS)		
14. Ship's stability during wind: static and dynamic action of wind on a ship and its stability.	7	Teacher assisted learning, slides, problem/solutions, videos
15. Ship's damage stability: classification of flooded compartments, permeability coefficient.	7	Teacher assisted learning, slides, problem/solutions, videos
16. Ship's damage stability: calculation of ships floatability in case of damage	8	Teacher assisted learning, slides, problem/solutions, videos
17. Division of ship's hull into watertight compartments.	8	Teacher assisted learning, slides, problem/solutions, videos
18. Ship's stability when grounding: reaction force produced by seabed, refloating the ship by unloading or shifting cargo.	9	Teacher assisted learning, slides, problem/solutions, videos
19. Ship's stability in waves: characteristics of waves, basic principles of ship's rolling motions, ship's rolling in calm water, ships rolling in during swell.	10	Teacher assisted learning, slides, problem/solutions, videos
20. Ship's stability in waves: diagrams for selection of safe course and speed, application of universal diagrams.	11	Teacher assisted learning, slides, problem/solutions, videos
21. Ship's stability in waves: changes in ship's stability during waves, parametric roll, broaching-to, pure loss of stability.	12	Teacher assisted learning, slides, problem/solutions, videos
Loading Computers (2 ECTS)		
22. Loadicator: the control of ship's hull strength, bending moments, shear forces and stability parameters during its operation.	7	Tutorials, teacher assisted learning, slides, problem/solutions, videos

COURSE MATERIALS

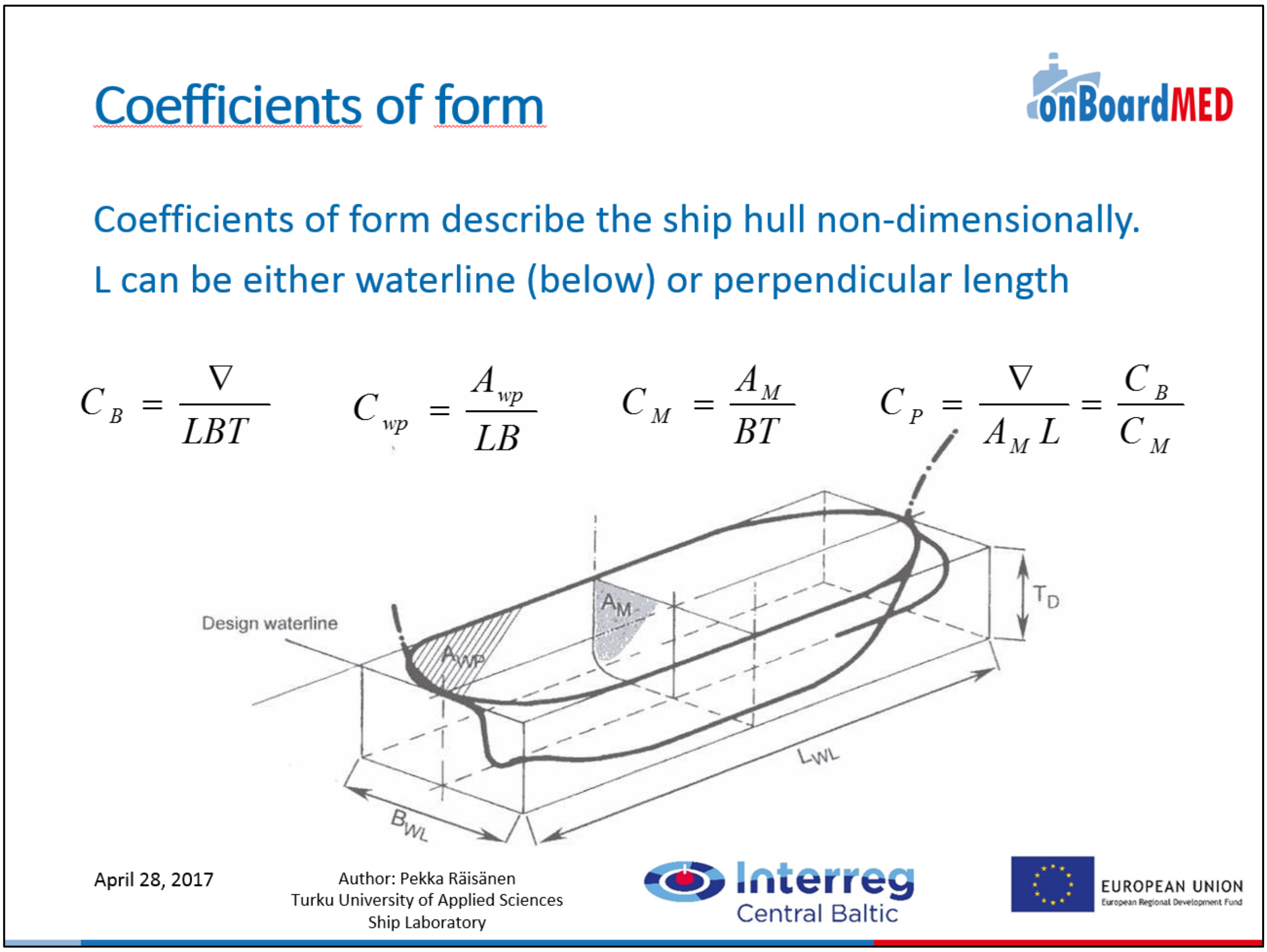
The main material types in the course are slides, videos, problem/solutions, links to public materials and design exercises. All can be presented by clicking a link in the Course Master Excel-file.

In addition, a suitable textbook should be used, e.g. Derrett, D.R.: Ship Stability for Masters and Mates, 6th ed. Butteworth Heinemann, 2006. Further, relevant International Maritime Organization publications, STCW Code and IMO Model Courses, and the rules should be consulted.

EXAMPLES OF MATERIALS

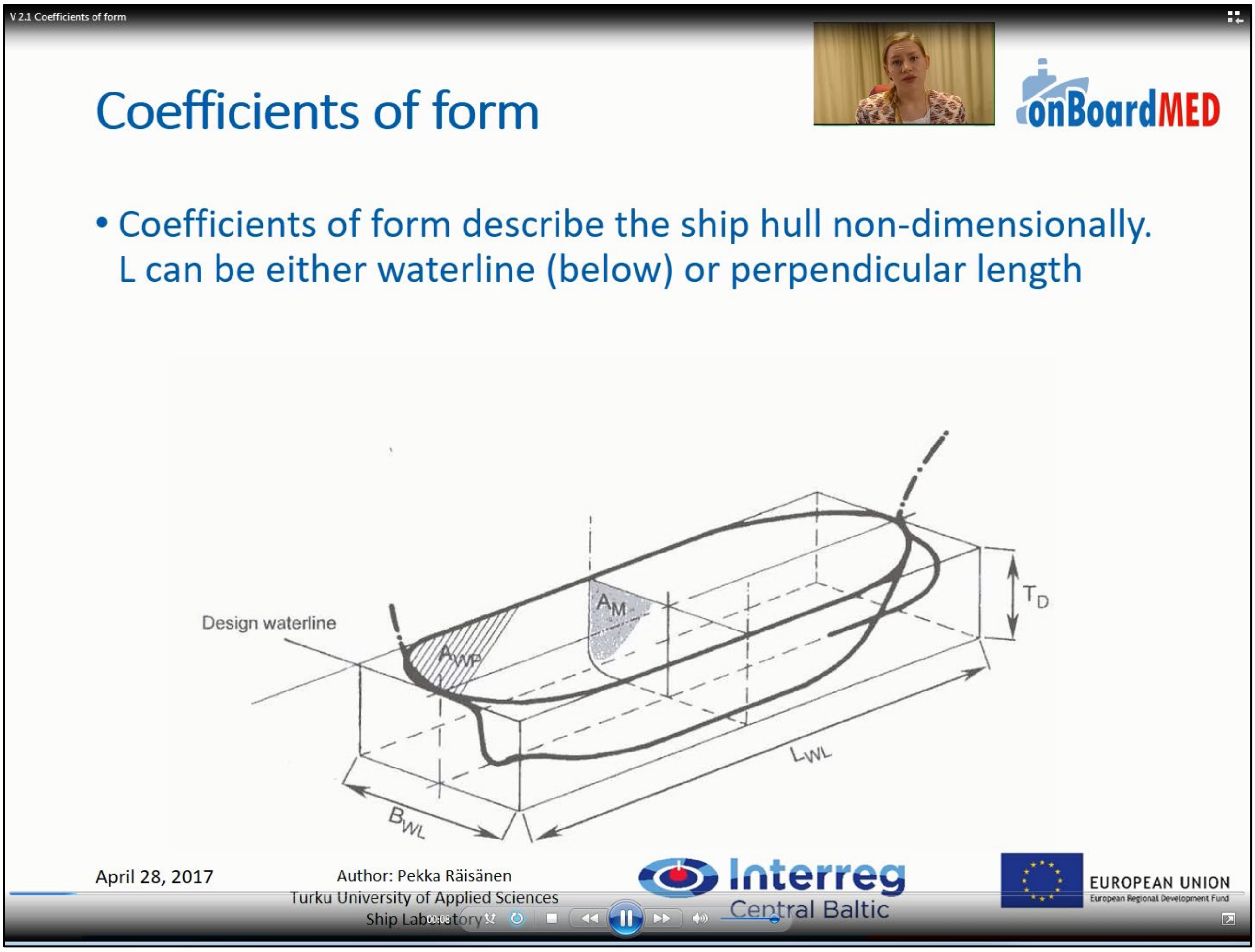
Slides

Sets of 1 to 15 slides per topic



Videos

Video presentations of the key slide shows, 1 to 10 minutes in length



Problem/solutions

Separate pages of problems and their solutions, to be printed out for classroom teaching, or distributed as pdf in distance learning

Author: Sergejs Mašiņenkovs, Latvian Maritime Academy

2.Ship's hull: coefficients of fineness, approximate calculations of ship's' hull parameters.

Source: Sergejs Mašiņenkovs

A ship has the following details:

Draught at the midships (T) = 12,05 m;

Length on the waterline (LWL) = 168 m;

Breadth on the waterline at the midships at given draught (BM) = 27,2 m;

The midship section coefficient (CM) = 0,946;

The longitudinal prismatic coefficient (CP) = 0,885;

Calculate the volume of displacement ∇ [m³].

calculations of ship's' hull parameters.

at given draught (BM) = 27,2 m;

46;

The longitudinal prismatic coefficient (CP) = 0,885;

Calculate the volume of displacement ∇ [m³].

SOLUTION:

1.Data available:

Length on the waterline, L_{WL} [m]	Breadth om the waterline, B_M [m]	Draught, T_M [m]	The midship section coefficient C_M	The longitudinal prismatic coefficient C_P
168,0	27,2	12,05	0,946	0,885

2.Formulas and calculations:

$$C_M(Midship\ section\ coefficient) = \frac{A_M}{B_M T_M}, where:$$

A_M *is midship section area at the given draught* $[m^2]$;
B_M *is the breadth at midship* $[m]$;
T_M *is the draught at midship* $[m]$;

$$therefore,\quad A_M = C_M \times B_M \times T_M, and:$$

$$C_P(Longitudinal\ prismatic\ coefficient) = \frac{\nabla}{L_{wL} \times A_M}, where:$$

∇ **is volume of displacement** $[m^3]$;
L_{wL} *is the length on the waterline at the given draught* $[m]$;

$$therefore,\quad \nabla = C_P \times L_{wL} \times A_M = C_P \times L_{wL} \times C_M \times B_M \times T_M;$$

∇=0,885x168x0,946x27,2x12,05=46099,86 [cub.m]

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Author Jaan Atspol Estonian Nautical School

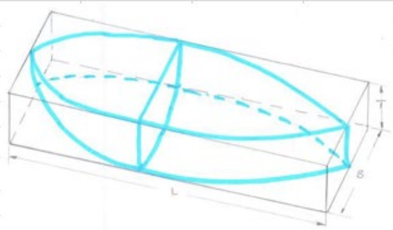
Source: Jaan Atspol

Calculate a) displacement volume

b) displacement mass

A ship has the following detals:

Waterline length	L (m)	160
Waterline breadth	B (m)	21
Draught	T (m)	9
Density of water	ρ (t/m^3)	1,02
Hull coefficent of fineness	C_B	0,8



$\nabla = C_B * L * B * T$

b) displacement mass

$\Delta = \rho * \nabla$

Calculate volume and mass of displacement				
L (m)	B (m)	T (m)	ρ (t/m3)	C_B
160	21	9	1,02	0,80

a) calculate volume of displacement (∇)		
$\nabla = L*B*T*C_B$	24192	m^3

b) calculate mass of displacement (Δ)		
$\Delta = \rho * \nabla$	24676	tons

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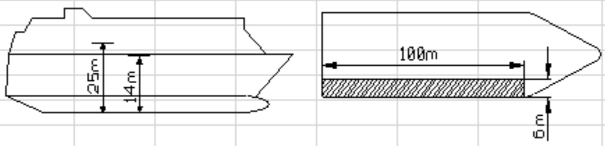
Author: Pekka Räisänen, Turku University of Applied Sciences

Source: Jonas Bergsten.
https://commons.wikimedia.org/wiki/File:Ferry_viking_line_amorella_20050823_001.jpg

Stability curve data of a passenger vessel (not illustrated) in a loading condition are tabulated below. Find wheter the ship fulfils the IMO:s IS Rule Criteria , when the GM is 2,1 m and the downflooding angle is 35 degrees.
In an emergency, the center of gravity of passengers is assumed to move from the initial KG of the ship to the lifeboat deck, where they are assumed to occupy the hatched area below evenly, and the height of their mass is 25 m from keel



T	v (knots)	KG	B	Δ (t)	n	Unit mass of a person (kg)	LWL	zpeople	ypeople
6	22	14	30	18500	2000	75	140	25	12

Heel (degrees)	GZ [m]	e [mrad]
0	0	0
10	0,399	0,033
20	0,813	0,139
30	1,052	0,309
40	0,700	0,471
50	-0,255	0,516

Relevant regulation at the International Maritime Organization site:
http://www.imo.org/en/KnowledgeCentre/IndexofIMOResolutions/Maritime-Safety-Committee-(MSC)/Documents/MSC.267(85).pdf

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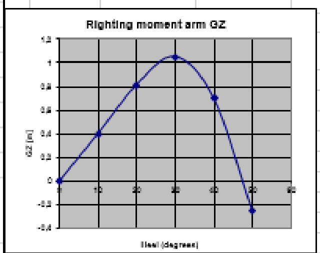
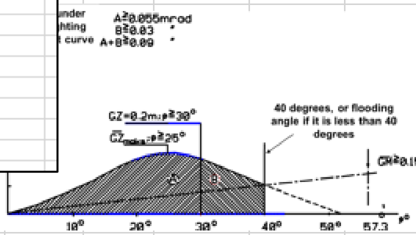
...ated below. Find wheter the ship
...degrees.
...KG of the ship to the lifeboat deck,
...mass is 25 m from keel

...ss ...on	LWL	z_{PEOPLE}	y_{PEOPLE}	m_{PEOPLE} (t)
	140	25	12	150





GM	2,1	greater than 0,15 m	OK	0.1

Heel from passenger crowding

The center of gravity of passengers is assumed to move from initial KG of the ship to the lifeboat deck

$KG_{NEW}=(D*KG-m_{PEOPLE}*KG+m_{PEOPLE}*z_{PEOPLE})/(D-m_{PEOPLE}+m_{PEOPLE})$		14,09	m		
$GM_{NEW}=GM+KG-KG_{NEW}$		2,01	m		
$M_{HEEL}=m_{PEOPLE}*y_{PEOPLE}$		1800	tm		
$M_{HEEL}=M_{RIGHTING}=D*GM_{NEW}*\sin(heel)$					
$heel=\arcsin(M_{HEEL}/(D*GM_{NEW}))$		2,8	degrees	less than 10 degrees,	OK

Heel from turning

	V_S	11,32	m/s		
$M_{HEEL}=0,2*V_S^2/L*D*(KG-T/2)$		3795	tm		
$M_{HEEL}=M_{RIGHTING}=D*GM_{NEW}*\sin(heel)$					
$heel=\arcsin(M_{HEEL}/(D*GM_{NEW}))$		5,6	degrees	less than 10 degrees,	OK

SOME REFERENCES

IMO publications

1. International Code for the Safe Carriage of Grain in Bulk (International Grain Code)
2. International Convention on Tonnage Measurement of Ships, 1969
3. INTERNATIONAL CODE ON INTACT STABILITY, 2008

Other publications

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3. La Dage, J. and Van Gemert, L. (Eds). Stability and Trim for the Ship's Officer. 3rd ed, Centreville, Maryland, US, Cornell Maritime Press, 1983
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15. GILLMER, THOMAS C., AND BRUCE JOHNSON. Introduction to Naval Architecture. Naval Institute Press, 1982. ISBN: 9780870213182

Terminology

1. ITTC Symbols and Terminology List 2014.pdf
2. MSC/Circ.920, MODEL LOADING AND STABILITY MANUAL, section 2.2, table 1, which are based on ISO standards (ISO 7462 and ISO 7463).

Own ideas for implementation

Working Group

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