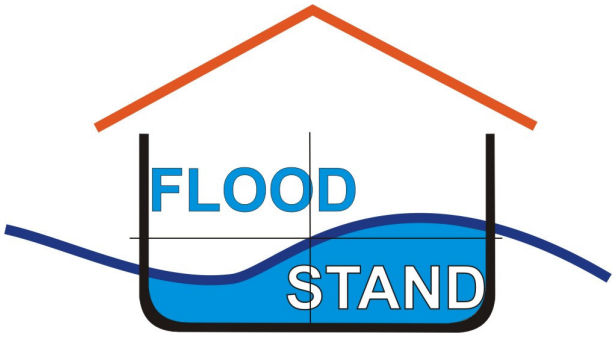
FLOODSTAND
FP7-RTD- 218532
Integrated Flooding Control and Standard for Stability and Crises Management



FLOODSTAND-deliverable:

Description of the mockup and test procedures; List of structures to be tested

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Investigating partners: CTO, STX, MEC, MW, AALTO (ex. TKK) **Authors: Adam Bocian, Rafał Klotzke Bartosz Borowiecki** **Reviewed by**: **Mateusz Weryk**	
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Abstract: The report contains a strength numeric analysis of tank, which is used to laboratory research on the ship's structural elements strength as the doors, windows, partition walls and others. The elements mentioned above have to be attached to the tank's structure and flooded over water to the pressure 200 kPa.

*This D2.1a (version 1.2.1) is the last corrected revision of D1.2, accepted by the SC finally on 1.10.2010.

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EXECUTIVE SUMMARY (public)

The report contains a strength numeric analysis of a tank, which is used to laboratory research on the ship's structural elements strength such as doors, windows, partition walls and others. The elements mentioned above have to be attached to the tank's structure and flooded over water to the pressure 220kPa.

The report also contains the following items:
- Description of test procedures (in chapter 4)
- List of structures to be tested.(in Appendix)
- Mock-up test design.(in Appendix)

As a result of this report one can find:
- test stand project with all necessary analysis
- test procedure with test specimens list

Progress beyond state of the knowledge:
Mock-up test stand as a unique measurement tool used for leakage phenomena investigation.

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TECHNICAL REPORT

No. RK - 2009/T - 160 /E

Title: Mock-up test design

Deliverable no. 2

Page 4
Number of pages 15
Copy No. …

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Approved by: Mateusz Weryk

Accepted by:

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GENERAL INFORMATION

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Project Title: Integrated flooding control and standard for stability and crises management

Project no.: FP7-RTD- 218532

CTO reference: 5.167.01.221

Work Package no 2: Flooding progression modelling

Task no 2.1: Experiments with leaking and collapsing structures

Subtask no 2.1.1: Planning and preparations for the tests

Subject of report
The report contains a strength numeric analysis of tank, which is used to laboratory research on the ship's structural elements strength as the doors, windows, partition walls and others. The elements mentioned above have to be attached to the tank's structure and flooded over water to the pressure 200kPa.

Keywords:

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……

Distribution of the Report:

Consortium: ……. copies
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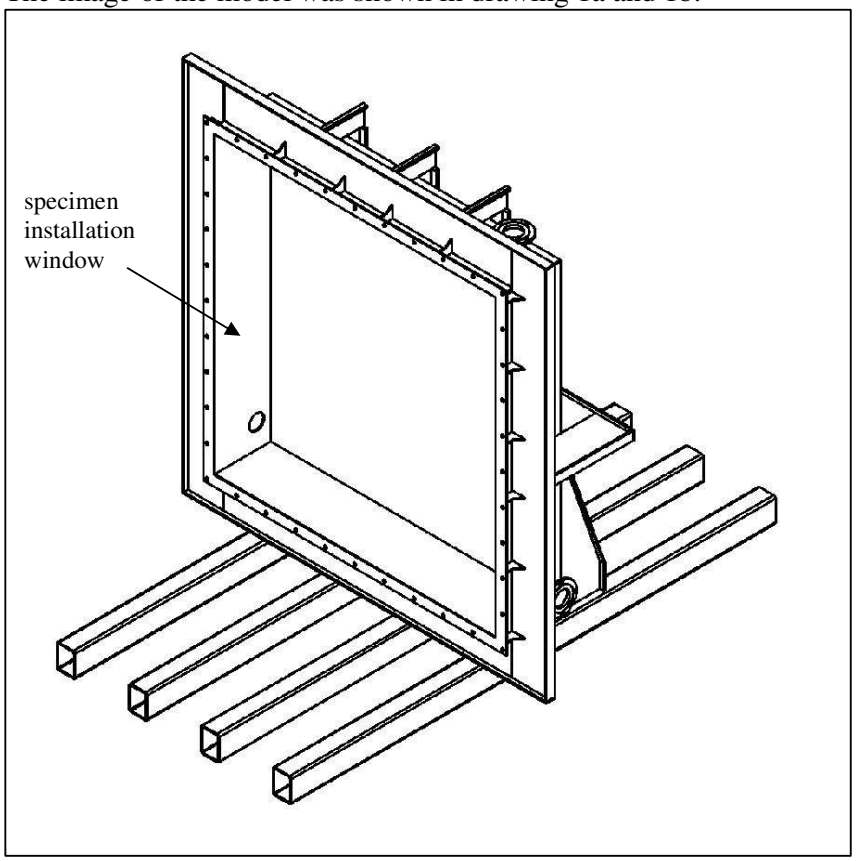
1. EXECUTIVE SUMMARY

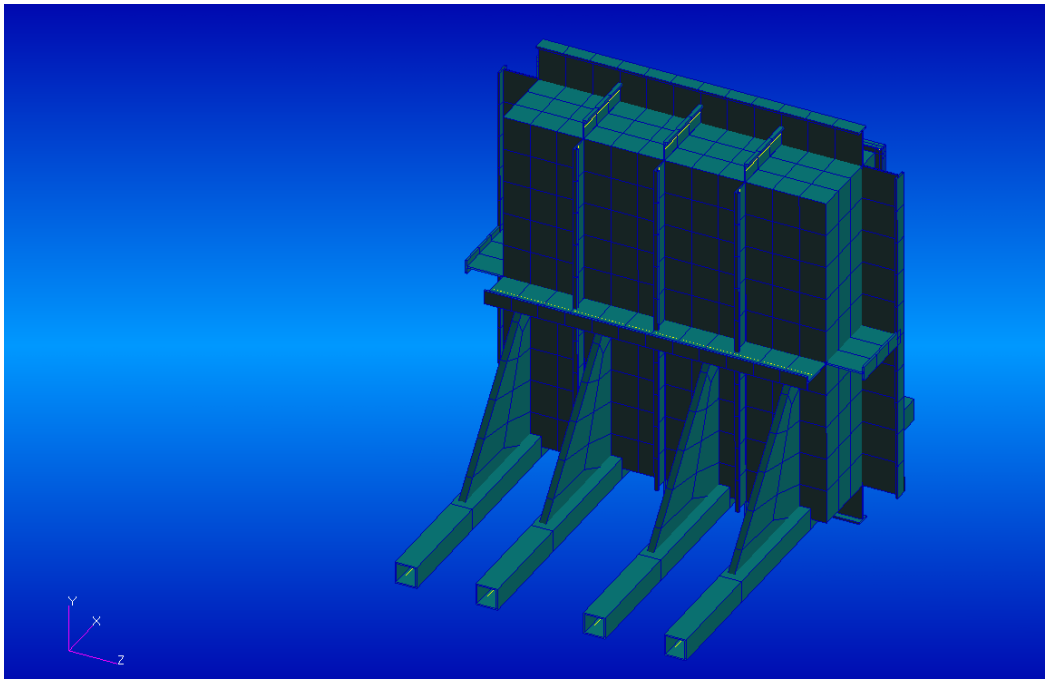
The report contains a strength numeric analysis of tank, which is used to laboratory research on the ship's structural elements strength as the doors, windows, partition walls and others. The elements mentioned above have to be attached to the tank's structure and flooded over water to the pressure 200kPa .

2. VIRTUAL MODEL FOR FEM ANALYSIS

The model of the tank was made in basing for provided documentation through:
MEYER WERFT in the K7769 file No. of drawings:
0001,0100,0101,0102,0103,0104 and consultation with Head of Design & Documentation Department of CTO S.A.
The model was made in the Patran 2008 r2 for MD Nastran program, calculations were made in the MD Nastran R3c program. The model is built from shell elements Quad4 and spatial Hex8 and one-dimensional Bar2. The total number of elements of the model amounts 1126.
The image of the model was shown in drawing 1a and 1b.



Drawing 1a. The tank model with specimen installation window marked.



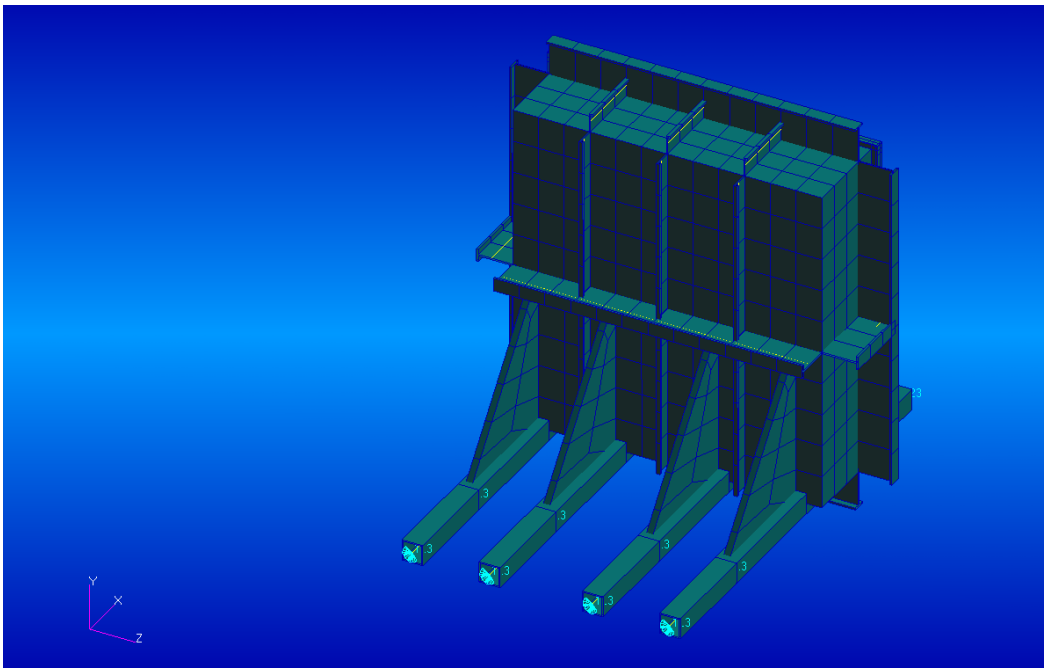
Drawing 1b. The tank model.

Material data used during numerical calculations was compiled in tab.1.

Table.1. Material properties.

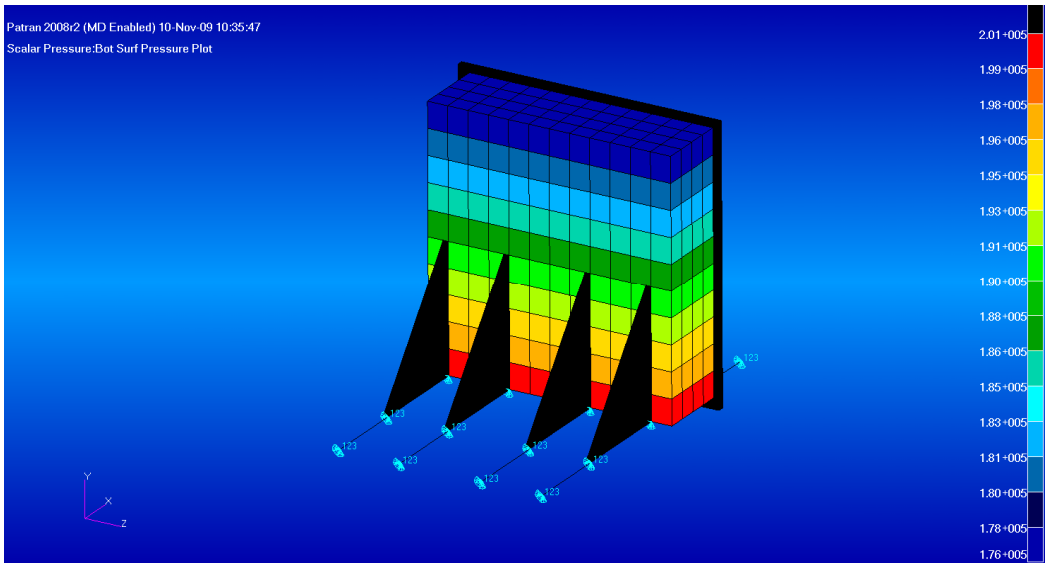
	Steel	Rubber gasket
Young modulus E [Pa]	$2{,}1 \cdot 10^{11}$	$0{,}1 \cdot 10^{9}$
Poisson ratio ν [-]	0,3	0,45
Density ρ [kg/m^3]	7800	2000

The boundary conditions – the tank attaching is shown on drawing 2.



Drawing 2. The tank model attaching (Stiffening is shown as 3D form).

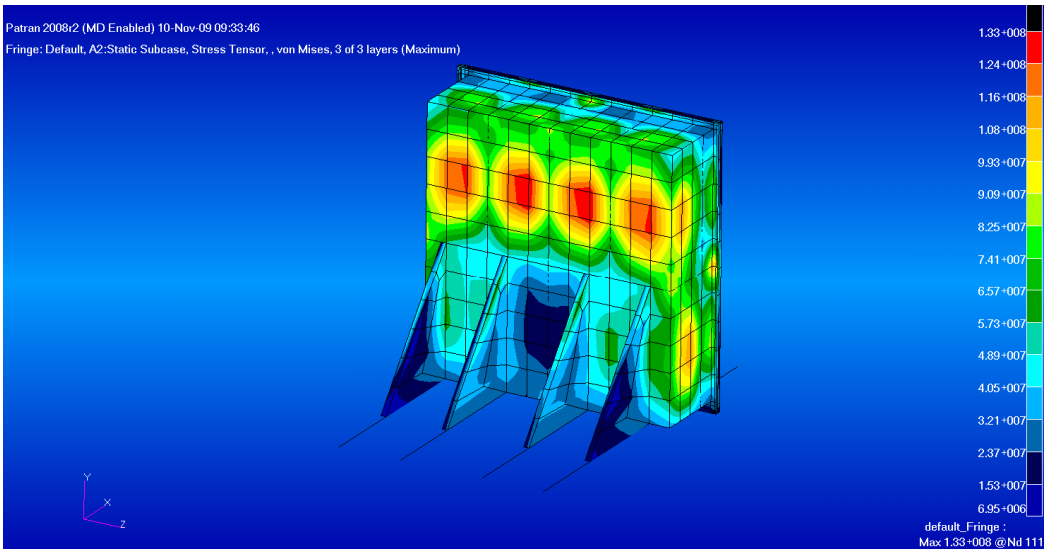
The sea water load of 200 kPa of column of liquid was shown in drawing no 3.



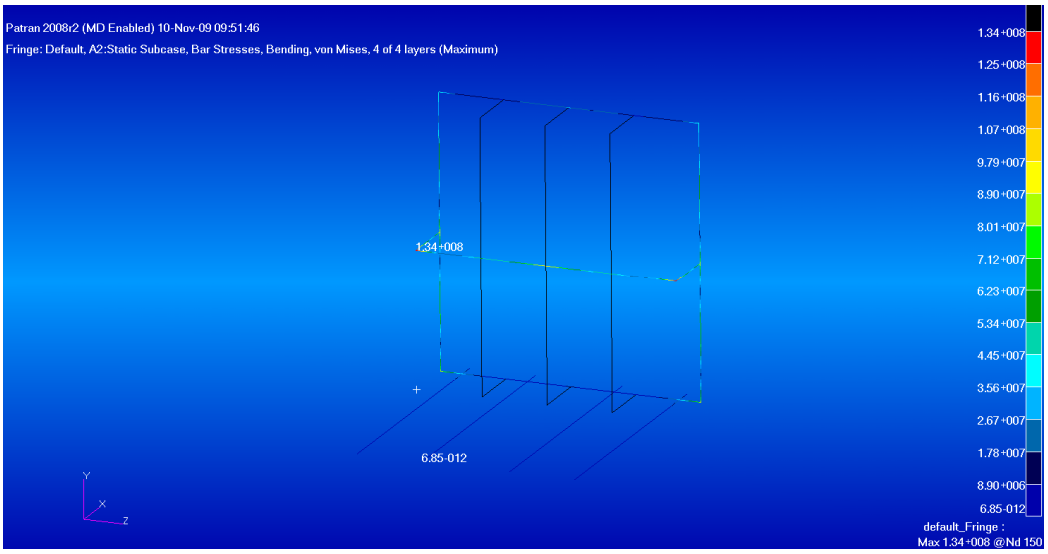
Drawing 3. The tank water load (hydrostatic scale pressure [Pa]).

3. RESULTS OF THE ANALYSIS

The numeric analysis results is shown in drawings 4 to 5.



Drawing 4. The stress distribution on tank's walls (scale pressure [Pa]).



Drawing 5. The stress distribution in tank's stiffening (scale pressure [Pa]).

4. TEST PROCEDURE.

1. Specimen preparation, connecting specimen to the mock-up stand, sensor allocation
2. Starting pump work, supply valve and air removal valve opening. Before this one will determine measurement point grid (for example every 1m column water)
3. When approaching measurement point , speed of flooding will be limited by pump revolution regulation with a use of inverter until flooding will be equal to pump performance, regulation can be also done using valves. When constant pressure is obtain then measurement starts. Flooding measurement is being executed with a use of flow-meters installed in piping system. Measured parameters will be recorded on acquisition computer. Sequence when in order to establish equilibrium point pressure is being raised by raising pump performance and reducing pump performance in moment of getting to the measurement point will be repeated up to the measurement range or specimen collapsing - **Test is executed properly when test object is damaged or water flow rate value exceeds critical value ~90 l/s or critical pressure above 220kPa**. In case when 2.5m column water is being exceeded (when tank is full) water will be flowing out the air removal valve – in this moment for continuous pressure increase this valve will be closed and membrane tank (which prevents from sudden pressure growth) will be filled.
4. Displacement sensor output will be recorded also on special acquisition computer. In case of a little leakage (for water-tight specimens) one will measure flow using small flow-meter.
5. After test is done disassembly of specimen and test frame is done.

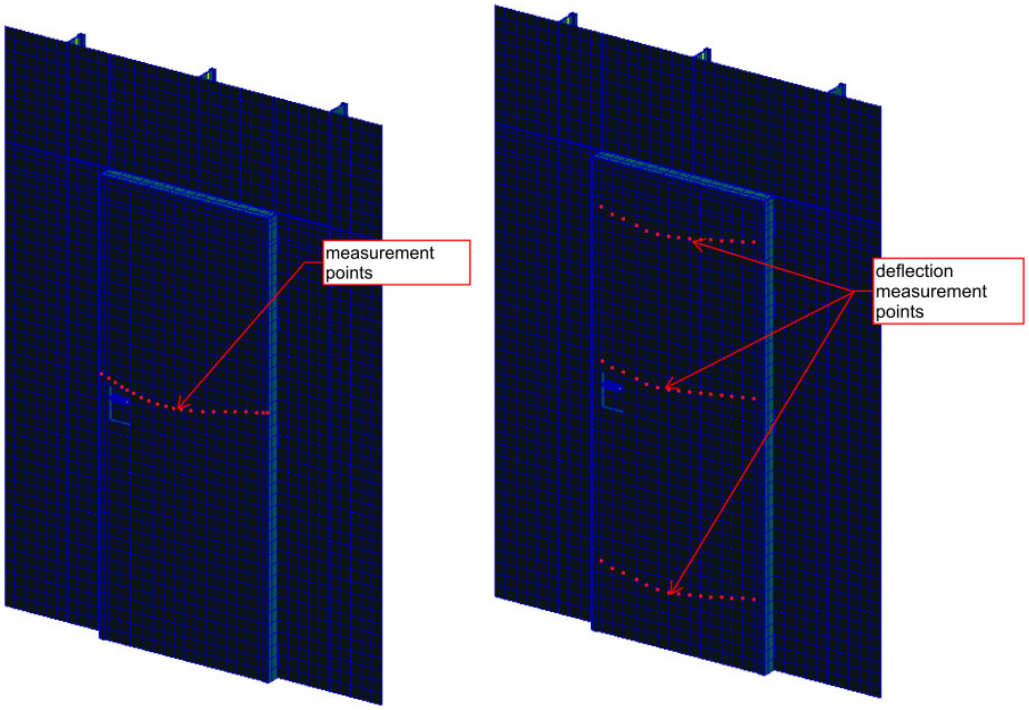
The final location of measurement points for each test item will be decided in close co-operation with the other partners (STX, MW TKK and NAPA), taking into account the knowledge gained in previous tests for semi-watertight doors. First measurement points are always done with small pressure increments (e.g. 0.2 m) in order to find out if the leaking rate and deformations take place already with small

pressures. Additional measurement points can be added if necessary also during the tests, in order to capture all relevant phenomena.

Below there is a table with measurement parameters.

Table.2. Measurement parameters table

Measurement parameters		
no.	**Parameter**	**additional info**
1	Pressure	pressure sensor
2	Leakage	flow meters
3	Displacement	laser transducer, optional strain gauges
4	Movie/photo	standard camera, optional Hi-Speed camera



Drawing 6. Deflection measurement points idea (established separately for every single test)

5. SUMMARY

The tank structure strength is ensured under applied loads and ready to carry out all needed tests. Mock-up test stand built according to this project will be an unique laboratory device which will help to understand real scale leakage phenomena.

List of structures to be tested

FLOODSTAND (218532)
WP2 Task 2.1

List of structures to be tested

Test Number	Item	Category	Prority 0 = low 3 = high	One direction/two directions	Number of repetitions of tests	Total number of tests	Number of Items to be purchased and shipped	Supplier of test sample
		Type B2						
1 (1.1+1.2)	1.1	A class fire door - sliding	2	2	1	2	2	MW
2 (2.1-2.4)	1.2	A class fire door - hinged	3	2	2	4	4	MW
3 (3.1+3.2)	1.3	A class fire door - double leaf	3	2	1	2	2	STXE
4 (4.1+4.2)	1.5	A class fire door - hinged, with hose port	3	2	1	2	1	MW
		Type B3						
5 (5.1-5.4)	3.2	B class joiner door - hinged	3	2	2	4	4	STXE
		Other						
6	4.3.2	Cold room sliding door	2	1	1	1	1	STXE
7	4.3.1	Cold room panel	3	1	1	0	0	STXE
8 (8.1+8.2)	4.8	Cabin wall panel, for modular constructions	3	1	1	2	2	STXE
9	4.9	Cabin wall panel, built on site	3	1	1	1	1	MW
		Type A2						
10	2.1	SWT door - sliding	3	1	1	1	1	STXE
		Other						
11	4.7	Window	2			1	1	MW
12	4.5	Cross flooding hatch, type STXE	2	1	1	1	1	STXE
13	4.6	Cross flooding hatch, type MW	2	1	1	1	1	MW

Note! Cold room sliding door and cold room panel tests have been combined into one test (test numbers 6 and 7).

Total number to be tested 22

Total number of items to be shipped 21

Mock-up test design project