FLOODSTAND
FP7-RTD- 218532

Integrated Flooding Control and Standard for Stability and Crises Management

FLOODSTAND-deliverable:

Benchmark data on time to capsize for a soft moored model

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Abstract:
A set of physical model experiments aiming at characterizing stochastic process of the time it takes for the vessel to capsize/sink after a hull breach event has been carried out at SSPA Sweden AB in the Maritime Dynamics Laboratory. A RoPax vessel model in scale 1:40 was used. A two compartment damage was modelled and a series of tests with a soft moored model at stationary beam-on-to-waves was performed.

Acknowledgements: The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 218532. The financial support is gratefully appreciated.

EXECUTIVE SUMMARY

A set of physical model experiments aiming at characterising stochastic process of the time it takes for the vessel to capsize/sink after a hull breach event has been carried out at SSPA Sweden AB in the Maritime Dynamics Laboratory. A RoPax vessel model in scale 1:40 was used. A two compartment damage was modelled and two series of tests at stationary beam-on-to-waves were performed.

In the first series of tests the model was free drifting with the waves for maximum 30 minutes. The results are given in SSPA Report no. 40094581-1 (Deliverable D4.1a).

In order to get more information about the time to capsize, up to 3 hours, for the lower wave heights, 2 m and below, another set of tests were carried out. In these tests the model was kept in position by means of a soft mooring system. In the present report the results of these tests are given.

REPORT

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FLOODSTAND
Integrated flooding and standard for stability and crises management
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Benchmark data on time to capsize

Capsizing tests at SSPA

Part 2: Soft Mooring

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Summary

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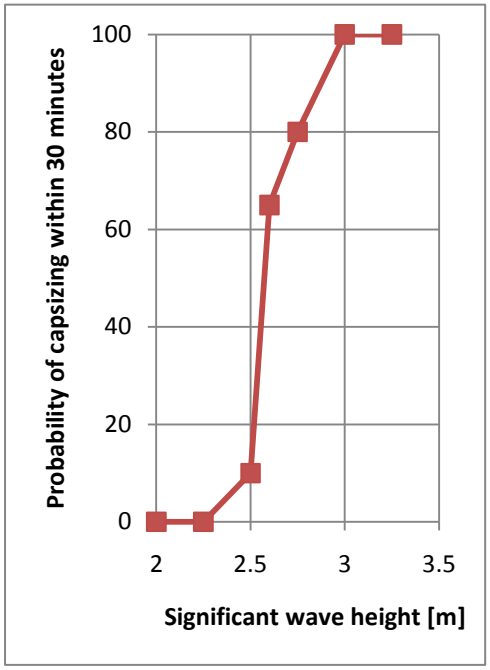
1 Introduction

A set of physical model experiments aiming at characterising stochastic process of the time it takes for the vessel to capsize/sink after a hull breach event has been carried out at SSPA Sweden AB in the Maritime Dynamics Laboratory. A RoPax vessel model in scale 1:40 was used. A two compartment damage was modelled and a series of tests at stationary beam-on-to-waves was performed. The series of tests comprised repetitions in order to create sufficiently consistent relative frequency distribution of time to capsize.

1.1 Tests with free drifting model

A first set of tests (83 tests) were carried out with the model free to drift with the waves. The results of these tests are given in SSPA Report no. 40094581-1 (Deliverable D4.1a). A test was interrupted when the average heel angle exceeded 20^{o} or the time exceeded 30 min in full scale time.

The results of the tests are summarized in the figure below.



1.2 Tests with a soft moored model

In order to get more information about the time to capsize, up to 3 hours, for the lower wave heights, 2 m and below, another set of tests were carried out. In these tests the model was kept in position by means of a soft mooring system. In the present report the results of these tests are given.

2 Ship data

The tests were carried out with a model of a RoPax vessel. The main data of the ship at the intact loading condition are given in Table 1:

Table 1 Main data of the intact ship

Parameter	Unit	Value	
Length, Lpp	[m]	137.4	
Breadth, moulded	[m]	24.2	
Draft, aft	[m]	5.61	
Draft, forward	[m]	5.17	
Displacement	[m^3]	12 046	
Block coefficient	[-]	0.683	
LCG (fwd of Lpp/2)	[m]	-4.66	
VCG (above BL)	[m]	10.62	
GM_T (measured)	[m]	Intact cond.	Damage cond.
		1.17	1.04
Radii of gyration in air, roll	[m]	8.954 (0.37*B)	
Radii of gyration in air, pitch	[m]	37.1 (0.27*Lbp)	

The SSPA ship model 3191-A was used in the tests. The body plan is shown in Figure 1. The model was manufactured in scale 1:40.

The model was equipped with two fixed rudders, SSPA stock propellers and bilge keels.

Table 2 Main data of the rudders

Parameter	Unit	Value
Area (one rudder), movable	[m^2]	8.75
Area (one rudder), total	[m^2]	10.85
Rudder height	[m]	4.00
% of Lbp · T per rudder	[%]	2.93

Table 3 Main data of the propellers

Parameter	Unit	Value
Diameter (full scale)	[m]	4.18
No of blades, Z	[-]	4
Pitch P/D at 0.7R	[-]	0.806
Blade area ratio	[-]	0.611

The length of the forward bilge keels is 35.2 m (#7.95 to #13.07) and the aft bilge keels 13.6 m (#5.38 to #7.36). The height of the bilge keels is 0.6 m

The design water line was marked on the model as well as marks for every other meter vertical distance.

2.1 The hull damage

Damage was caused to the model according to SOLAS damage opening standard by means of a V-cut in the hull from bottom to top. The depth of the cut is B/5 = 4.84 m and the length is 0.03L+3 m = 7.12 m. The position of the centre of the damage is 37.8 m forward of AP, see Figure 2.

The flooded compartments below the car deck are R511, R512, R519, R521 and R611 as shown in Figure 3. The total gross volume of the flooded compartments is 3 246 m^3. The net volume was measured to 2 418 m^3. The volume of the intact side tanks on the starboard side R513, R514 and R515 is 16.3, 25.5 and 21.2 m^3 respectively.

The trim angle of the damaged ship was measured to 0.45 deg relative to the intact ship and the heel angle was 4.25 deg towards the port.

Photos of the model are shown in Figure 4.

3 Model tests

3.1 Test facility and procedure

The tests were carried out with a soft moored model in the Maritime Dynamics Laboratory (MDL). MDL has a basin with the dimensions 88 m x 39 m and variable water depth between 0 and 3.0 m.

Wave generators for producing regular waves and irregular long-crested waves are installed on two perpendicular sides of the basin. A multi-motion carriage, used for data logging and model control, spans the whole basin.

Measurement signals from the model are transferred to the carriage via a lightweight measuring arm, which does not influence the motions of the model. Control signals from the measuring arm are directly linked to the carriage control computer and data logging system.

A test starts with the model secured to the carriage by means of stretched cords at a position 20 m from the wave generators with the port side (damaged side) facing the wave generators. The wave generators are started and the different wave components are successively sent away towards the model, with the shortest waves first, in such a way that the wave spectrum will be fully developed when all wave components reach the position of the model. Shortly before this the model is released from the carriage and the data logging system is started. The model is kept in position by means of a soft mooring system.

A test is interrupted when the average heel angle exceeds 20 deg or when the duration of the test exceeds 3 hours in full scale time.

The model is then secured to the carriage and drained from water. In order to be sure that there is no water left in the model before the next test the trim and heel are checked in a static measurement.

3.2 Soft mooring system

In order to make it possible to allow measuring times up to 3 hours the model has to be prevented from drifting. This was obtained by means of a soft mooring system. The system consisted of four cords attached to the model in the water line/centre line, two in the stern and two in the bow at about 45^{o} angle. In each cord there was a soft spring adjusted in such away that the natural frequencies in surge, sway and yaw were well below the wave frequencies. A sketch and photos of the mooring system are shown in Figure 5.

3.3 Measurements

The following parameters were measured at a sampling frequency of 50 Hz in model scale corresponding to 7.91 Hz in full scale.

Table 4 Measured parameters

Parameter	Unit
Wave height CL (123.6 m aft L/2 in the CL)	m
Surge	m
Sway	m
Heave	m
Roll	deg.
Pitch	deg.
Yaw	deg.

A definition of coordinate system is given in Enclosure 1.

Video recordings of all tests were made. Video cameras were positioned at bow and side perspective on the port side.

Photos from some tests are shown in Figure 6.

3.4 Capzising tests

The test programme according to the table below was carried out in beam sea at zero speed.

Table 5 Test programme

$H_{1/3}$ [m]	T_p [sec.]	No. of tests
1.50	4.90	3
2.00	5.66	3

The wave spectra were generated according to the Jonswap formulation with γ = 3.3.

The waves were calibrated at a fixed position in the basin before the tests. The position was the same as the model's i.e. 20 m from the wave generators.

4 Results

The results of the wave calibration are given in Appendix 01.

In Appendix 02 time series plots of all tests are given. The plotted parameters are Wave height CL, low pass filtered and unfiltered roll and pitch and yaw. The low pass filter was a digital filter of the order of 256 with a cut-off frequency of 0.01 Hz.

In Appendix 03 statistical tables of each test are given. The results are summarized in Table 6.

Table 6 Results from capsizing tests

Ser/Run	Nominal $H_{1/3}$ [m]	Measured $H_{1/3}$ [m]	Time to capsize [h:min:sec]
3/25	1.50	1.33	1:02:38
3/27	1.50	1.28	> 3:00:00
3/29	1.50	1.29	1:19:16
3/18	2.00	1.96	0:20:04
3/20	2.00	1.89	0:18:58
3/22	2.00	1.84	0:16:58

In Appendix 04 the results from decay tests in roll, surge, sway and yaw are plotted and analysed. The used analysis method is described in Enclosure 2.

The results from the static measuring that preceded each test are given in tables in Appendix 05.

The contents of the attached DVD records are listed in Appendix 06.

Time series of all tests and static measuring are stored on an attached CD. A specification is given in Appendix 07.

5 Figures, enclosures and appendices

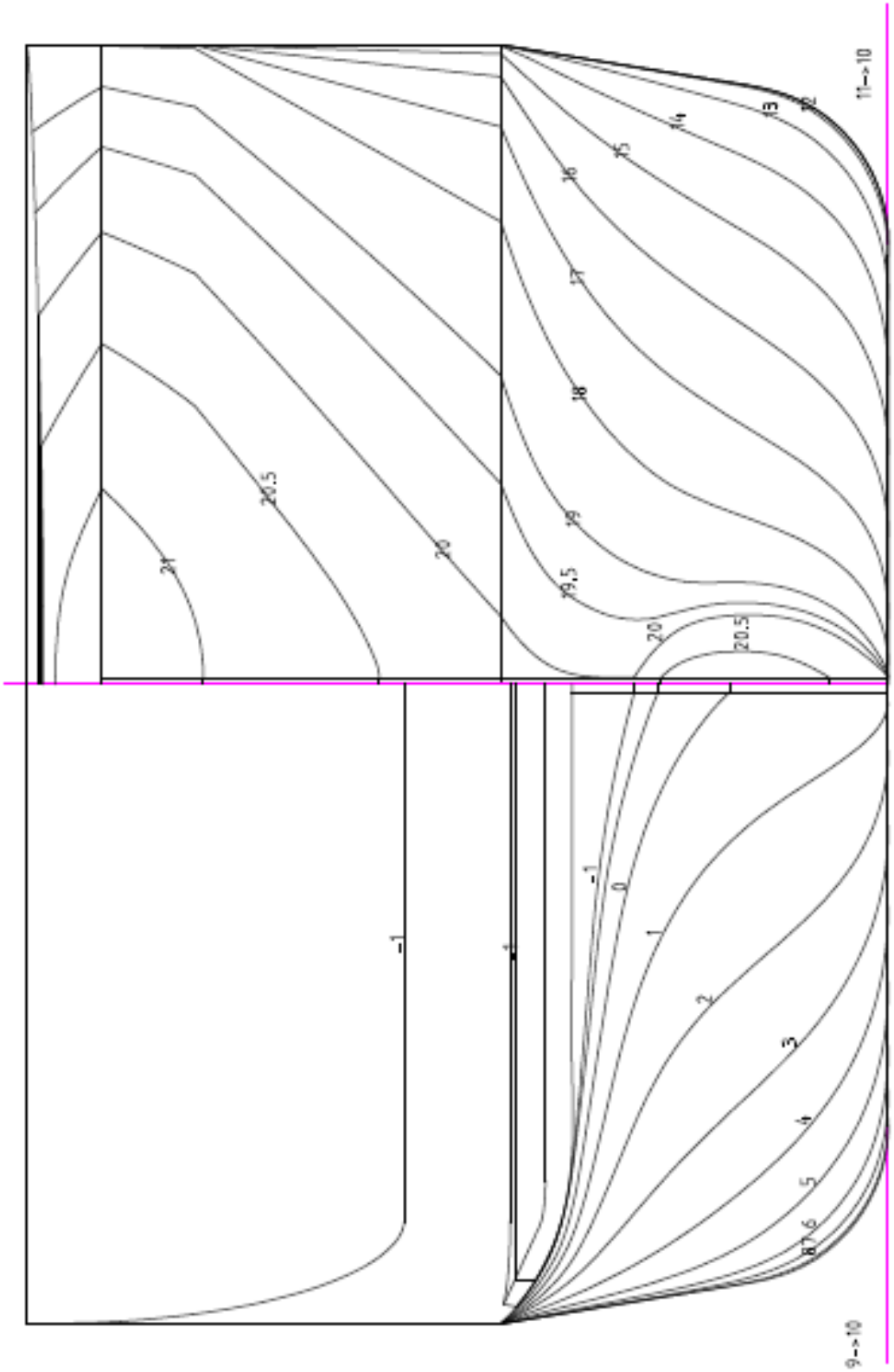
Table of figures

Table of tables

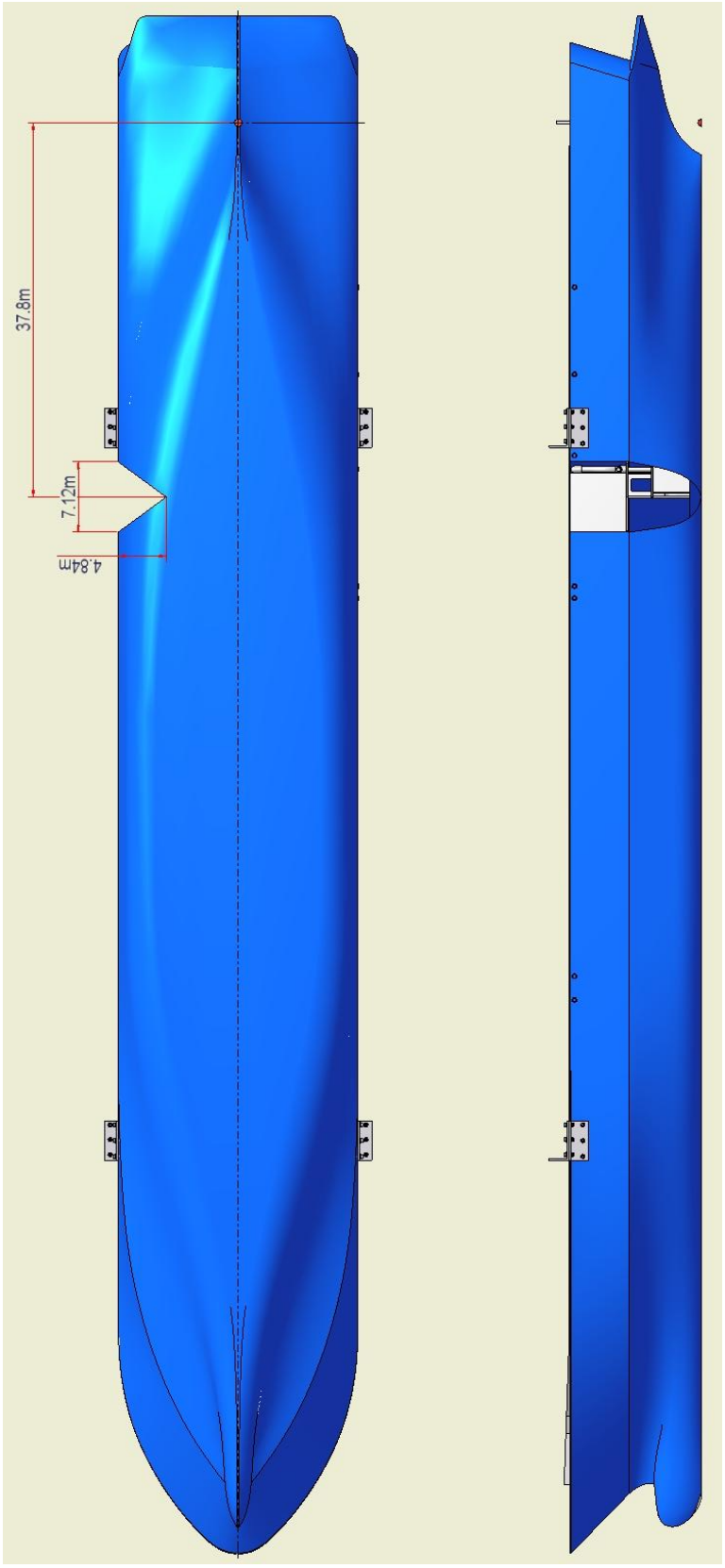
Table of enclosures

Table of appendices

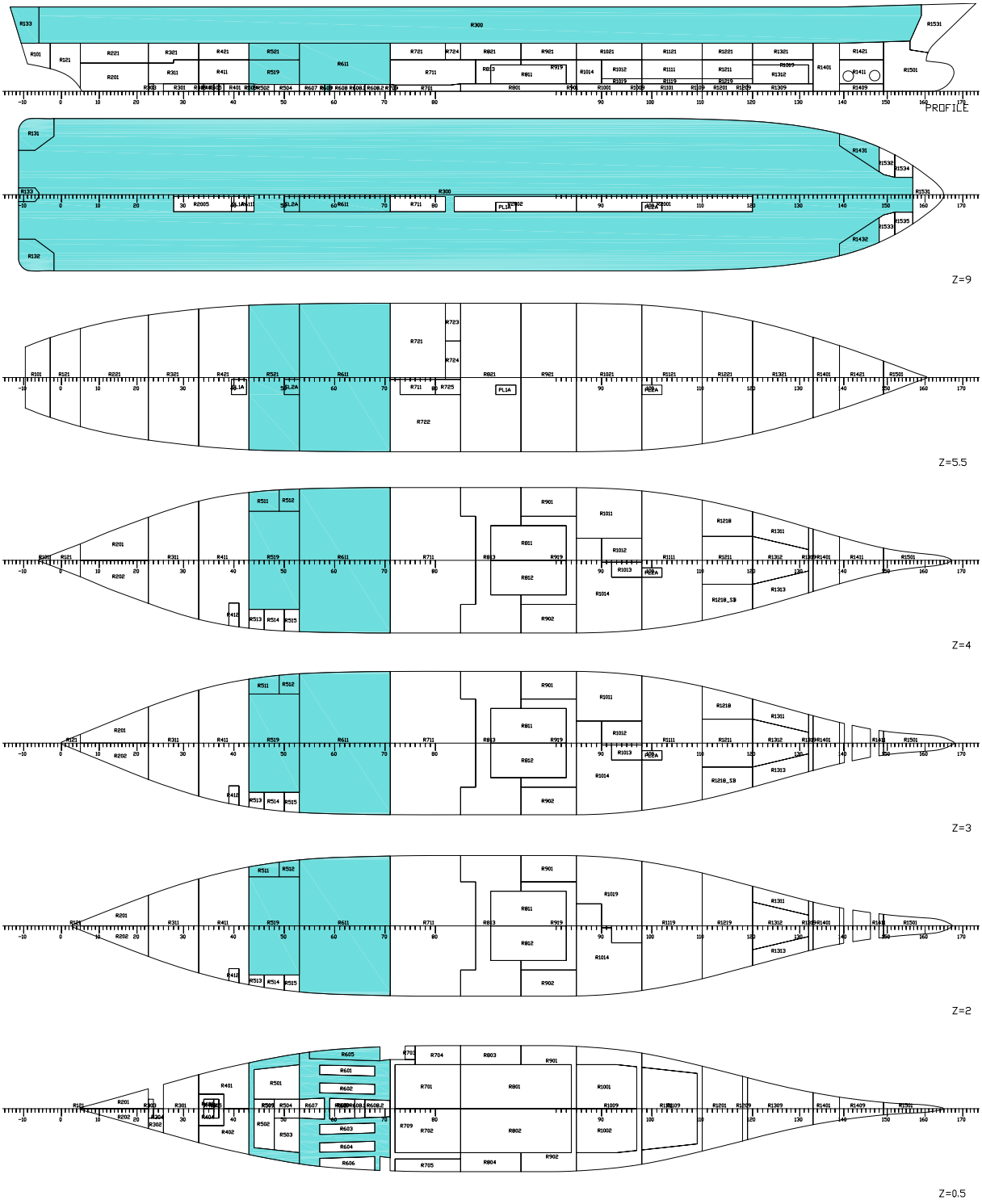
Body plan Figure: 1



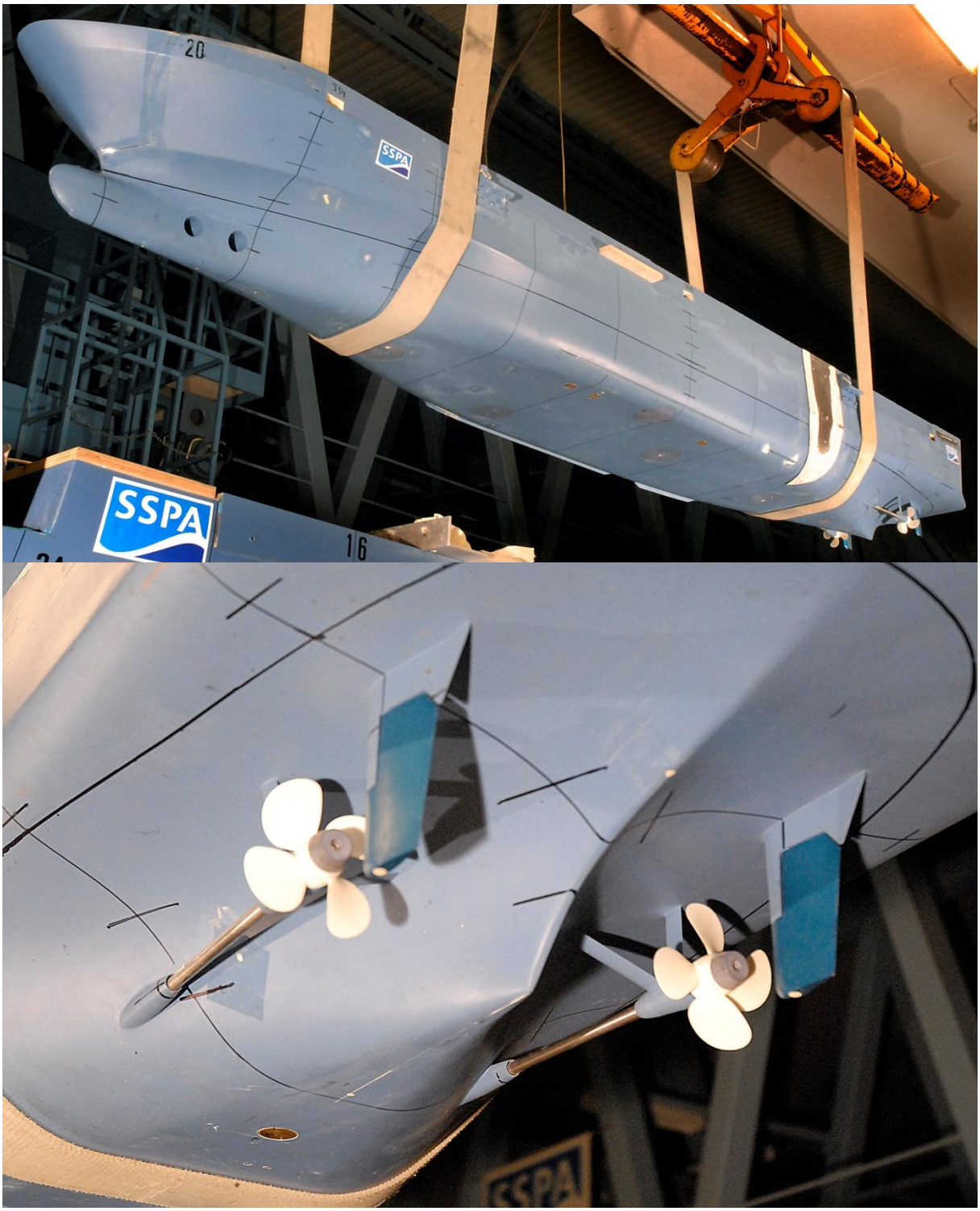
The damage Figure: 2



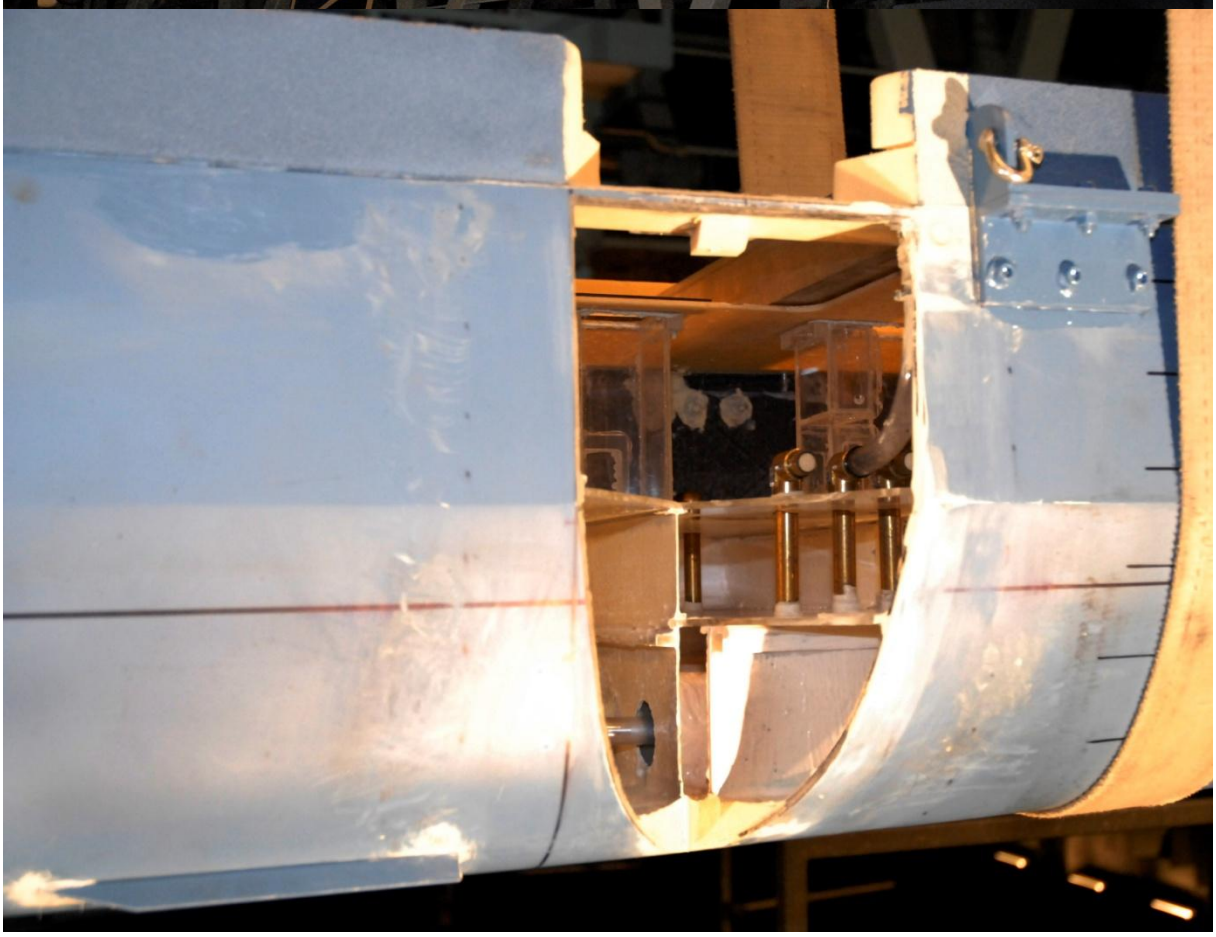
Flooded compartments Figure: 3



Photos of ship model Figure: 4a

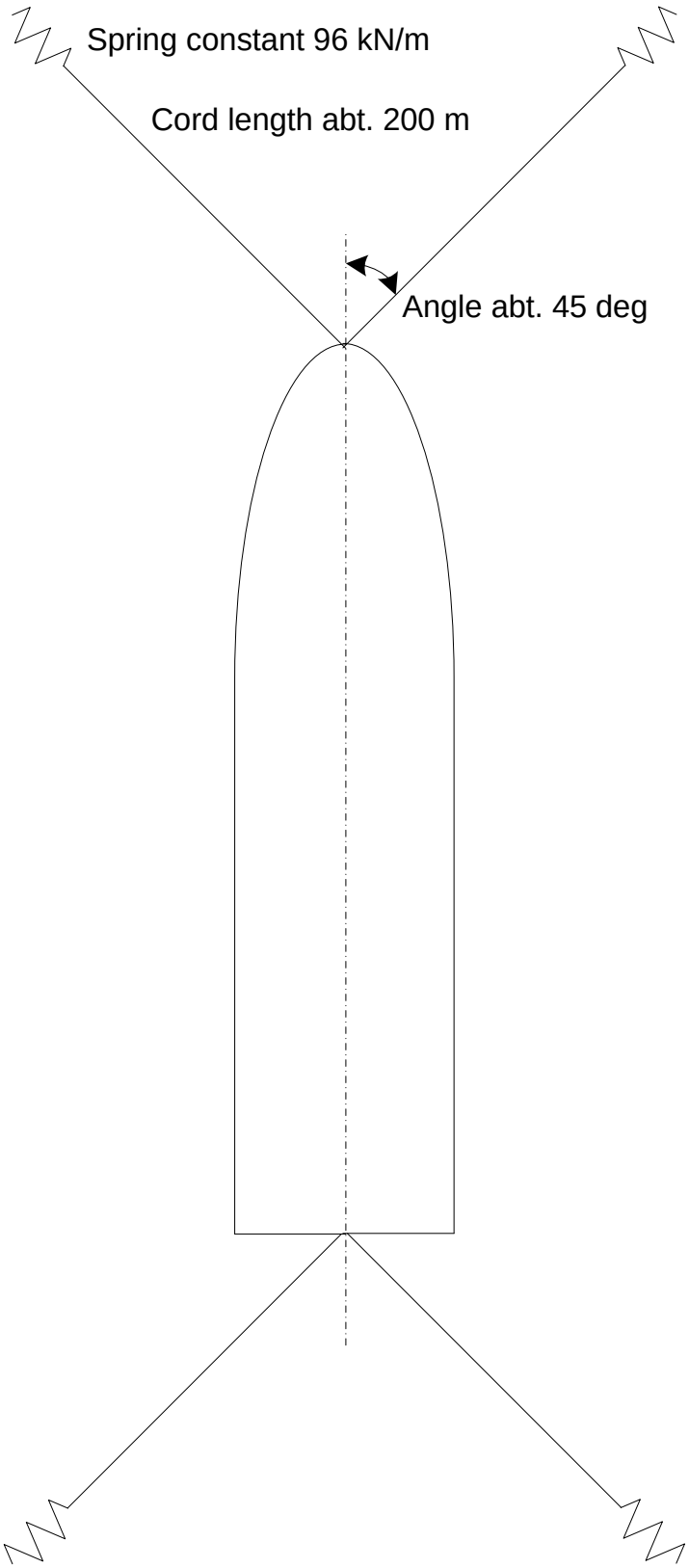


Photos of ship model Figure: 4b



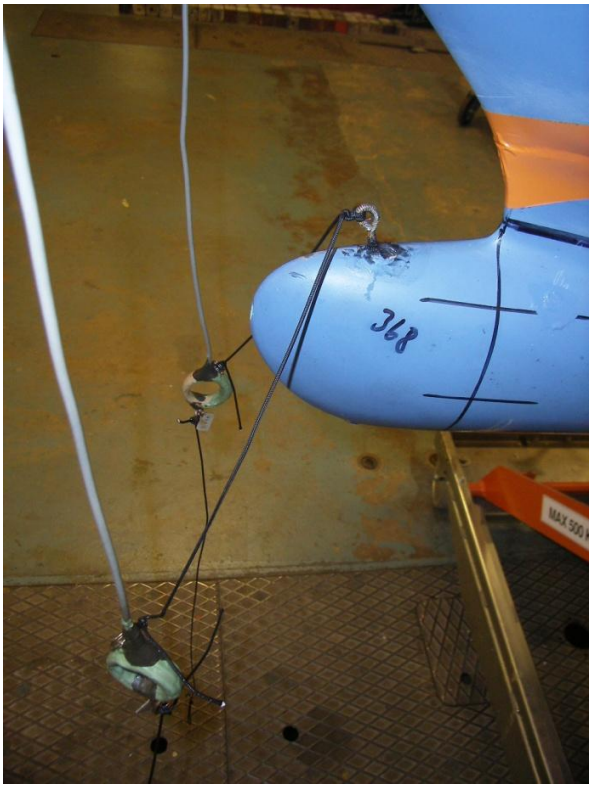
Sketch of test arrangement

Figure: 5a

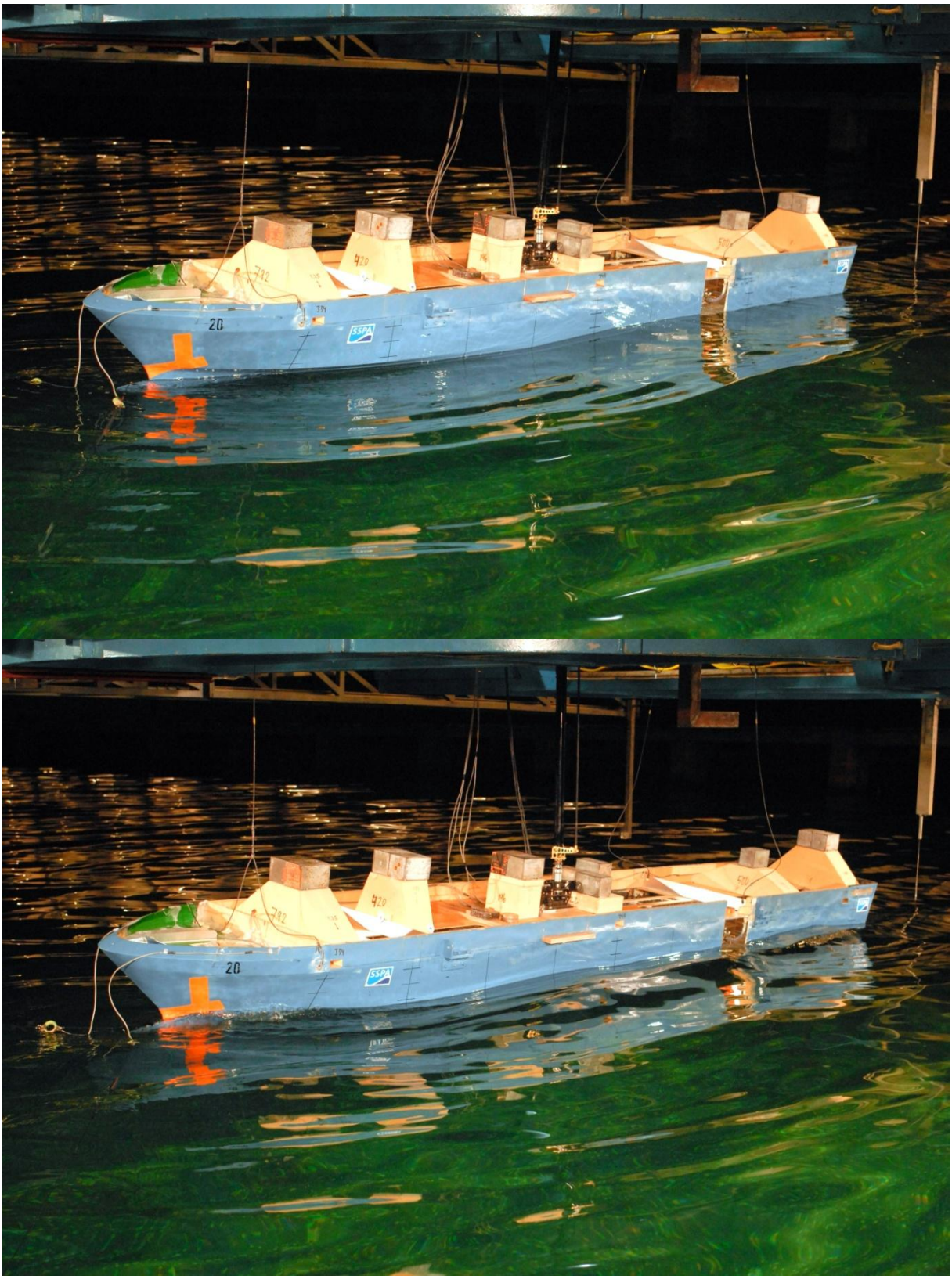


Photos of test arrangement

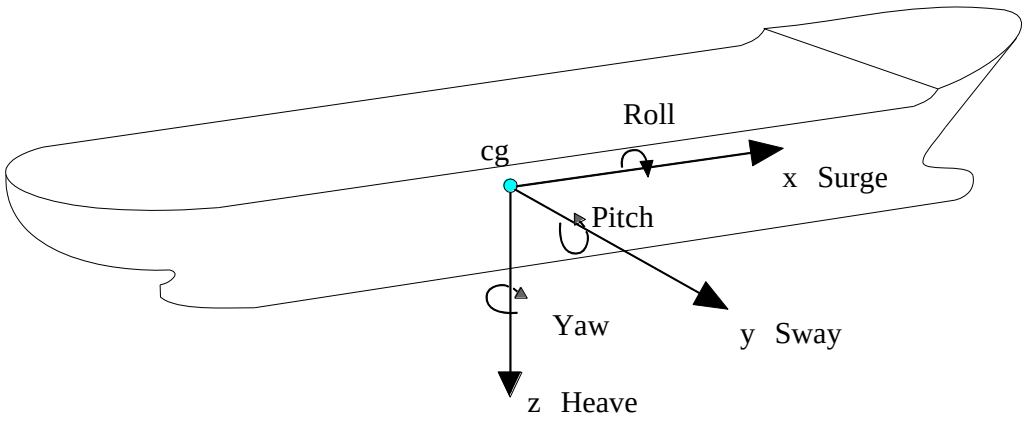
Figure: 5b

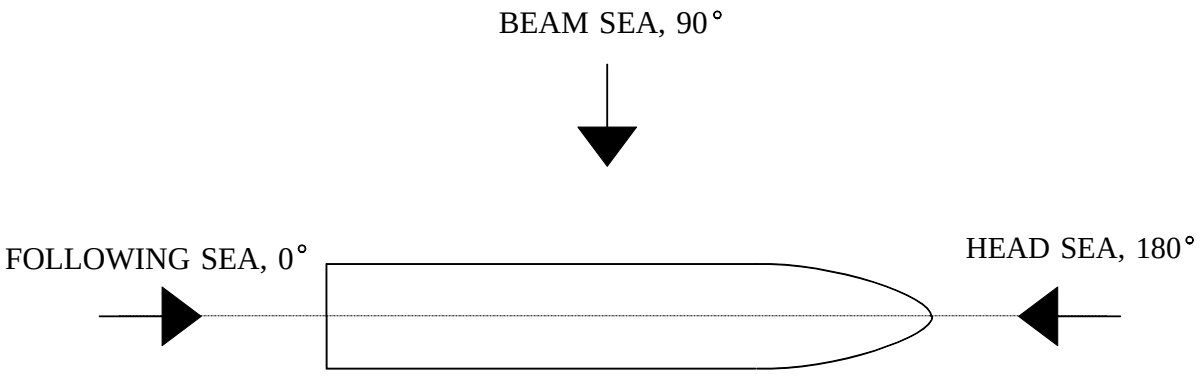


Photos from tests Figure: 6



Enclosure: 1





Sign convention according to ITTC

- heading angle and yaw rate are positive for a turn to starboard
- rudder angle is negative for a turn to starboard
- longitudinal rudder force is positive pointing forward
- lateral rudder force is positive pointing starboard
  - rudder stock torque is positive clockwise seen from above
  - wave height is positive downwards
  - relative motion is positive for increasing freeboard
  - lateral acceleration is positive to starboard (gravity component included)

All results given in this report are presented in full scale using Froude scaling.

Decay tests Enclosure: 2

A decay test is performed by giving the model a slight offset from its equilibrium where after the model is allowed to oscillate. Due to damping the amplitudes will successively decay

From the recorded decay curves the damping coefficients may be derived from the decrease of motion amplitude for the successive oscillations. Also natural period may be derived from these tests.

The decay may be described by:

$$\ddot{\phi} + 2\varsigma\omega_0\dot{\phi} + \omega_0^2\,\phi + d\dot{\phi}\,\left|\dot{\phi}\right| = 0$$

Where:	ζ	is the linear damping
	$\omega 0$	is the natural frequency
	d	is the non-linear damping

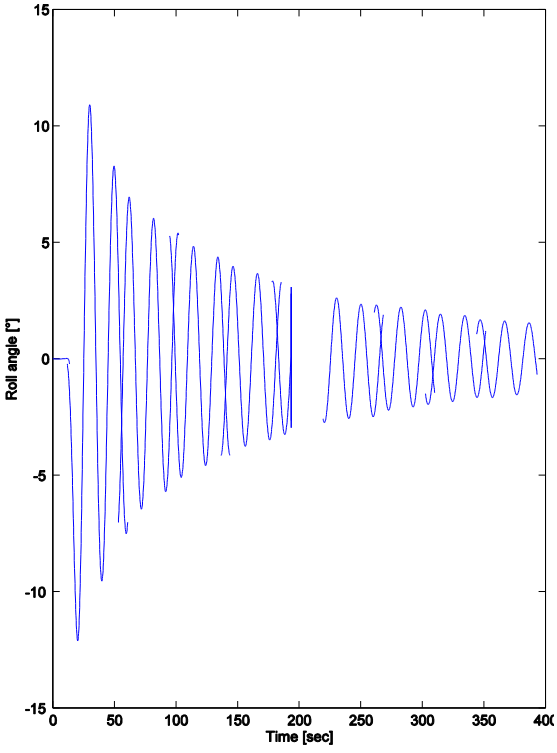
At the evaluation of a decay test the non-linear damping (d) is assumed to be 0. The damping factor may then be derived according to the expression below.

$\xi = \ln(\phi o/\phi n)/2\pi n$

Where:

ξ	= damping factor
ϕo	= amplitude at first oscillation
ϕn	= amplitude at n:th oscillation
n	= number of oscillations
ln	= natural logarithm

An example of a decay test is shown in the figure.



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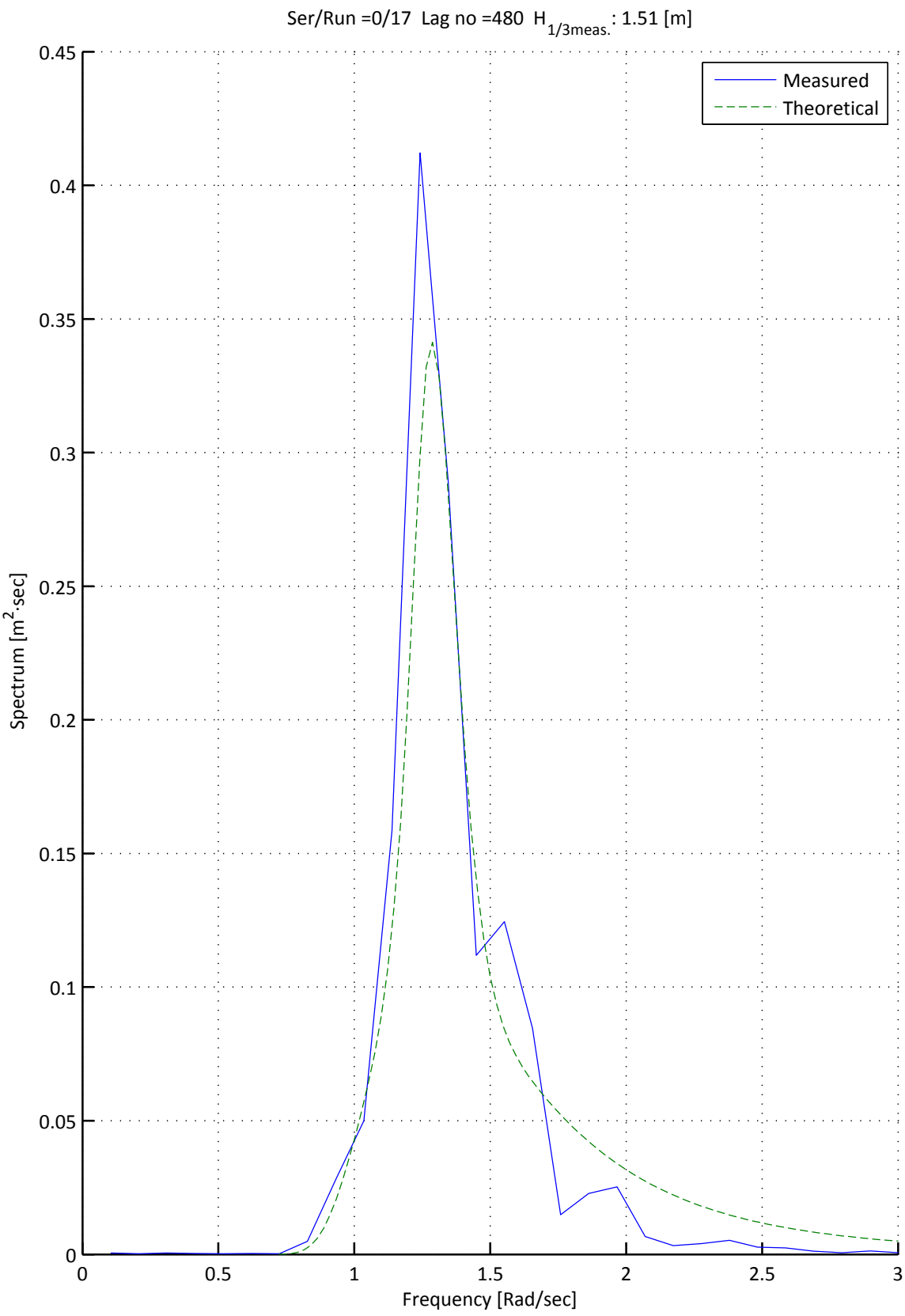
$H_{1/3}$ = 1.5 m T_p = 4.90 sec γ = 3.3 Appendix: 01

Jonswap spectrum Figure: 1



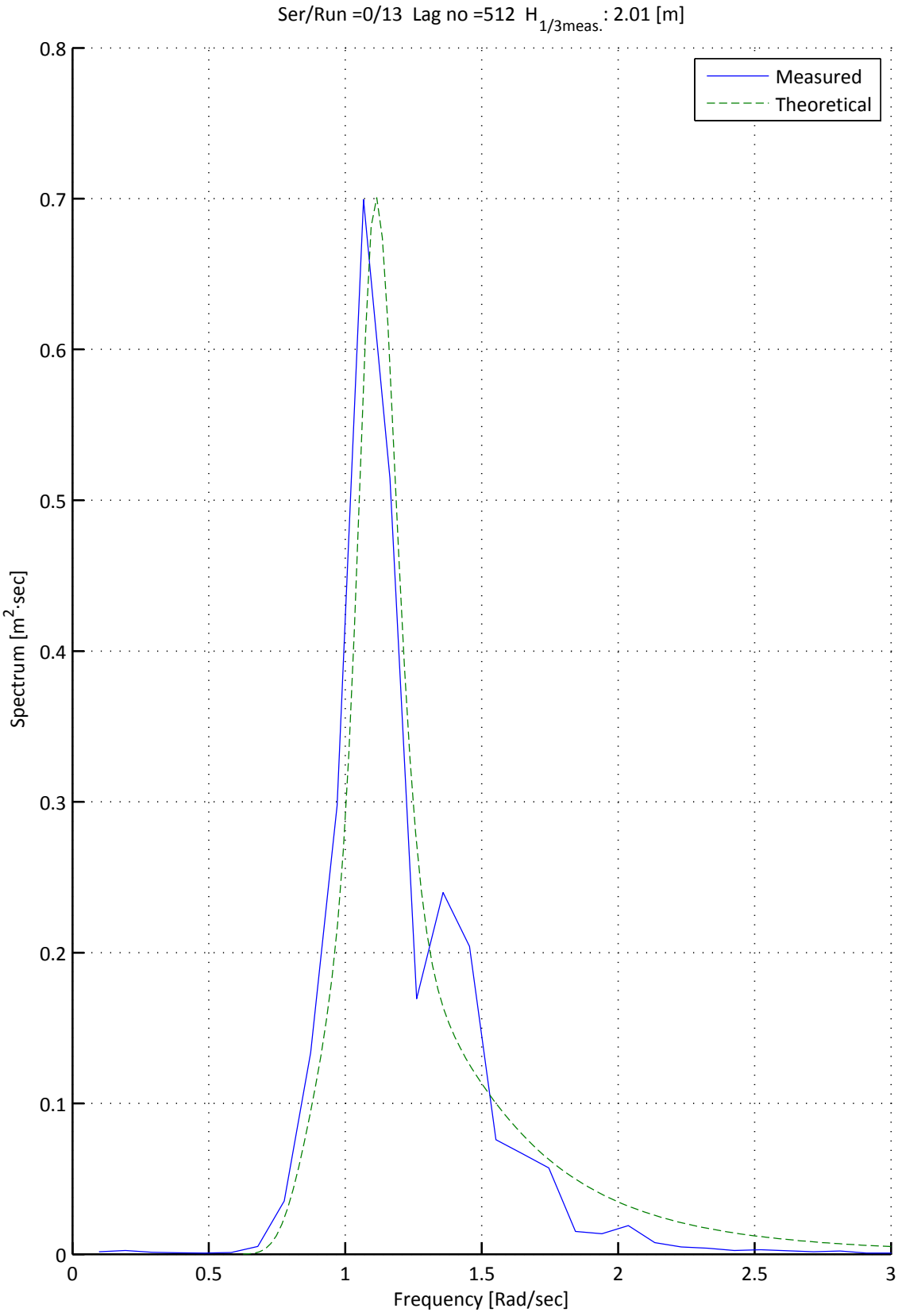
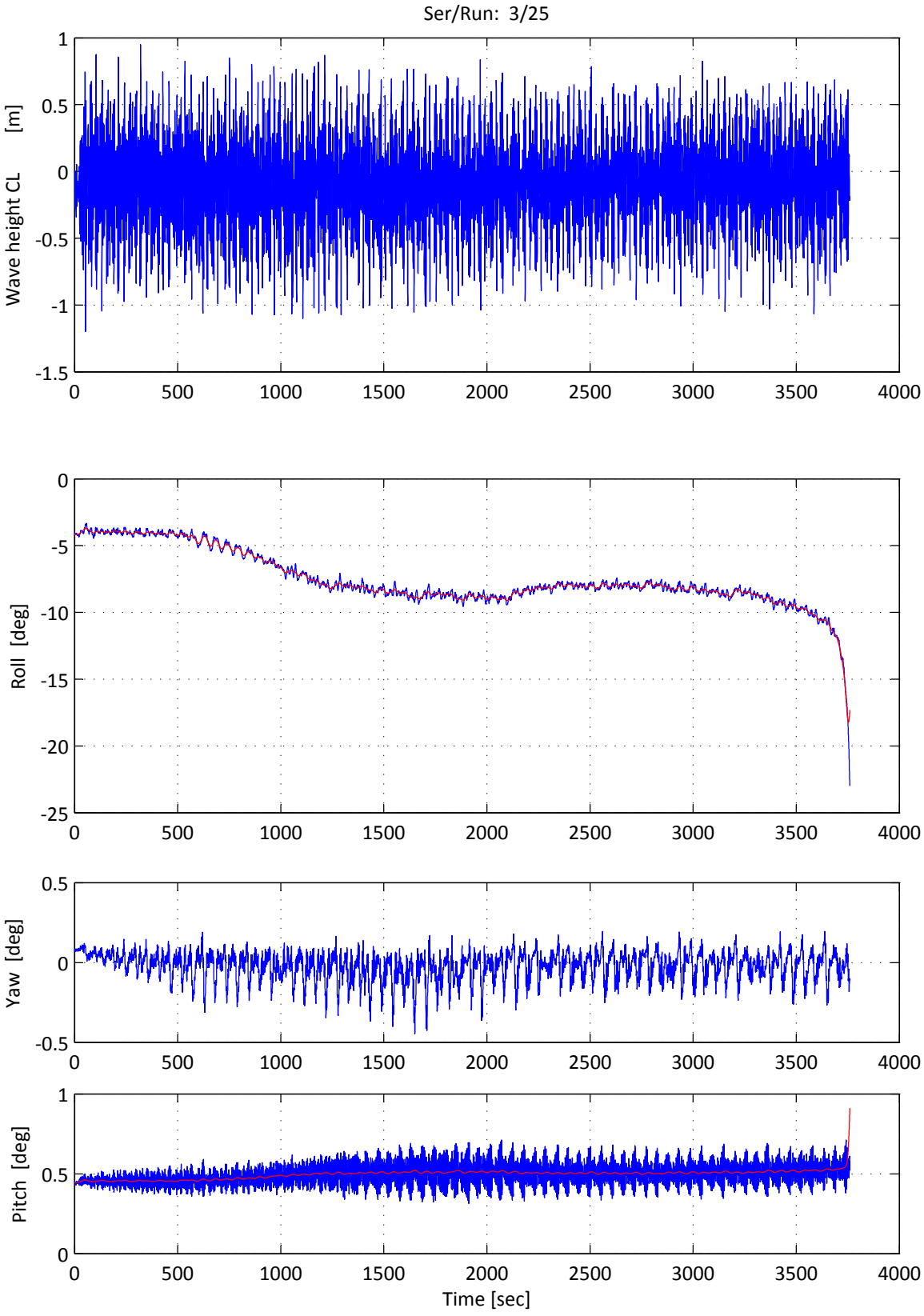
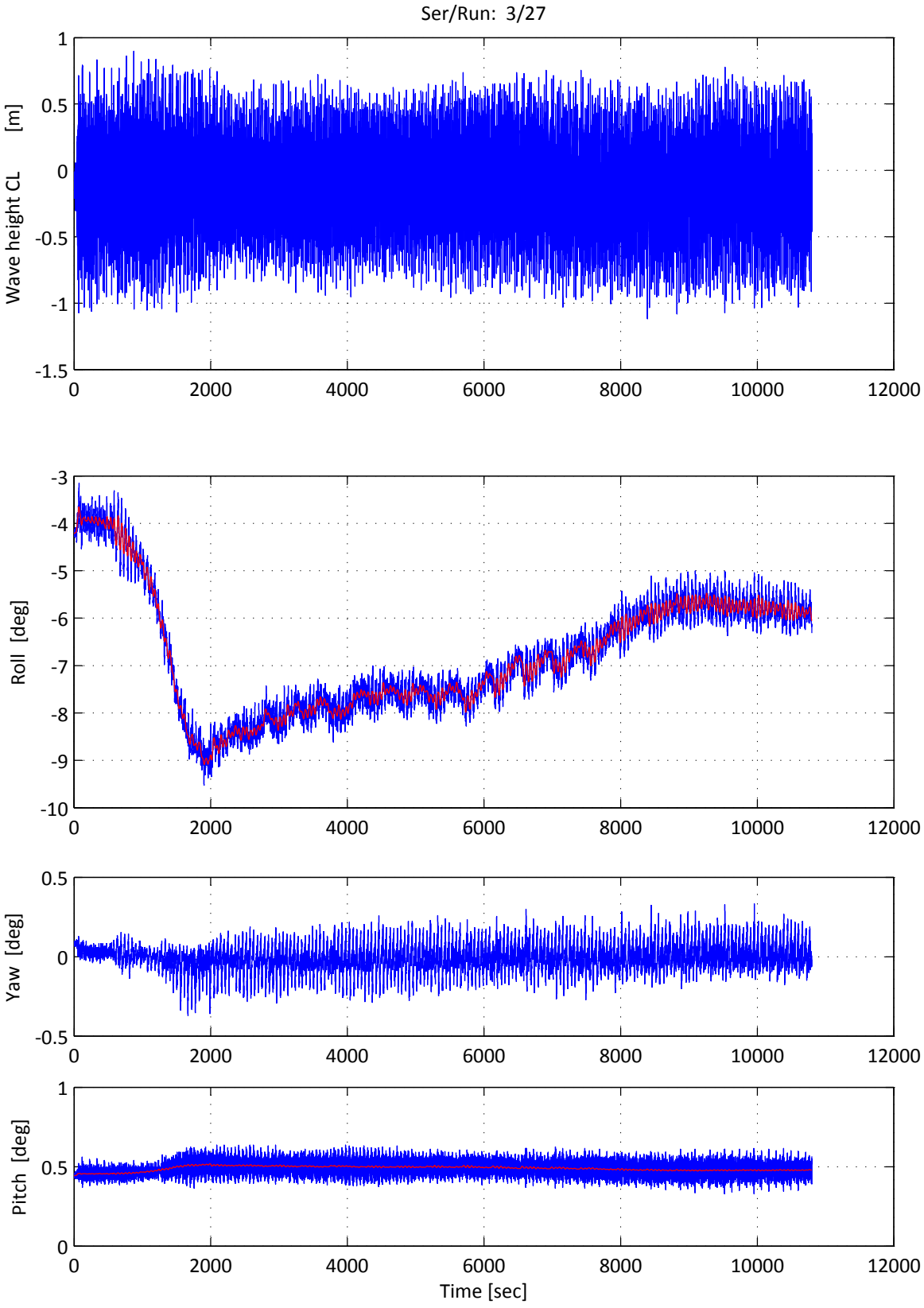

Ser/Run =0/13 Lag no =512 H1/3meas.: 2.01 [m]
Measured
Theoretical
Spectrum [m2·sec]
Frequency [Rad/sec]
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
0.5
1
1.5
2
2.5
3

Table of contents

Figure [no.]	Wave height [m]	Spectral peak period [sec]	Serie [no.]	Run [no.]
1	1.50	4.90	3	25
2	1.50	4.90	3	27
3	1.50	4.90	3	29
4	2.00	5.66	3	18
5	2.00	5.66	3	20
6	2.00	5.66	2	22


Ser/Run: 3/25
Wave height CL [m]
Roll [deg]
Yaw [deg]
Pitch [deg]
Time [sec]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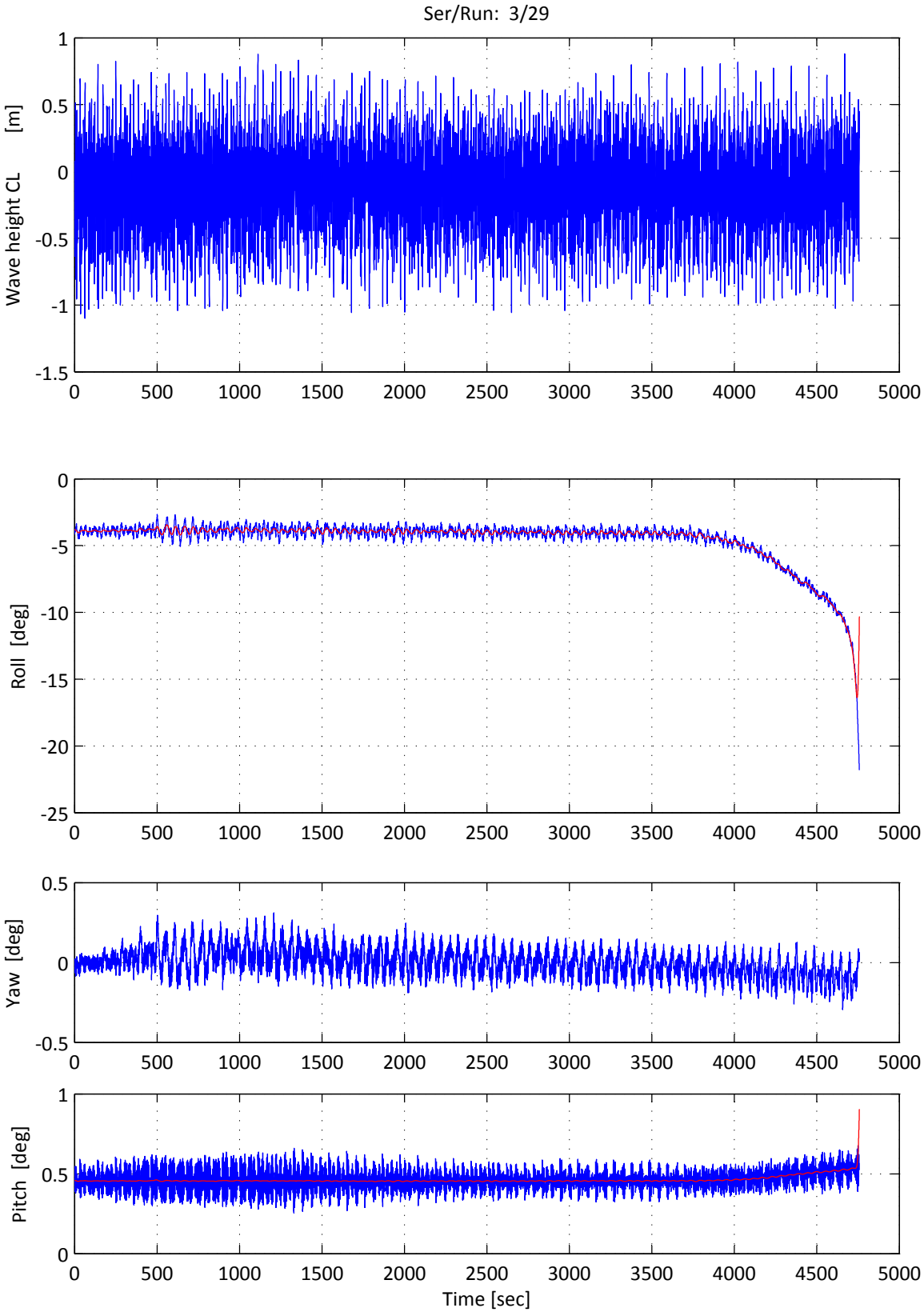
Wave height CL [m]
Roll [deg]
Yaw [deg]
Pitch [deg]
Time [sec]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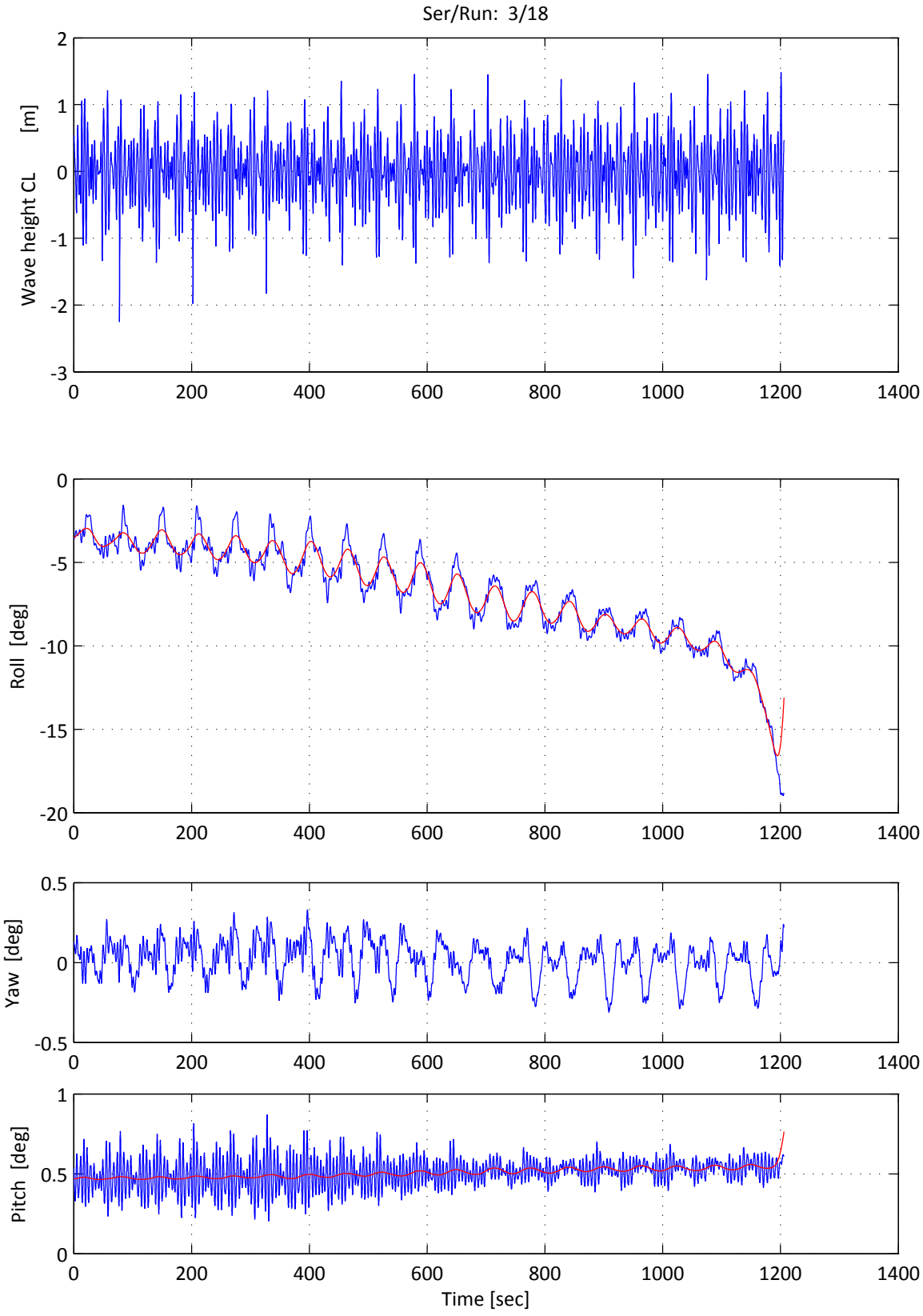
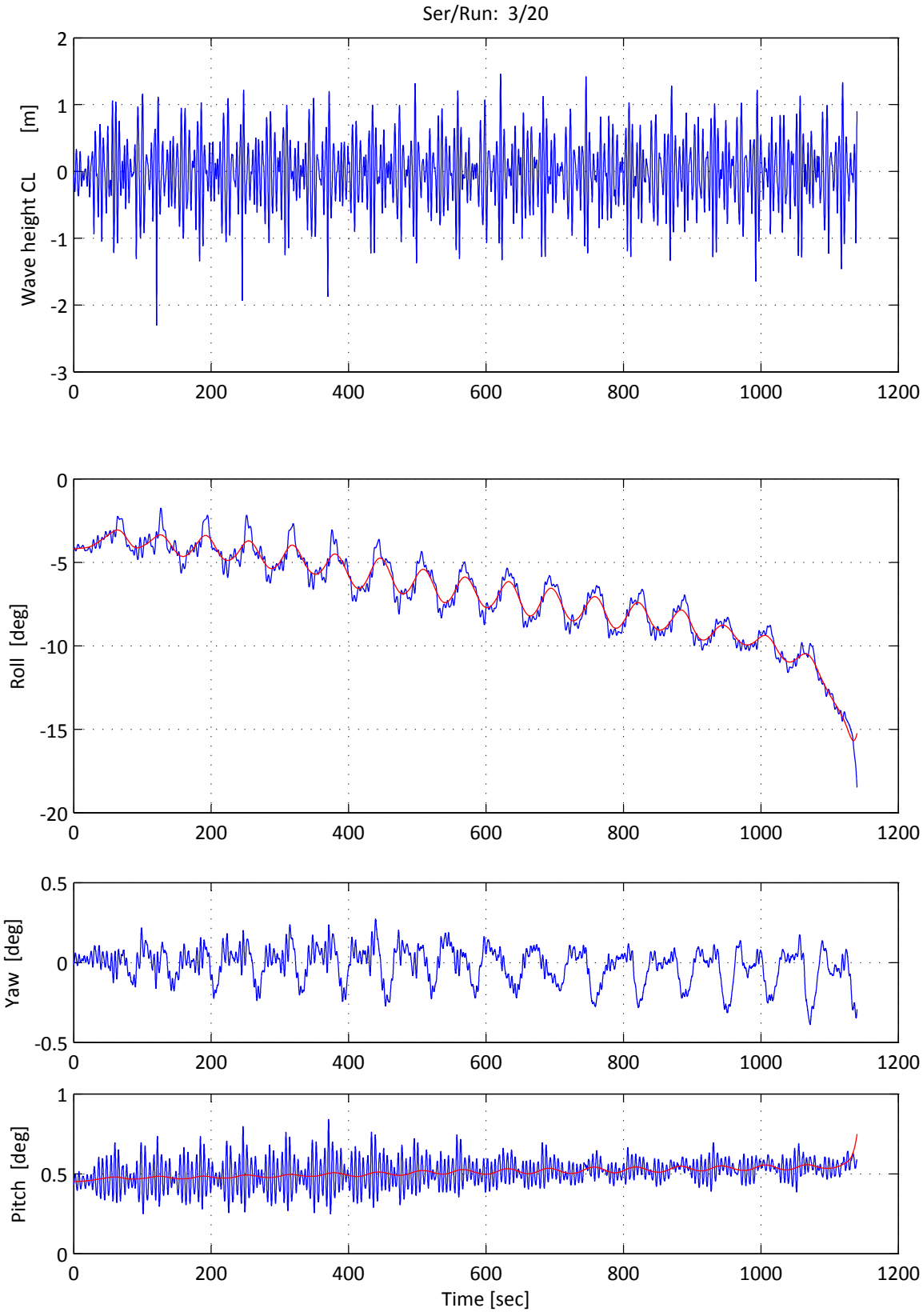
Wave height CL [m]
Roll [deg]
Yaw [deg]
Pitch [deg]
Time [sec]


Ser/Run: 3/18
Wave height CL [m]
Roll [deg]
Yaw [deg]
Pitch [deg]
Time [sec]

Jonswap spectrum

$H_{1/3}$ = 2 m T_p = 5.66 sec γ = 3.3 Appendix: 02

Water depth: 102.0 m Figure: 5



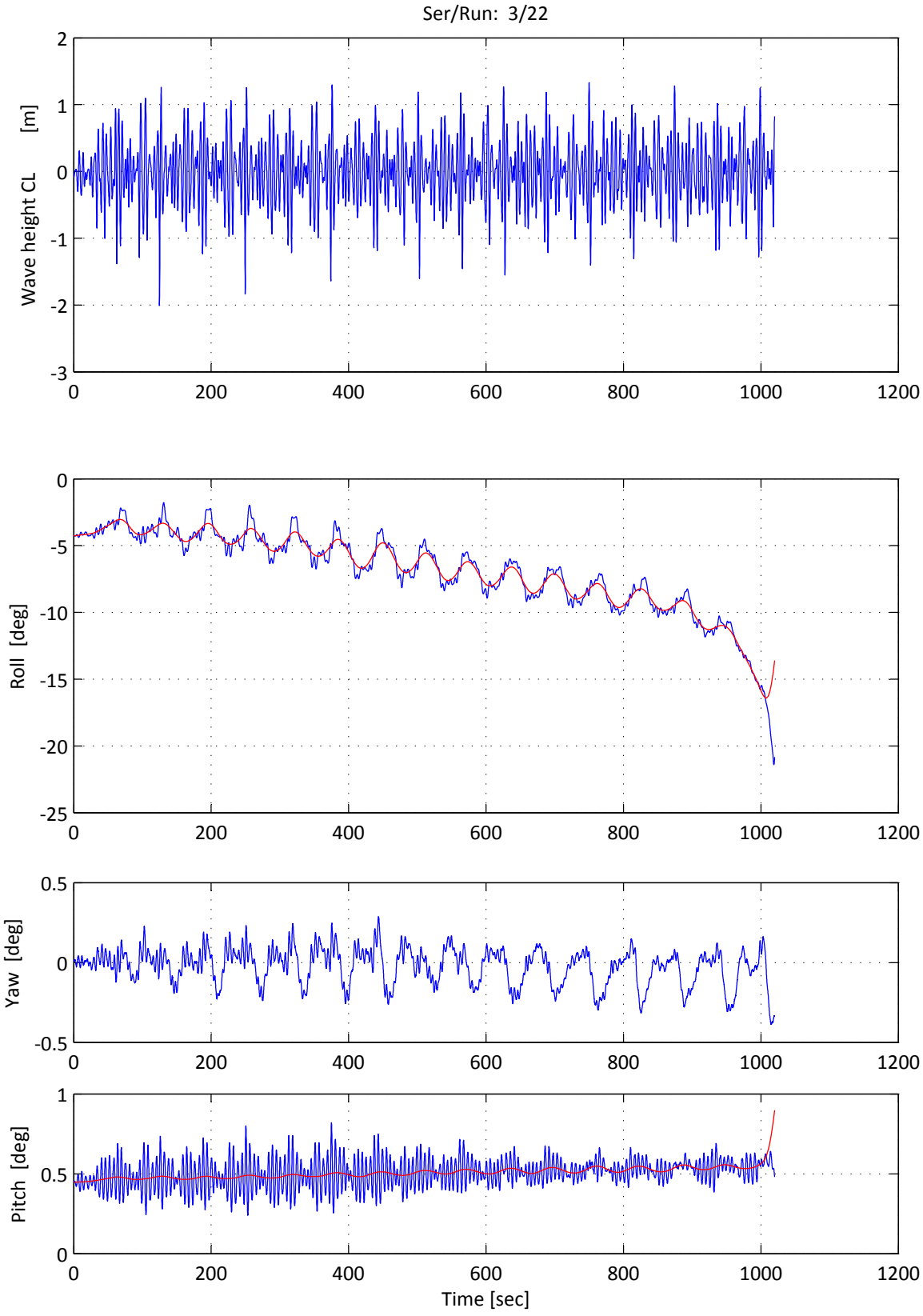

Ser/Run: 3/22
Wave height CL [m]
Roll [deg]
Yaw [deg]
Pitch [deg]
Time [sec]

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Figure [no.]	Wave height [m]	Spectral peak period [sec]	Serie [no.]	Run [no.]
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6	2.00	5.66	3	22

Definitions

Statistical analysis of all measured signals includes min, mean, max and significant values according to:

Minimum value = $x_{min} < x_i$ (i= 1,2,3... N)

Mean value = $\bar{x} = \frac{1}{N}\sum_{i=1}^{N} x_i$

Maximum value = $x_{max} > x_i$ (i= 1,2,3... N)

Where: x_i (i= 1,2,3... N) = measured signal
N = Number of samples (measurement time)x(sampling frequency)

Significant single amplitude = $2\cdot\sigma$
Significant double amplitude = $4\cdot\sigma$

Where: $\sigma^2 = \frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^2$

All significant values of measured signals are given as significant single amplitudes except wave height, which is given as significant double amplitude.

Zero crossing period
Suppose the total number of zero up crossings is nc+1 = t_0 , t_1 ... t_{nc} then the zero crossing period, T_z is estimated according to:

$T_z = (t_{nc} - t_0)/nc$

Note that: Nominal wave height = Total significant wave height
Nominal wave period = Spectral peak period for Jonswap spectrum

Ser no	:	3
Run no	:	25
Scale factor	:	40.000
Measuring time	:	62 min 38 sec
Sampling frequency	:	7.906 Hz
Ship speed (Nominal)	:	1.00 knots
Ship length	:	137.40 m
Wave heading	:	90.00 deg
Water depth	:	102.00 m
Nominal wave height	:	1.50 m
Nominal wave period	:	4.90 sec

		Minimum Value	Mean Value	Maximum Value	Signif. single ampli-tude	Period of enc. (s)
Wave height CL	[m]	-1.20	-0.08	0.95	1.33*	4.68
Wave heading	[deg]	269.86	270.07	270.50	0.18	10.47
Speed	[knots]	0.00	0.10	0.43	0.14	4.55
Surge	[m]	-0.04	0.00	0.04	0.02	4.11
Sway	[m]	-0.33	0.00	0.28	0.20	5.42
Heave	[m]	0.12	0.56	0.96	0.25	5.41
Roll	[deg]	-21.57	-7.55	-3.33	4.22	160.56
Pitch	[deg]	0.32	0.50	0.71	0.13	5.08
Yaw	[deg]	-0.45	-0.02	0.19	0.18	10.44
Roll(filt)	[deg]	-18.23	-7.55	-3.71	4.18	0.00
Pitch(filt)	[deg]	0.44	0.50	0.81	0.05	815.74

Significant single amplitude = 2*standard deviation
* Significant wave height = 4*standard deviation

Ser no	:	3
Run no	:	27
Scale factor	:	40.000
Measuring time	:	179 min 58 sec
Sampling frequency	:	7.906 Hz
Ship speed (Nominal)	:	1.00 knots
Ship length	:	137.40 m
Wave heading	:	90.00 deg
Water depth	:	102.00 m
Nominal wave height	:	1.50 m
Nominal wave period	:	4.90 sec

		Minimum Value	Mean Value	Maximum Value	Signif. single ampli-tude	Period of enc. (s)
Wave height CL	[m]	-1.12	-0.09	0.90	1.28*	4.69
Wave heading	[deg]	269.68	270.02	270.39	0.18	10.33
Speed	[knots]	0.00	0.10	0.48	0.14	4.23
Surge	[m]	-0.04	0.00	0.04	0.02	4.41
Sway	[m]	-0.35	0.00	0.26	0.20	5.34
Heave	[m]	0.15	0.56	0.94	0.24	5.38
Roll	[deg]	-9.53	-6.76	-3.15	2.58	66.05
Pitch	[deg]	0.33	0.49	0.64	0.09	5.42
Yaw	[deg]	-0.37	-0.00	0.33	0.18	10.32
Roll(filt)	[deg]	-9.08	-6.76	-3.65	2.55	624.01
Pitch(filt)	[deg]	0.44	0.49	0.52	0.03	370.86

Significant single amplitude = 2*standard deviation
* Significant wave height = 4*standard deviation

Ser no	:	3
Run no	:	29
Scale factor	:	40.000
Measuring time	:	79 min 16 sec
Sampling frequency	:	7.906 Hz
Ship speed (Nominal)	:	1.00 knots
Ship length	:	137.40 m
Wave heading	:	90.00 deg
Water depth	:	102.00 m
Nominal wave height	:	1.50 m
Nominal wave period	:	4.90 sec

		Minimum Value	Mean Value	Maximum Value	Signif. single ampli-tude	Period of enc. (s)
Wave height CL	[m]	-1.10	-0.11	0.88	1.29*	4.54
Wave heading	[deg]	269.66	269.97	270.26	0.17	8.89
Speed	[knots]	0.00	0.10	0.48	0.14	4.38
Surge	[m]	-0.05	0.00	0.04	0.02	4.37
Sway	[m]	-0.33	-0.00	0.25	0.19	5.44
Heave	[m]	0.13	0.54	0.93	0.25	5.40
Roll	[deg]	-20.98	-4.60	-2.67	3.64	51.07
Pitch	[deg]	0.26	0.46	0.68	0.12	5.39
Yaw	[deg]	-0.29	0.00	0.31	0.17	8.90
Roll(filt)	[deg]	-16.38	-4.59	-3.45	3.48	33.90
Pitch(filt)	[deg]	0.45	0.46	0.80	0.04	66.79

Significant single amplitude = 2*standard deviation
* Significant wave height = 4*standard deviation

Ser no	:	3
Run no	:	18
Scale factor	:	40.000
Measuring time	:	20 min 4 sec
Sampling frequency	:	7.906 Hz
Ship speed (Nominal)	:	1.00 knots
Ship length	:	137.40 m
Wave heading	:	90.00 deg
Water depth	:	102.00 m
Nominal wave height	:	2.00 m
Nominal wave period	:	5.66 sec

		Minimum Value	Mean Value	Maximum Value	Signif. single ampli-tude	Period of enc. (s)
Wave height CL	[m]	-2.25	-0.01	1.48	1.96*	5.15
Wave heading	[deg]	269.68	270.00	270.32	0.24	14.97
Speed	[knots]	0.00	0.38	1.33	0.53	8.19
Surge	[m]	-0.07	0.00	0.07	0.05	5.55
Sway	[m]	-0.76	-0.00	0.59	0.50	7.22
Heave	[m]	-0.22	0.64	1.52	0.62	6.00
Roll	[deg]	-18.92	-6.78	-1.59	5.94	48.02
Pitch	[deg]	0.20	0.51	0.87	0.18	6.32
Yaw	[deg]	-0.31	0.01	0.33	0.24	14.81
Roll(filt)	[deg]	-16.59	-6.77	-2.96	5.63	55.81
Pitch(filt)	[deg]	0.46	0.51	0.71	0.06	68.15

Significant single amplitude = 2*standard deviation
* Significant wave height = 4*standard deviation

Ser no	:	3
Run no	:	20
Scale factor	:	40.000
Measuring time	:	18 min 58 sec
Sampling frequency	:	7.906 Hz
Ship speed (Nominal)	:	1.00 knots
Ship length	:	137.40 m
Wave heading	:	90.00 deg
Water depth	:	102.00 m
Nominal wave height	:	2.00 m
Nominal wave period	:	5.66 sec

		Minimum Value	Mean Value	Maximum Value	Signif. single ampli-tude	Period of enc. (s)
Wave height CL	[m]	-2.30	-0.01	1.46	1.89*	5.19
Wave heading	[deg]	269.69	269.98	270.35	0.22	15.95
Speed	[knots]	0.00	0.36	1.31	0.52	8.10
Surge	[m]	-0.07	-0.00	0.07	0.05	5.34
Sway	[m]	-0.71	0.00	0.57	0.48	7.15
Heave	[m]	-0.25	0.63	1.49	0.61	5.97
Roll	[deg]	-16.98	-6.90	-1.75	5.42	38.63
Pitch	[deg]	0.25	0.51	0.84	0.17	6.43
Yaw	[deg]	-0.39	-0.02	0.27	0.22	15.81
Roll(filt)	[deg]	-15.68	-6.91	-3.06	5.25	57.93
Pitch(filt)	[deg]	0.45	0.51	0.69	0.06	66.36

Significant single amplitude = 2*standard deviation
* Significant wave height = 4*standard deviation

Ser no	:	3
Run no	:	22
Scale factor	:	40.000
Measuring time	:	16 min 58 sec
Sampling frequency	:	7.906 Hz
Ship speed (Nominal)	:	1.00 knots
Ship length	:	137.40 m
Wave heading	:	90.00 deg
Water depth	:	102.00 m
Nominal wave height	:	2.00 m
Nominal wave period	:	5.66 sec

		Minimum Value	Mean Value	Maximum Value	Signif. single ampli-tude	Period of enc. (s)
Wave height CL	[m]	-2.01	-0.01	1.33	1.84*	5.12
Wave heading	[deg]	269.66	269.97	270.33	0.22	17.10
Speed	[knots]	0.00	0.36	1.28	0.52	8.01
Surge	[m]	-0.07	-0.00	0.08	0.05	5.38
Sway	[m]	-0.73	0.00	0.57	0.49	7.35
Heave	[m]	-0.25	0.64	1.49	0.62	5.98
Roll	[deg]	-20.68	-6.90	-1.78	6.08	30.12
Pitch	[deg]	0.24	0.50	0.82	0.18	6.41
Yaw	[deg]	-0.39	-0.02	0.29	0.22	17.01
Roll(filt)	[deg]	-16.41	-6.89	-3.05	5.75	55.74
Pitch(filt)	[deg]	0.45	0.51	0.81	0.07	67.45

Significant single amplitude = 2*standard deviation
* Significant wave height = 4*standard deviation

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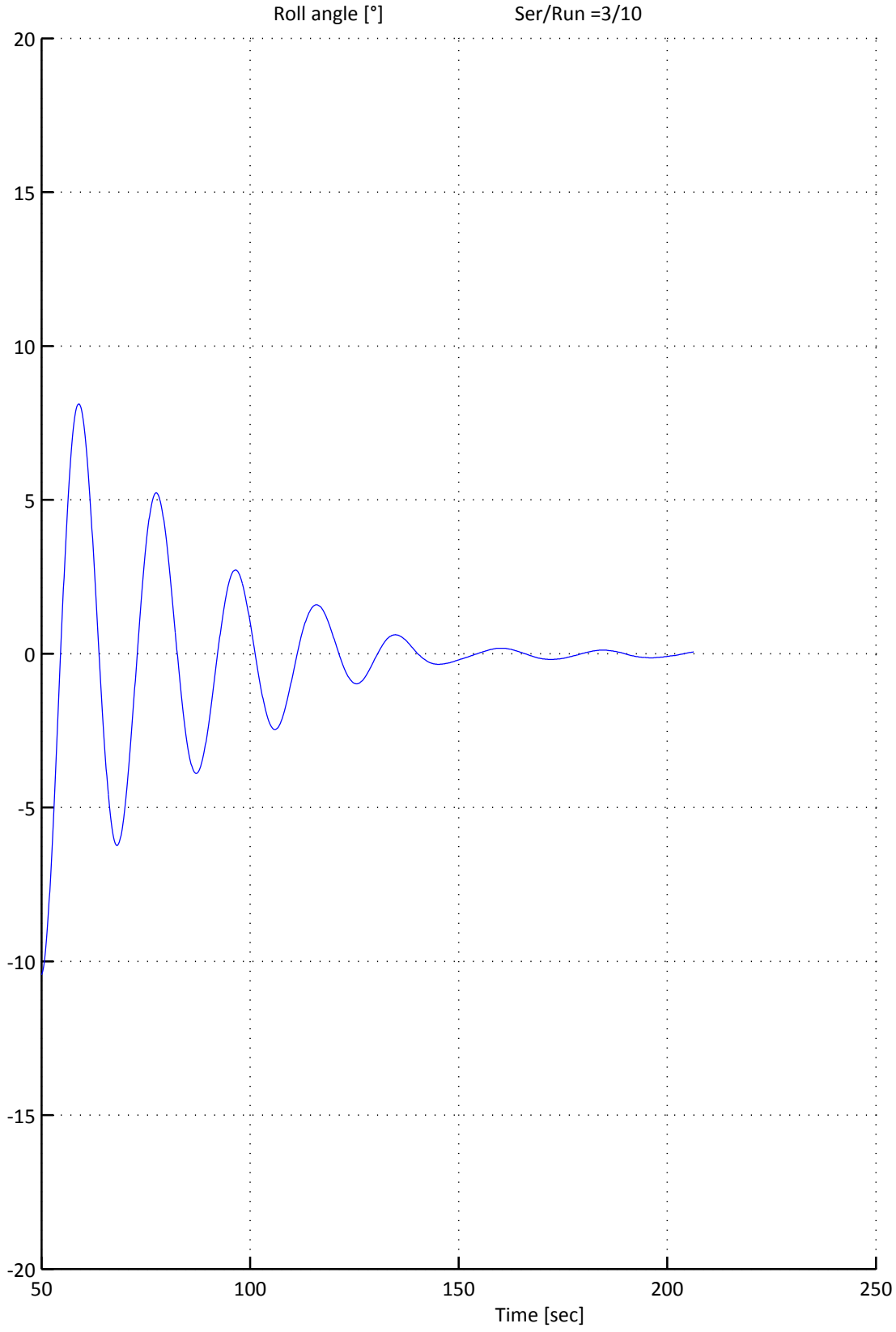
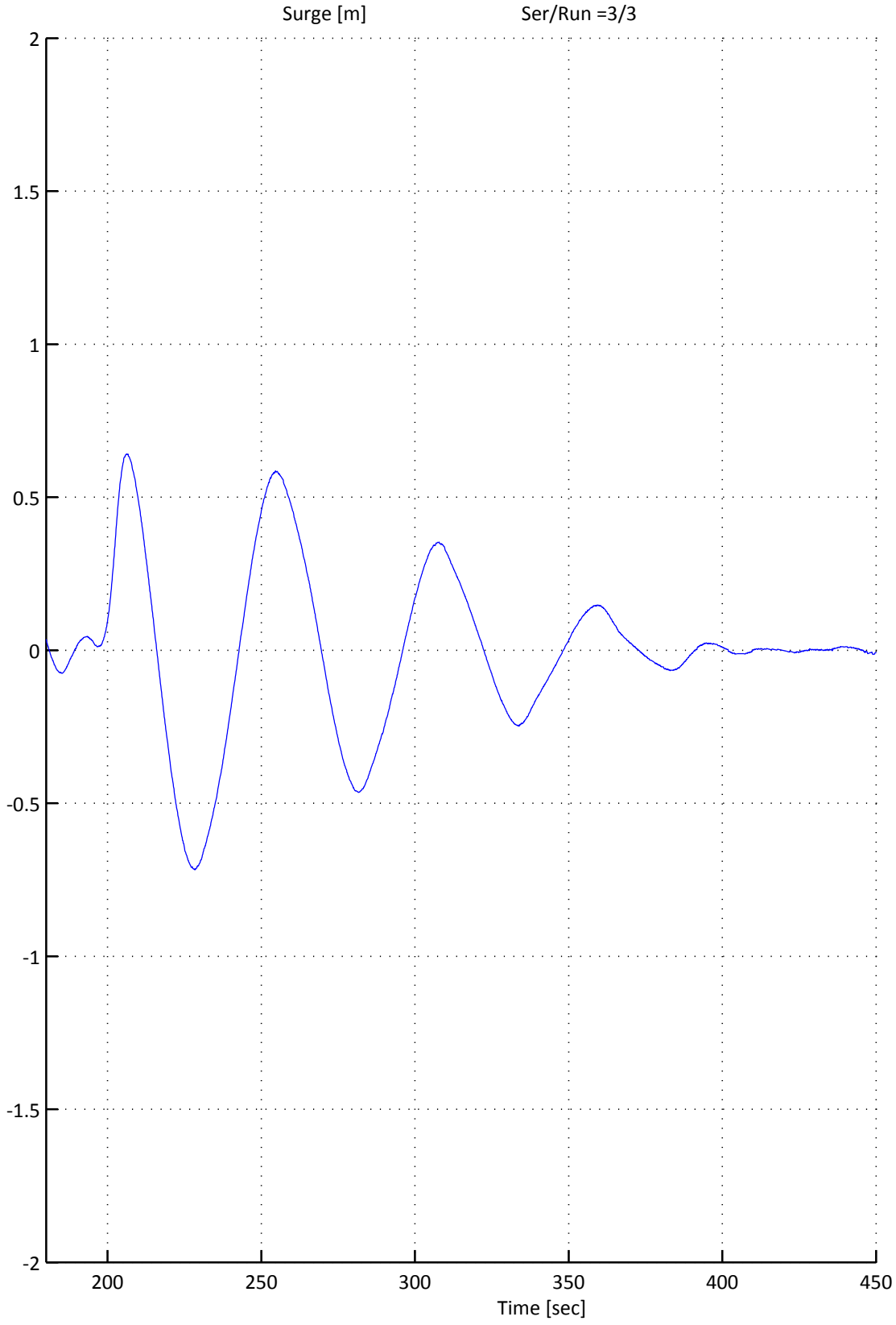

Roll angle [°]
Ser/Run =3/10
20
15
10
5
0
-5
-10
-15
-20
50
100
150
200
250
Time [sec]

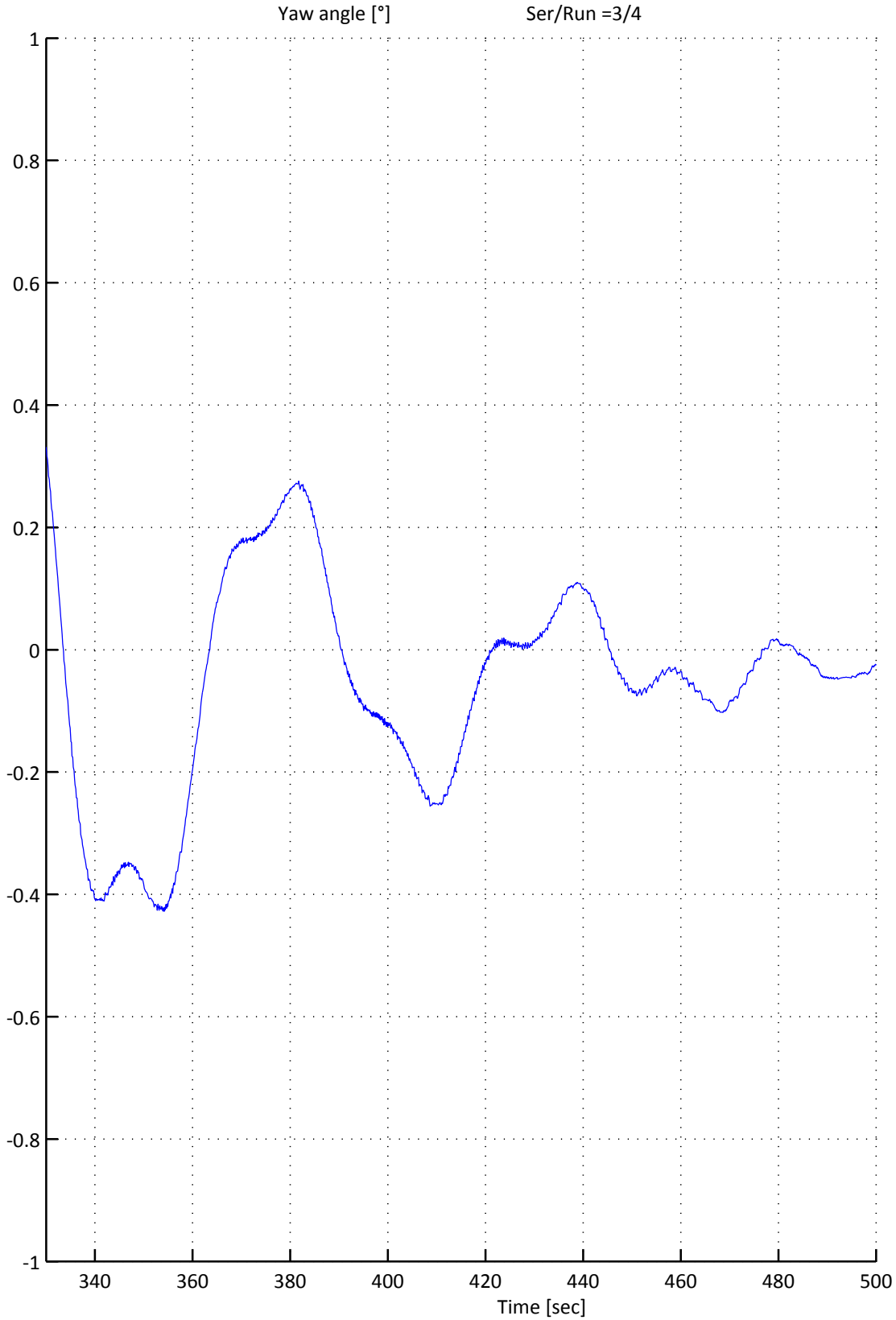
Ser no	:	3
Run no	:	10
Scale factor	:	40.000
Sampling frequency	:	7.906 Hz
Ship length	:	137.40 m
Water depth	:	102.00 m
Mean decay period	:	21.00 sec
Mean damping, zeta	:	0.1028 -

No	Minima (deg)	Maxima (deg)	Double amplitude (deg)	Damping (-)	Period (sec)
1	-6.24	5.23	11.47		18.72
2	-3.89	2.72	6.62	0.0876	18.72
3	-2.46	1.59	4.05	0.0828	19.99
4	-0.98	0.61	1.59	0.1047	18.97
5	-0.35	0.17	0.52	0.1227	25.68
6	-0.19	0.11	0.30	0.1160	23.91


Surge [m]
Ser/Run =3/3
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
200
250
300
350
400
450
Time [sec]

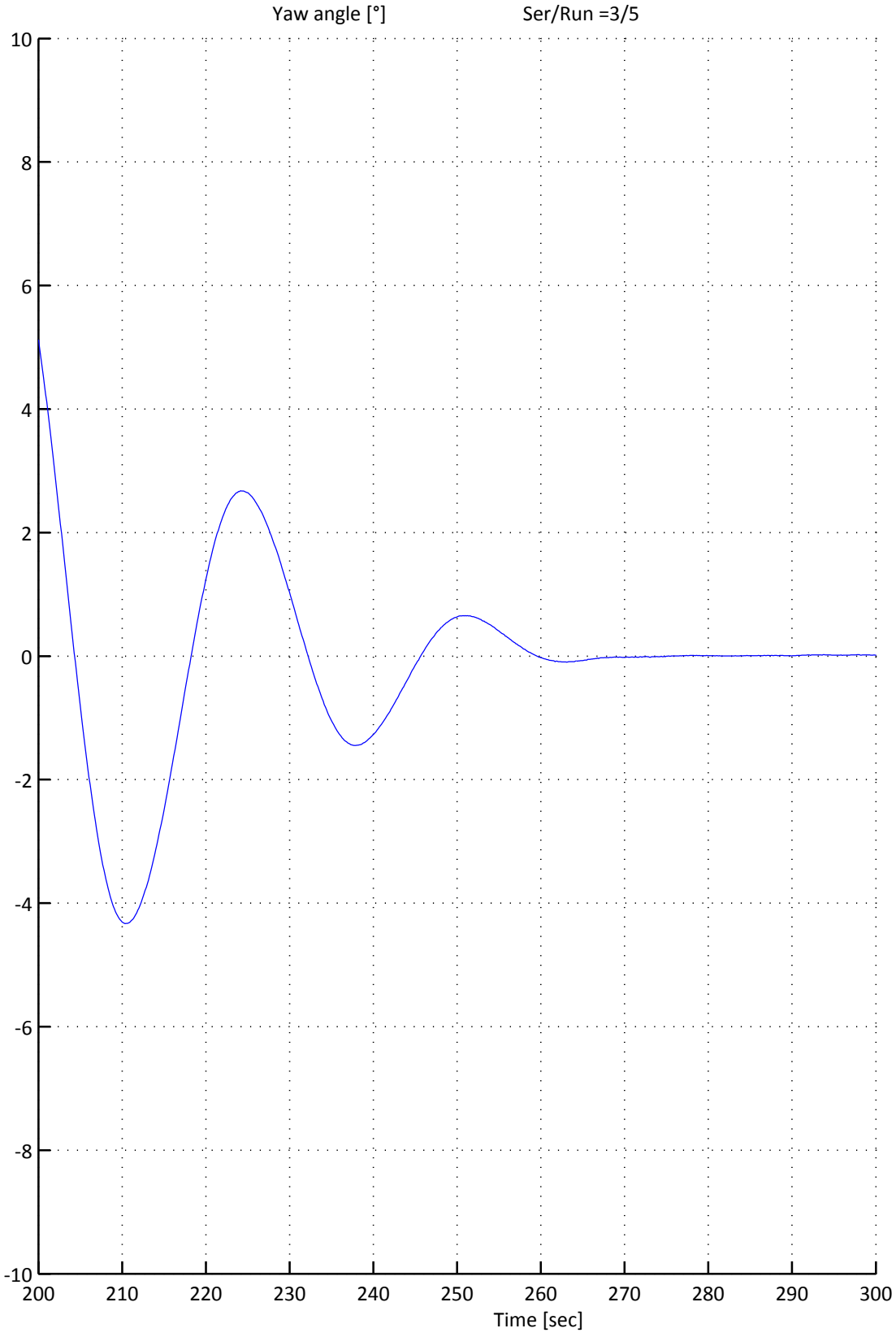
Ser no	:	3
Run no	:	3
Scale factor	:	40.000
Sampling frequency	:	7.906 Hz
Ship length	:	137.40 m
Water depth	:	102.00 m
Mean decay period	:	47.94 sec
Mean damping, zeta	:	-0.0247 -

No	Minima (m)	Maxima (m)	Double amplitude (m)	Damping (-)	Period (sec)
1	-0.08	0.64	0.72		34.91
2	-0.72	0.59	1.30	-0.0952	53.51
3	-0.46	0.35	0.82	-0.0105	52.87
4	-0.25	0.15	0.40	0.0316	50.47


Yaw angle [°]
Ser/Run =3/4
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
340
360
380
400
420
440
460
480
500
Time [sec]

Ser no	:	3
Run no	:	4
Scale factor	:	40.000
Sampling frequency	:	7.906 Hz
Ship length	:	137.40 m
Water depth	:	102.00 m
Mean decay period	:	37.50 sec
Mean damping, zeta	:	0.1498 -

No	Minima (m)	Maxima (m)	Double amplitude (m)	Damping (-)	Period (sec)
1	-0.43	0.28	0.70		56.92
2	-0.26	0.11	0.37	0.1040	55.02
3	-0.10	0.00	0.10	0.1522	31.50
4	-0.00	0.02	0.02	0.1933	6.58


Yaw angle [°]
Ser/Run =3/5
10
8
6
4
2
0
-2
-4
-6
-8
-10
200
210
220
230
240
250
260
270
280
290
300
Time [sec]

Ser no	:	3
Run no	:	5
Scale factor	:	40.000
Sampling frequency	:	7.906 Hz
Ship length	:	137.40 m
Water depth	:	102.00 m
Mean decay period	:	23.65 sec
Mean damping, zeta	:	0.2593 -

No	Minima (deg)	Maxima (deg)	Double amplitude (deg)	Damping (-)	Period (sec)
1	-4.33	2.68	7.01		27.83
2	-1.45	0.66	2.11	0.1915	27.32
3	-0.10	0.02	0.12	0.3271	15.81

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Figure [no.]	Wave height [m]	Spectral peak period [sec]	Serie [no.]	Run [no.]	Static measuring Run no.
1	1.50	4.9	3	25	24
	1.50	4.9	3	27	26
	1.50	4.9	3	29	28
2	2.00	5.66	3	18	17
	2.00	5.66	3	20	19
	2.00	5.66	3	22	21

```
  Ser no                :         3
  Run no                :        24
  Measuring time        :   3 min 58 sec
  Sampling frequency    :     7.906 Hz
  Static measuring before test
                           Minimum  Mean   Maximum
                           Value    Value  Value
-----------------------------------------------------
Roll               [deg]    -4.28   -4.24   -4.20
Pitch              [deg]     0.44    0.44    0.45
```

```
  Ser no                :         3
  Run no                :        26
  Measuring time        :   7 min 54 sec
  Sampling frequency    :     7.906 Hz
  Static measuring before test
                           Minimum  Mean   Maximum
                           Value    Value  Value
-----------------------------------------------------
Roll               [deg]    -4.27   -4.25   -4.23
Pitch              [deg]     0.45    0.44    0.45
```

```
  Ser no                :         3
  Run no                :        28
  Measuring time        :   14 min 36 sec
  Sampling frequency    :     7.906 Hz
  Static measuring before test
                           Minimum  Mean   Maximum
                           Value    Value  Value
-----------------------------------------------------
Roll               [deg]    -4.27   -4.25   -4.22
Pitch              [deg]     0.43    0.44    0.46
```

Ser no : 3
Run no : 17
Measuring time : 3 min 13 sec
Sampling frequency : 7.906 Hz
Static measuring before test

		Minimum Value	Mean Value	Maximum Value
Roll	[deg]	-4.27	-4.24	-4.21
Pitch	[deg]	0.45	0.45	0.45

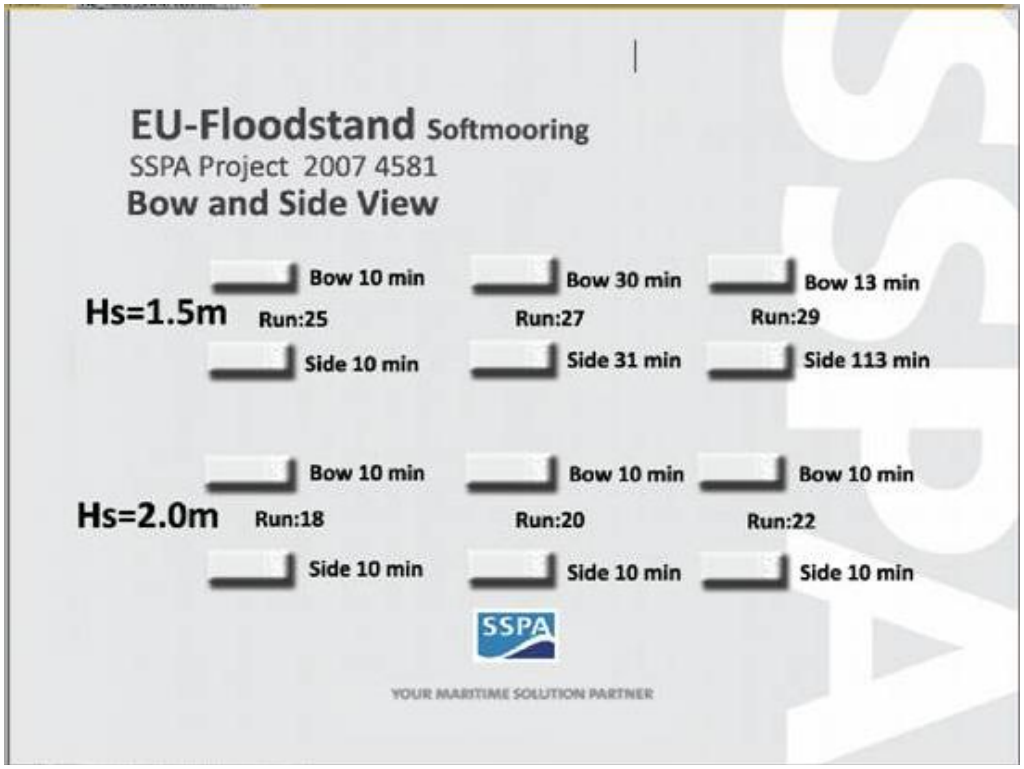
Ser no : 3
Run no : 19
Measuring time : 8 min 15 sec
Sampling frequency : 7.906 Hz
Static measuring before test

		Minimum Value	Mean Value	Maximum Value
Roll	[deg]	-4.32	-4.31	-4.30
Pitch	[deg]	0.45	0.45	0.45

Ser no : 3
Run no : 21
Measuring time : 3 min 58 sec
Sampling frequency : 7.906 Hz
Static measuring before test

		Minimum Value	Mean Value	Maximum Value
Roll	[deg]	-4.36	-4.34	-4.32
Pitch	[deg]	0.45	0.45	0.45

Contents


EU-Floodstand Softmooring
SSPA Project 2007 4581
Bow and Side View
Hs=1.5m
Bow 10 min
Run:25
Side 10 min
Bow 30 min
Run:27
Side 31 min
Bow 13 min
Run:29
Side 113 min
Hs=2.0m
Bow 10 min
Run:18
Side 10 min
Bow 10 min
Run:20
Side 10 min
Bow 10 min
Run:22
Side 10 min
SSPA
YOUR MARITIME SOLUTION PARTNER

Sampling rate (model scale): 50 Hz

Sampling rate (full scale =50/$\sqrt{40}$) : 7.906 Hz

All variables are stored in full scale units in the *.asc files with time step $\sqrt{40}$ /50 sec.

Ordinary capsizing tests are stored in the folder **Timeseries** in columns according to below:

Column no	Channel	Unit
1	Wave height CL	[m]
2	Wave heading	[deg]
3	Speed	[knots]
4	Surge	[m]
5	Sway	[m]
6	Heave	[m]
7	Roll	[deg]
8	Pitch	[deg]
9	Yaw	[deg]
10	Roll(filt)	[deg]
11	Pitch(filt)	[deg]

Static measuring tests are stored in the folder **TimeseriesSM** in columns according to below:

Column no	Channel	Unit
1	Roll	[deg]
2	Pitch	[deg]