Impact of Malfunction Load Cell and Mechanical actuator Sensor to Performance of Ship Stability General Cargo Simulator at Unit Laboratorium and Workshop STIP Jakarta

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Abstract

Ship Stability General Cargo Simulator (SSTS) is a laboratory to provide training on the configuration and procedures for maintaining ship stability as a training facility for cadets in the engineering field. The Ship Stability General Cargo Simulator configuration at STIP Marunda Jakarta describes a general cargo ship configuration in which it has equipment to simulate cargo loading and ship ballast filling, which serves to simulate ship conditions when loading cargo.

Maintenance and repair are activities carried out to improve, maintain, and return equipment in good and ready-to-use condition. In relation to the maintenance of laboratory equipment, maintenance is intended as a preventive effort or prevention so that the equipment is not damaged or is maintained in good condition, ready to operate. Besides that, maintenance is also intended as an effort to adjust or repair laboratory equipment that has already been damaged or is not feasible so that it becomes ready to be used for practical activities for students or cadets. Some of the maintenance that needs to be done on this Ship Stability Simulator are: Electrical system, Filling System, Drain System, Actuator System, Measurement Level System. Research purposes :The research objectives of this paper that make this is to obtain solutions so that maintenance and repairs can operate properly,viability of laboratory

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facilities as training infrastructure in the STIP Marunda Jakarta environment, always in a state of optimal use.

Methodology of research is Calibration and Adjusting, inspectional, Repairing, function test try and error.

Keywords: Malfunction, Sensor, Simulator Performance

1. Introduction

This ship stability practicum guide module is prepared with reference to the contents of the Lesson Plan of the Quality Standard System for function: controlling the operation of the ship and care for person on board at the operational level, Competence: maintain seaworthiness of the ship, subject: ship stability, with one basic requirement that: before the points of ship stability practicum are implemented in the laboratory, cadets are required to have obtained ship stability theory subjects in class.

With the aim that instructors/lecturers and/or cadets can understand the connection between the types and steps of the experiment/measurement with the QSS subjects as their reference, the two materials are placed side by side in one document page, namely: the QSS subjects that become The reference is presented in the left column, and the experimental measurement steps are presented in the right column. In this way, the Instructor/Lecturer and the cadets have the same information so that what subjects are the concern of QSS and in what way the QSS subjects can be better understood by the cadets through an experimental/measurement approach in each series of practicum activities, apart from the “teaching method” and “searching aids” suggested by QSS (considering that at the time QSS was compiled by the STC-group, the Real Equipment Laboratory Scale Ship Stability Simulator was not yet available).

The experiments/measurements in the following ship stability practicum activities are arranged in such a way that the cadets, under the guidance of the instructors, can implement a QSS subject in the experimental/measurement activities, even though the "objective" that QSS is aiming for is only in the form of K (K = Knowledge) (only a small number of

QSS subjects have an "objective" with category S (S = Skill), which generally involves diagrams, graphs or curves as a medium of understanding).

1.1. Identification of problems

- There is a damage to the actuator push lever where the push lever or actuator runs on its own without getting orders from the consul.
- There is a damage to the loadcell which functions as a load reading sensor.
- On the miniature side of the hull, there was damage to the hull paint because it was always submerged in water.
- In the aquarium water filling filter tube cracks occur, causing water leakage in the form of droplets.
- The water supply hose on the ship is brittle due to age so it breaks.

1.2. Research Aims and Objectives

1.2.1. Research purposes

The research objectives of this paper are to obtain solutions so that maintenance and repairs can operate properly, namely:

- Repair of tank and seat glass
- Ballast control panel on consult desk.
- Corrosion on the lower body of the ship.
- The hydraulic lever sensor sometimes works sometimes it doesn't, sometimes the lever goes down by itself
- There is a leak in the water filter tube

1.2.2. Benefits of research

- To make it easy for readers to understand related to Maintenance and repairs on ship stability, kalangie is an important laboratory on board.
- To make comparison material for readers to better understand how important it is to maintain and repair hydraulic levers, sensors, water filters and ballast pumps.

2. Literasi Theory

Ship model hydrostatic data;

Figure 1. Hydrostatic Curve of Bulk Carrier Ship Model - (Sea water ρ = 1025 kg/m3)

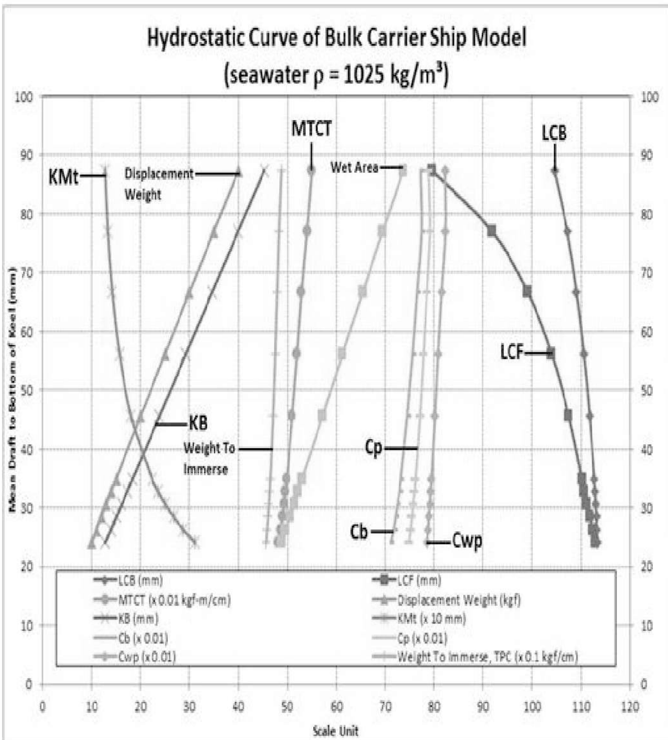


Figure 2. Hydrostatic Curve of Bulk Carrier Ship Model – (Freshwater ρ = 1000 kg/m3)

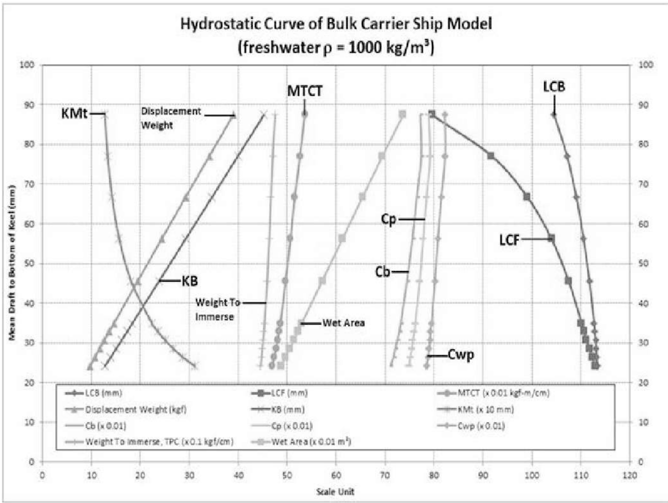


Figure 3. Cross Curve of Stability of Bulk Carrier Ship Model - (GZ Curve, assumed KG = 102,44mm, seawater ρ = 1025 kg/m3)

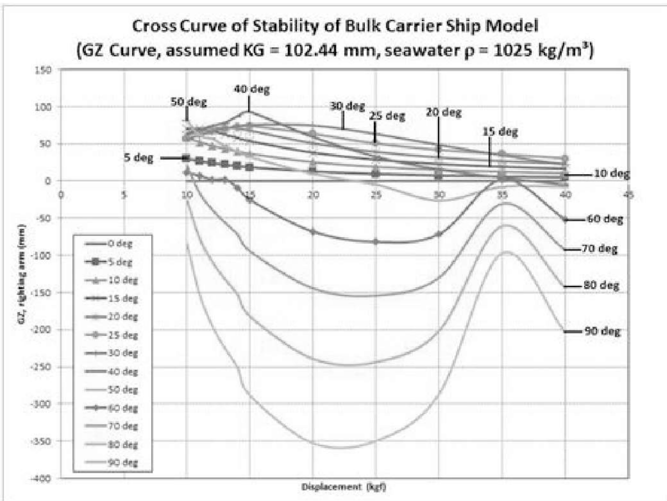


Figure 4. Cross Curve of Stability of Bulk Carrier Ship Model - (GZ Curve, assumed KG = 102,44mm, seawater ρ = 1000 kg/m3)

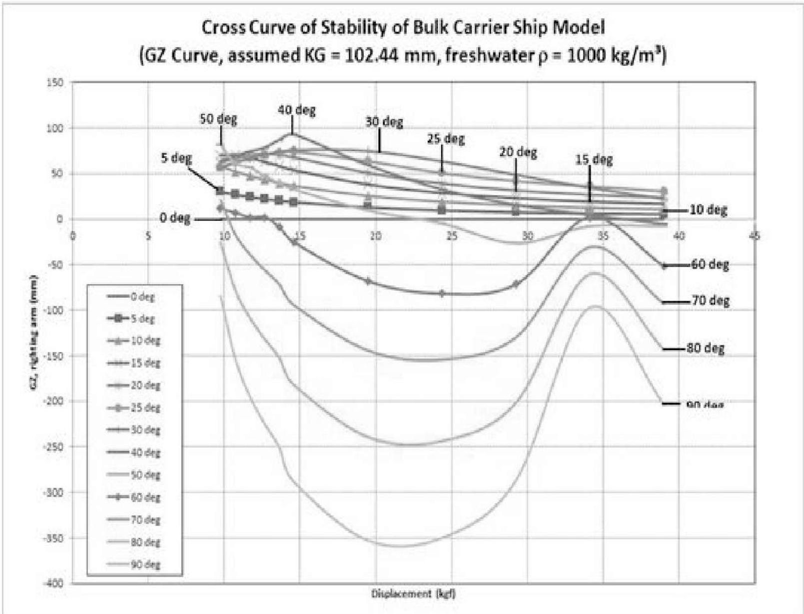
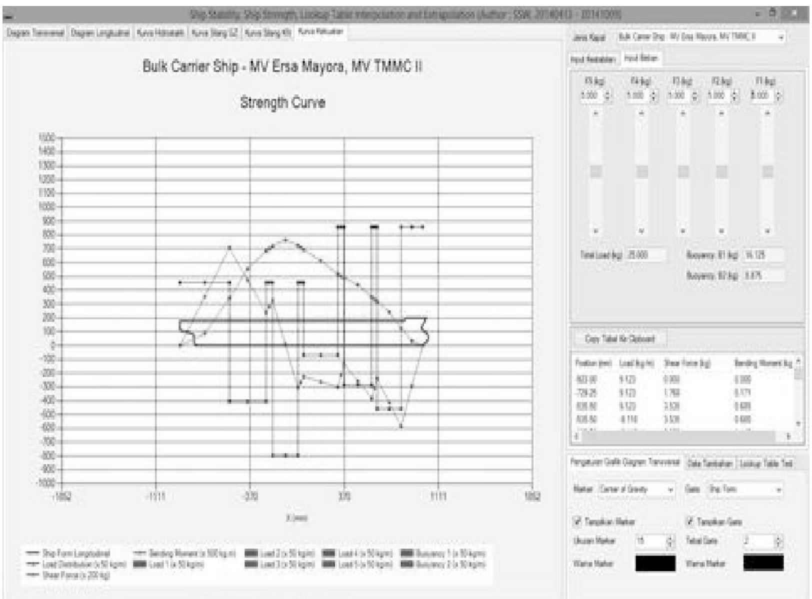


Figure 5. Bulk Carrier Ship – MV Ersa Mayora, MV TMMC II - Strength Curve



3. Research Methods

The type of research used in this study is descriptive qualitative research, which describes a number of data which are then analyzed and compared based on the ongoing reality and then tries to provide solutions to existing problems in order to obtain better results than before. This research focuses on the analysis of the stability of the simulator in the laboratory and workshop units that will affect changes in the stability of the ship simulator. The research approach that can be carried out is the proactive method where the method is an analysis that has been carried out before and has been carried out from other institutions that have the stability of similar ship simulators.

The research subject focuses on analysis of ship simulator stability damage. The stages carried out in this research include a preliminary survey, literature study, problem identification, problem formulation, research objectives, data collection and processing, data analysis, recommendations for improvement, conclusions. At the preliminary survey stage, a survey was conducted to get an overview of the actual condition of the object under study, namely initial stability data on the ship stability simulator in the laboratory unit and looking for data from other institutions that are in the process of adding simulators on similar training vessels. The literature study stage is studying theories and science that are relevant to the problems studied. Literature sources are obtained from printed books, scientific journals, and other written sources. At the problem identification stage, it is carried out to look for deficiencies that exist in the stability change analysis process in the laboratory unit. For the problem formulation stage regarding things that can hinder the analysis process. The stage of determining research objectives is needed to be able to plan steps that can be taken in research so that research can be more focused and can be run smoothly. The last stage is data collection and processing which includes identification of the equipment planned for repair, Mapping the identification in the initial data and equipment so that future stability changes can be analyzed, Next is the Analysis and Discussion stage, namely Analyzing steps to improve the stability of the simulator in laboratory units thereby improving the initial stability of the ship simulator. In the Improvement Recommendation phase, an analysis of the design of improvements that can be applied to simulator planning in the laboratory unit is carried out. And the last is Conclusion. At this stage, several conclusions are drawn as answers to the problems raised in the study. Based on the conclusions drawn, some suggestions or suggestions for improvement in an effort to improve the performance and productivity of the agency and to conduct further research can be given.

In carrying out this research, we use the following data:

Calibration Data When Maintenance Ship Stability (Ship General Cargo Mv Aldebaran)

Table 1. Cargo Hold When Emty

Cargo Hold 1		0kg	2kg	4kg	5kg
NO	SENSOR	Volt			
1	1-1P	0.31	1.38	2.22	2.49
2	1-2P	0.18	0.42	0.63	0.96
3	1-1SB	0.06	0.06	0.19	0.51
4	1-2SB	0.33	1.09	1.88	2.25

3. Result and Discussion

Ship Stability General Cargo Simulator (SSTS) is a laboratory to provide training on the configuration and procedures for maintaining ship stability as a training facility for cadets in the engineering field. The Ship Stability General Cargo Simulator configuration at STIP Marunda Jakarta describes a general cargo ship configuration in which it has equipment to simulate cargo loading and ship ballast filling, which serves to simulate ship conditions when loading cargo.

Maintenance and repair are activities carried out to improve, maintain, and return equipment in good and ready-to-use condition. In relation to the maintenance of laboratory equipment, maintenance is intended as a preventive effort or prevention so that the equipment is not damaged or is maintained in good condition, ready to operate. Besides that, maintenance is also intended as an effort to adjust or repair laboratory equipment that has already been damaged or is not feasible so that it becomes ready to be used for practical activities for students or cadets.

Some of the maintenance that needs to be done on this Ship Stability Simulator are:

- Electrical system
- Control system
- Filling System
- Drain System
- Actuator System
- Measurement Level System

3.1. Scope of Job Working

The Ship Stability Simulator maintenance work consists of the following activities:

- Cleaning (cleaning)
- Check (inspection)
- Repair (repair)
- Test the function (function test).

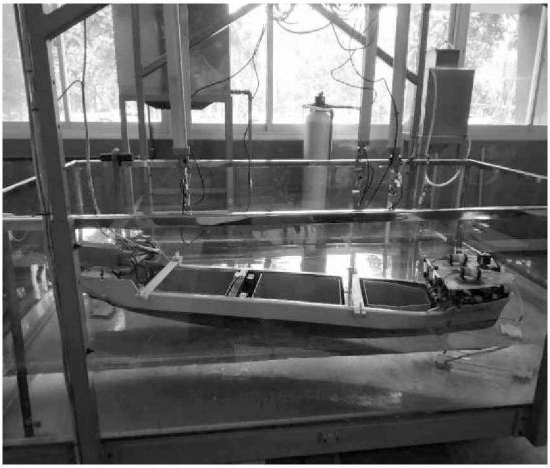


Figure 6. Ship Stability General Cargo Simulator STIP Marunda Jakarta Conditions.

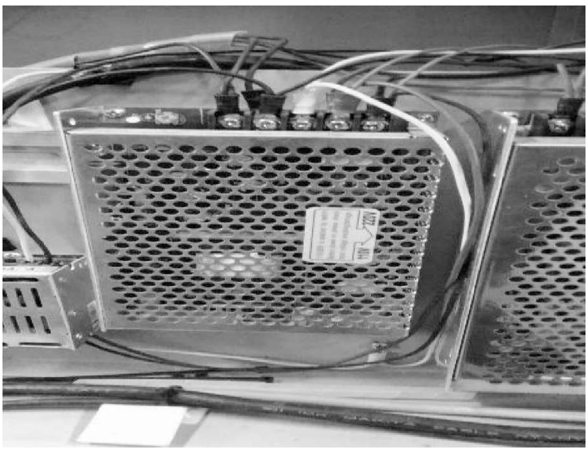


Figure 7. Power Supply 12VDC no output

Based on the Technical Inspection (February 17, 2020) conducted by the engineering team of PT. TMU, especially the Ship Stability Simulator in a state of not being able to turn on.

Steps that have been carried out:

- Check Electrical system power supply 12VDC is damaged
- Check the condition of the hull needs to be repainted
- Check Cargo Compartment submerged in water
- Check the water line hose is leaking and broken
- Check Water Filter is leaking
- Check Cargo Compartment bubbly paint condition
- Check Wiring system needs repair
- Check Instructor Computer
- Check Control & Monitoring Console
- Check CBT Console

From the results of the technical inspection carried out, it is necessary to replace and repair several damaged components and repaint the Compartment Water pump.

3.2. Maintenance Work and research schedule Implementation

The implementation of this Maintenance work must be completed within 15 (fifteen) calendar days.

- Survey Activities
- Technical Inspection

- Maintenance and Repair
- Function test

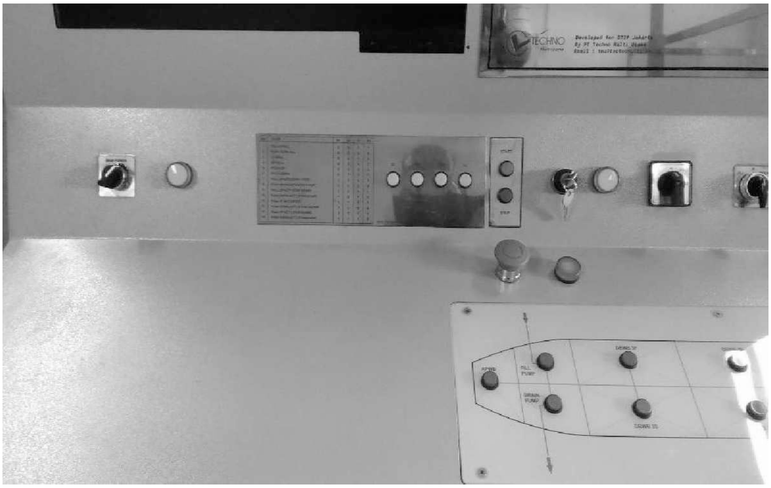


Figure 8. Install Key switch + green indicator to activate the Actuator when it is operated and Emergency switch + red indicator for emergency stop in the event of a malfunction the actuator moves outside the control command.

Replacement of faulty Load cell sensor on Actuator Port1:

Figure 9. Check measurement data and recalibration

Figure 10. Repair of ballast level and draft level sensors Setting and calibration of draft and ballast level sensors Checking and responding to output signals from draft and ballast levels, replacing faulty sensors and calibration.

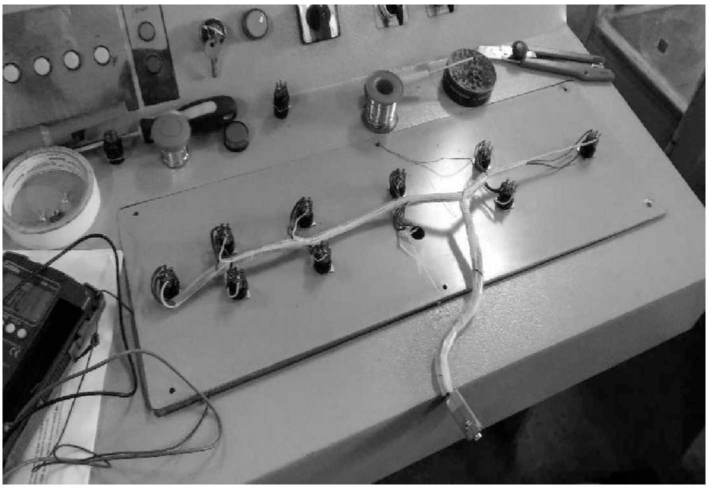


Figure 11. Replacement Push Button ON/OFF 16mm, Indicator light, Micro controller & programming

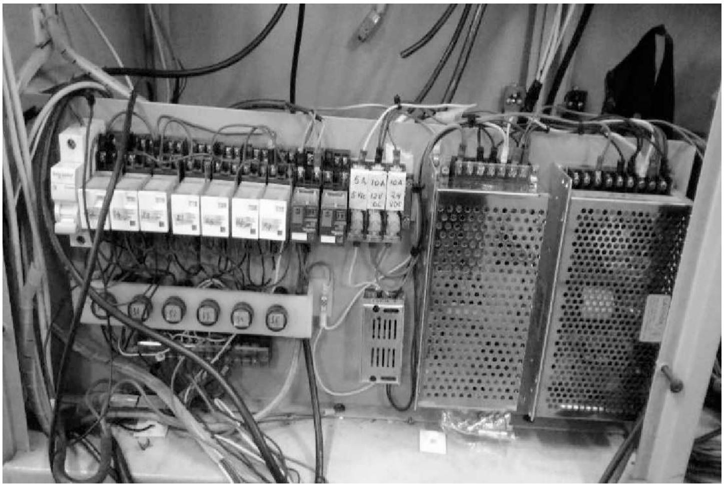


Figure 12. Replace the power supply input 220VAC, output 12 VDC / 10A by adding a safety fuse for each Power supply 5VDC / 5A, 12VDC / 10A, 24VDC / 10A. Replacing Main Power Switch with Selector Switch + Green Light Indicator. Streamlined cable routing and added relays for Actuator Power Switch.

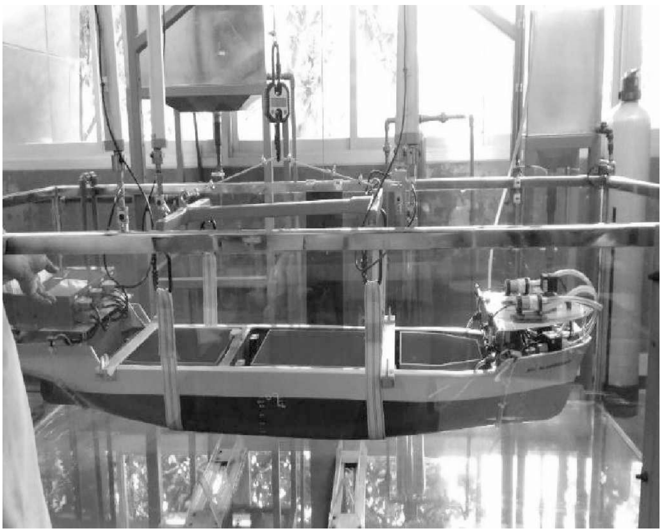


Figure 13. Installation Hoist is a tool to lift and weigh the ship before being floated

3.3. Result and Discussion

Calibration Data On Ship Stability Preventive

(General Cargo Ship Mv Aldebaran)

Fiscal Year 2021

3.3.1. Hatch Table When Empty

Table 2. Hatch When Empty (hatch 1, hatch 2)

Hatch 1		**0kg**	**2kg**	**4kg**	**5kg**
NO	SENSOR	Volt			
1	1-1P	0.31	1.38	2.22	2.49
2	1-2P	0.18	0.42	0.63	0.96
3	1-1SB	0.06	0.06	0.19	0.51
4	1-2SB	0.33	1.09	1.88	2.25
Hatch 2					
NO	SENSOR	Volt			
1	2-1P	0.78	1.1	1.94	2.46
2	2-2P	0.52	0.55	0.57	0.85
3	2-1SB	0.45	0.5	1.32	1.57
4	2-2SB	0.29	1.26	1.57	1.7
NO	SENSOR	Volt			
1	3-1P	0.79	1.39	1.89	2.2
2	3-2P	0.03	0.08	0.62	0.92
3	3-1SB	0.2	0.7	1.21	1.54
4	3-2SB	1.19	1.6	2.01	2.42

3.3.2. Data Sensor hatch 1 Port 1

Table 3. Data Sensor hatch 1 - Port 1

No	Kg	Volt Output(Volt)
1	0	0.0074
2	0.55	0.418
3	0.99	0.984
4	1.91	1.914
5	3.01	3.054
6	4.04	4.1
7	5	5.14
8	4.07	4.18
9	3.14	3.205
10	1.84	1.967
11	1.26	1.1269
12	0.61	0.605
13	0	0.0074

Note: Replacement of the load cell sensor, because the sensor output is offset at 0 kg load > 1Volt. And the signal conditioning setting is already at its maximum.

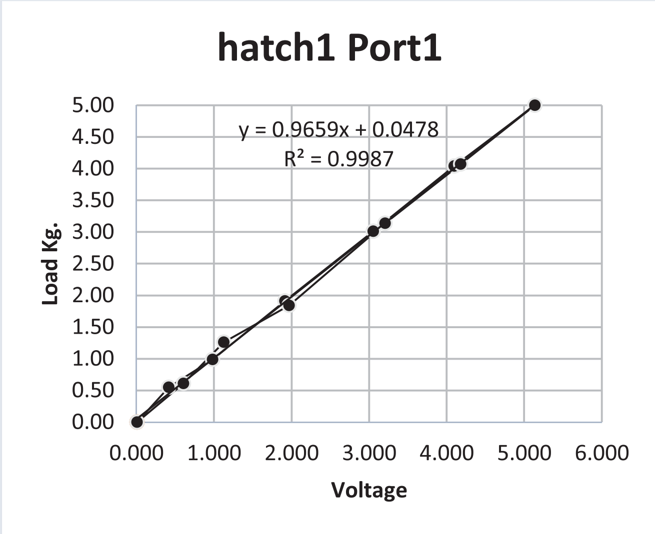


Figure 14. hatch 1 – Port 1

3.3.3. Data Sensor hatch 1 SB02

Table 4. Data Sensor hatch 1 - Port 1

No	Kg	volt Output(Volt)
1	0	0.0068
2	0.55	0.505
3	0.96	0.922
4	1.98	1.94
5	3.03	2.992
6	4.35	4.36
7	5	5.042
8	4.33	4.36
9	3.05	3.05
10	2.07	2.065
11	1.18	1.163
12	0.68	0.665
13	0	0.0068

Note: Replacement of the load cell sensor, because the sensor output is offset at 0 kg load > 0.8Volt. And the signal conditioning setting is already at its maximum.

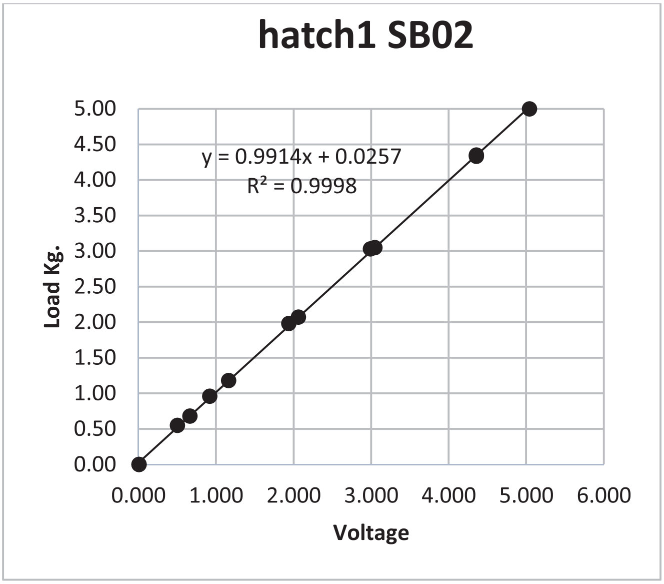


Figure 15. hatch 1 – SB 02

3.3.4. Draft 1P

Table 5. Draft 1P

NO	MARK	VOLT	
1	0	0.75	when not in water
2	1	1.5	
3	2	1.9	
4	3	2.25	
5	4	2.8	
6	4.5	3	
7	5	3.25	

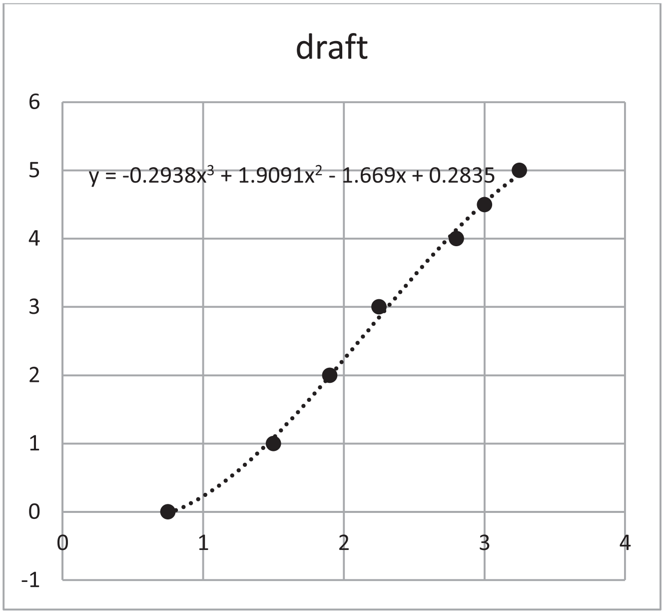


Figure 16. Draft on Ship

Table 6. Draft 1P

NO	MARK	VOLT	descr	
1	0	1.16	step3a	when not in water
2	3.5	1.79	step 6	
3	4	1.89	step 7	
4	4.5	1.97	step 8	
5	5	2.09	step 9	
6			step10	
7			step11	ini step11

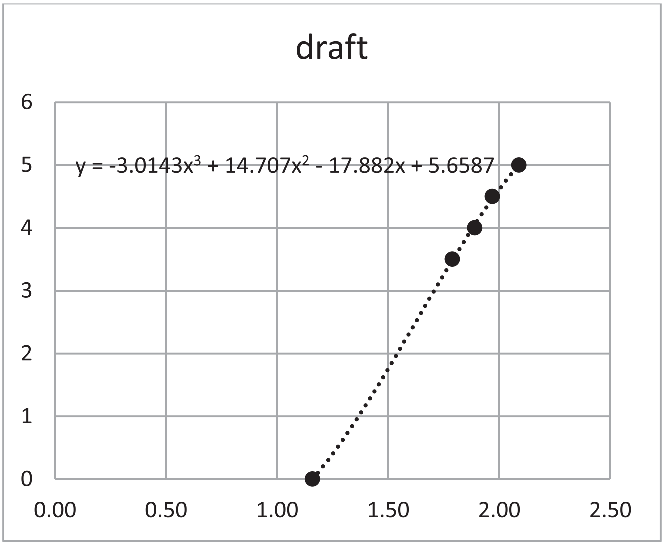


Figure 17. Draft on Ship

3.3.5. Draft 2P

This table will be filled automatically according to the measurement results during the Draft addition process

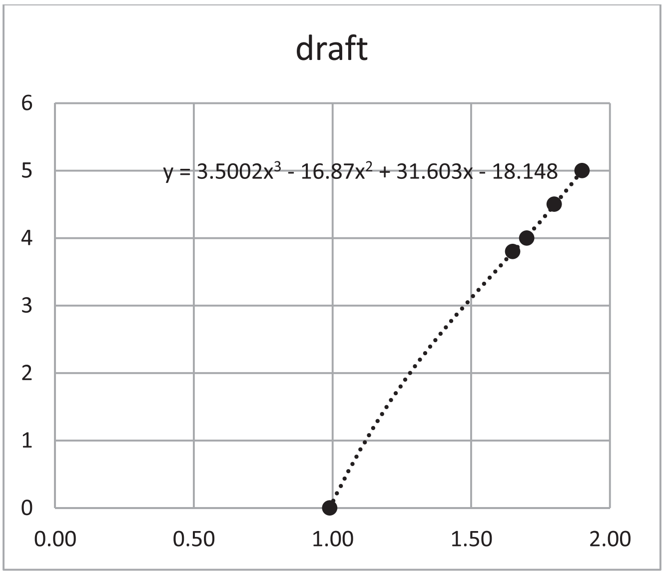


Figure 18. Draft on Ship

3.3.6. Draft 2SB

This table will be filled automatically according to the measurement results during the Draft addition process.

Table 7. Draft 2SB

NO	MARK	VOLT	descr	
1	0	1.10	step3a	when not in water
2	3.8	1.81	step 6	
3	4	1.86	step 7	
4	4.5	1.93	step 8	
5	5	2.05	step 9	
6			step 10	
7			step 11	

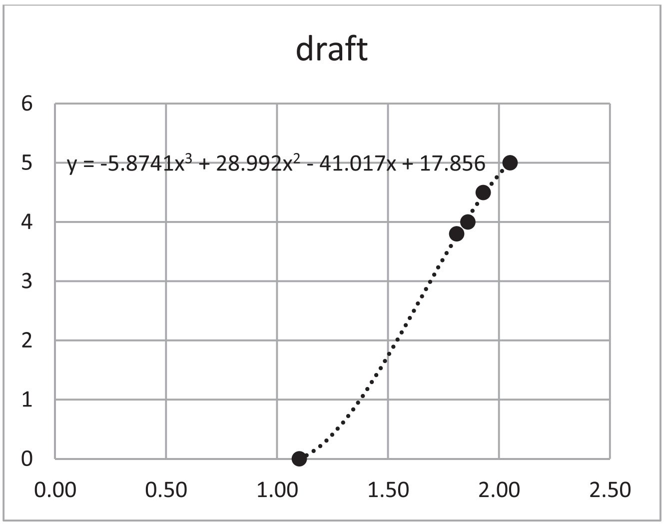


Figure 19. Draft on Ship

3.3.7. Draft 1SB

This table will be filled automatically according to the measurement results during the Draft addition process.

Table 8. Draft 1SB

NO	MARK	VOLT	descr	
1	0	1.13	step3a	when not in water
2	3.5	1.76	step 6	
3	4	1.86	step 7	
4	4.5	1.96	step 8	
5	5	2.08	step 9	
6			step 10	
7			step 11	ini step11

Table 9. Draft 1SB

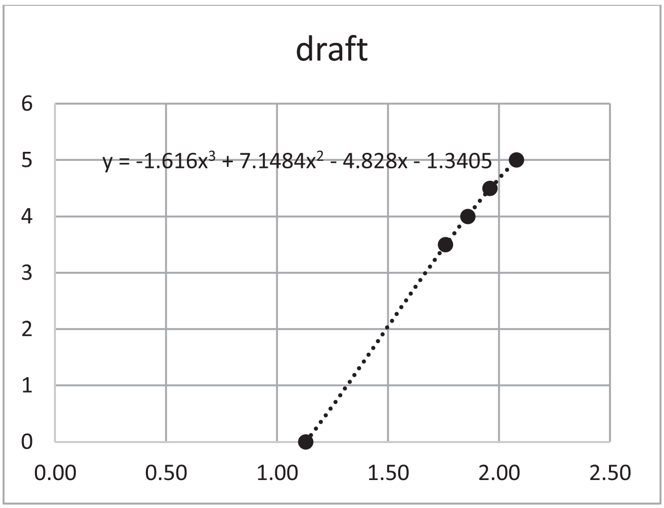


Figure 20. Draft on Ship

3.3.8. Aquarium Level Calibration (Example)

Give the load gradually, from zero to maximum load

- Record the output voltage that arduino monitors when the water is empty
- Fill the water, at a certain level, for example 5 cm.
- Record the monitored voltage on Arduino
- Repeat until the water level is about 30 cm

Note: ideally the equation is a straight line (linier)

Example :

Table 10. Level Calibration

No	Level (cm)	Volt Output (Volt)
0	0	0.490
1	5	1.039
2	10	1.431
3	15	1.843
4	20	2.294
5	25	2.745
6	30	3.196

No	Level (cm)	Volt Output (Volt)
0	0	1.180
1	4	1.47
2	8	1.88
3	12	2.26
4	16	2.65
5	20	3.04
6	24	3.43

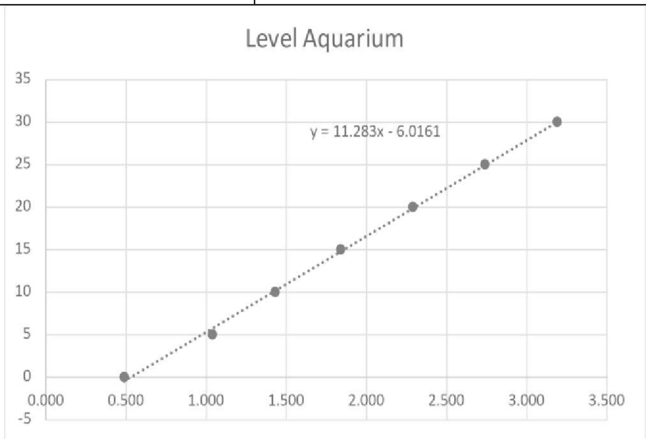


Figure 21. Level in Aquarium

Give the load gradually, from zero to maximum load

- Record the output voltage that arduino monitors when the water is empty
- Fill the water…., at a certain level, for example 5 cm.
- Record the monitored voltage on Arduino
- Repeat until the water level is about 30 cm

Note: ideally the equation is a straight line (linier)

Example :

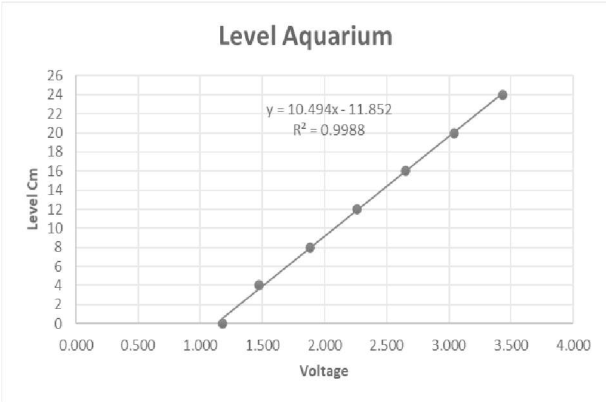


Figure 22. Level in Aquarium

Give the load gradually, from zero to maximum load

- Record the output voltage that arduino monitors when the water is empty
- Fill the water…., at a certain level, for example 5 cm.
- Record the monitored voltage on Arduino
- Repeat until the water level is about 30 cm

Note: ideally the equation is a straight line (linier)

Example:

Table 11. Level Aquarium

No	Level (cm)	Tegangan Output (Volt)
0	0	1.040
1	4	1.31
2	8	1.75
3	12	2.12
4	16	2.51
5	20	2.9
6	24	3.29

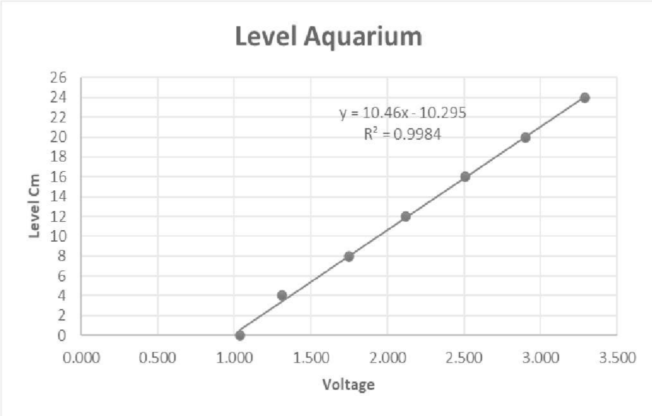


Figure 23. Level in Aquarium

3.3.9. Hydraulic Lever Calibration

Give the load gradually, from zero to maximum load

- Record the output voltage that arduino monitors when the water is empty
- Fill the water…., at a certain level, for example 5 cm.
- Record the monitored voltage on Arduino
- Repeat until the water level is about 30 cm

Note: ideally the equation is a straight line (linier)

Example :

Mechanical lever load cell calibration (1P Lever)

Give the load gradually, from zero to maximum load

- Give loadcell
- Record the weight of the load in the Weight column
- Record the output voltage that the Arduino detects. In the Output voltage column

- Repeat for the next weight

Table 12. The graph and the equation of the line automatically appear auto log

No	weight (kg)	Volt Output (Volt)
0	0	0.100
1	2.1	0.51
2	3.99	0.880
3	6.03	1.31
4	8.05	1.730
5	10.04	2.1
6	12.13	2.530
7	14.41	3
8	16.3	3.390
9	18.44	3.8
10	20.04	4.140

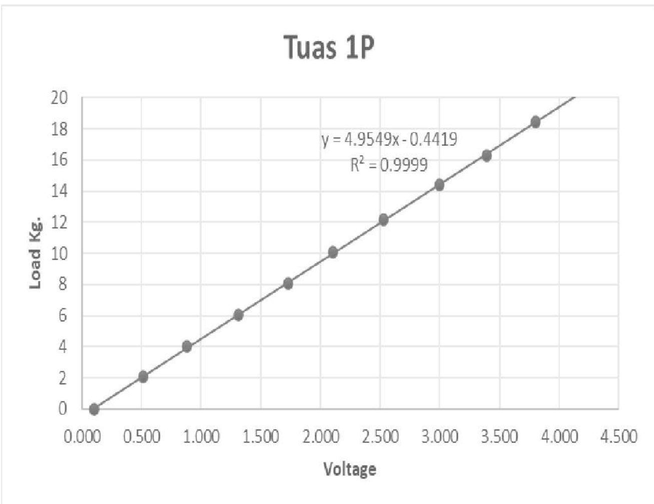


Figure 24. lever 1P

Mechanical lever load cell calibration (2P Lever) Give the load gradually, from zero to maximum load:

- Give loadcell
- Record the weight of the load in the Weight column
- Record the output voltage that the Arduino detects. In the Output voltage column
- Repeat for the next weight
- The graph and the equation of the line automatically appear

Table 13. load cell calibration

No	weight (kg)	volt Output (Volt)
0	0	0.470
1	2.04	0.9
2	4.42	1.390
3	6.19	1.75
4	8.05	2.100
5	10.12	2.53
6	12.69	3.050
7	14.42	3.4
8	16.02	3.730
9	18.33	4.2
10	19.97	4.520

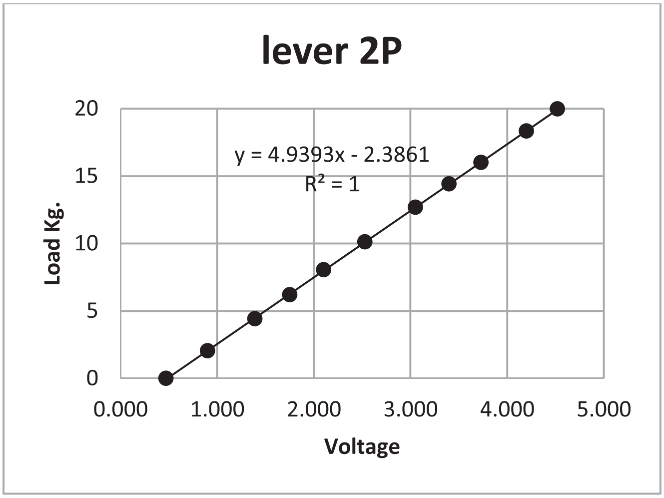


Figure 25. lever 2P

Table 14. weight calibration

No	weight (kg)	volt Output (Volt)
0	0	0.100
1	2.1	0.46
2	4.1	0.860
3	6.13	1.28
4	8.23	1.710
5	10.14	2.09
6	12.2	2.500
7	14.08	2.88
8	16.11	3.300
9	18.24	3.72
10	20.04	4.080

Mechanical lever load cell calibration (1SB Lever).

Give the load gradually, from zero to maximum load:

- Give loadcell
- Record the weight of the load in the Weight column
- Record the output voltage that the Arduino detects. In the Output voltage column
- Repeat for the next weight
- The graph and the equation of the line automatically appear

Table 15. weight calibration

No	Weight (kg)	Volt Output (Volt)
0	0	0.490
1	2.28	0.95
2	4.14	1.330
3	6.11	1.74
4	8.34	2.180
5	10.03	2.51
6	12.22	2.940
7	14.5	3.41
8	16.44	3.800
9	18.19	4.15
10	19.99	4.510

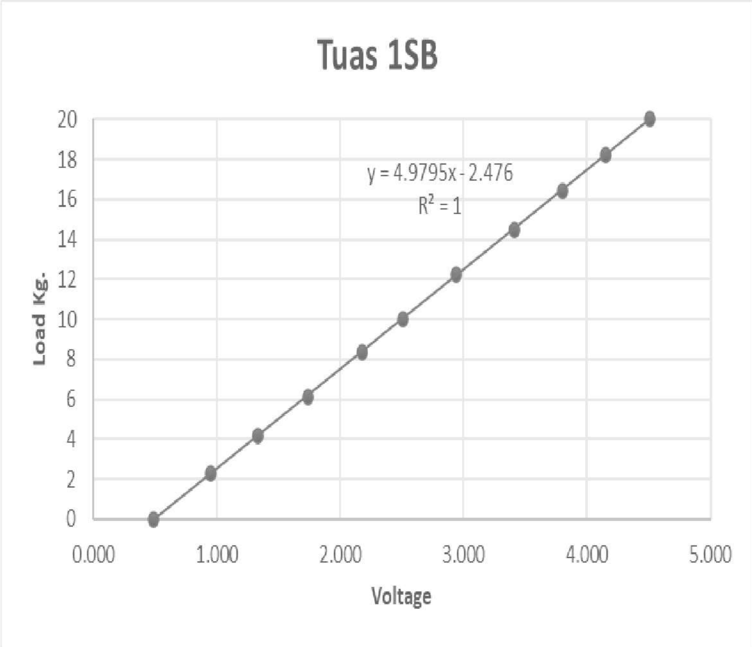


Figure 26. lever 1SB

Mechanical lever load cell calibration (2SB Lever)

Give the load gradually, from zero to maximum load

- Give loadcell
- Record the weight of the load in the Weight column
- Record the output voltage that the Arduino detects. In the Output voltage column
- Repeat for the next weight
- The graph and the equation of the line automatically appear

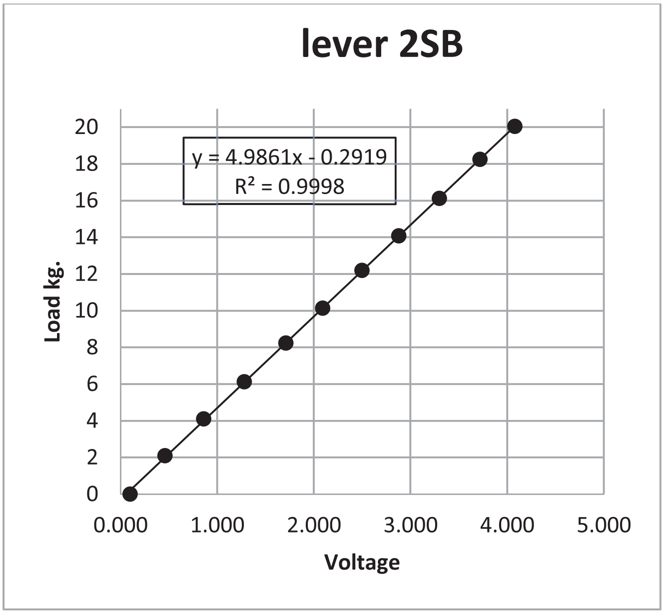


Figure 27. lever 2SB

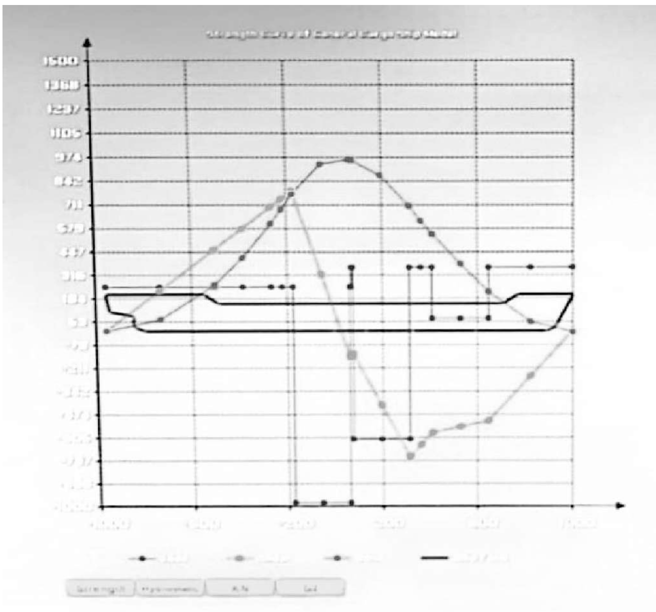


Figure 28. result Data Tabel Strength When Loaded

Figure 29. Data Monitoring Draft, Angle, Arm Force, Cargo Compartment and Aquarium Water Level (a)

Figure 30. Data Monitoring Draft, Angle, Arm Force, Cargo Compartment and Aquarium Water Level (b)

Figure 31. Data Monitoring Draft, Angle, Arm Force, Cargo Compartment and Aquarium Water Level (c)

Figure 32. Data Monitoring Draft, Angle, Arm Force, Cargo Compartment and Aquarium Water Level (d)

4. CONCLUSION

4.1. Conclusion

- The factor causing the non-optimal practice of Cargo Ship Simulator Stability learning in the Laboratory unit is Malfunction Load and mechanical actuator Sensors on Ship Stability equipment.
- Lack of discipline of technicians in carrying out maintenance so that treatment is neglected and does not run according to the established procedures as it should be;
- In order to minimize or reduce damage and reduce high costs, STIP / the company uses a planned maintenance strategy.

4.2. Recommendation

- STIP must conduct a selection of technicians who want to join or conduct training for technicians, to match the desired criteria.
- Technicians in the laboratory to always carry out ship stability equipment maintenance to support practical learning activities in the laboratory.

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