Evaluation of Fender Feasibility at Bolok Ferry Port, East Nusa Tenggara Province

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ABSTRACT
Bolok Ferry Port is a port that connects many islands in East Nusa Tenggara Province, Bolok Ferry Port also plays an important role in the distribution of logistics and basic necessities for the community as well as a means for passengers to board and disembark from ferry ships. One of the things that must be considered in the operation of the ferry port is the security of the port facilities. However, currently Bolok Ferry Port does not have adequate berthing facilities and in accordance with applicable regulations. This makes the berthing facilities at Bolok Ferry Port have shortcomings and the possibility of accidents that cause discomfort to passengers when the ship docks at the port. Therefore, the study focuses on fulfilling the suitability and condition of the fender. The research was conducted based on the applicable provisions and regulations. So that researchers conducted observations and measurements to find data related to the characteristics and facilities that are in accordance with the provisions that focus on fenders so that passenger satisfaction with the docking process at the port gets a good response. And researchers provide suggestions to relevant agencies to conduct periodic checks on the condition of the docking facilities and replace fenders that are not appropriate and lacking. The results of this study are that the type of fender that is in accordance with the characteristics of the ship at the Bolok Ferry Port is not yet appropriate so that a re-check is needed from the port so that the fender is replaced with an appropriate one and returns to its maximum condition.
Keywords : Evaluation, Eligibility, Fender

1. INTRODUCTION

A port is a place consisting of land and/or waters with certain boundaries as a place for government activities and business activities that are used as a place for ships to dock, for passengers to embark and disembark, and/or for loading and unloading goods, in the form of a terminal and a place for ships to anchor which is equipped with shipping safety and security facilities and port supporting activities as well as a place for intra- and inter-mode transportation transfers.

Ferry Port is a sea, river, and lake port used to serve ferry transportation that functions to connect road networks and/or railway networks separated by waters to transport passengers and vehicles and their cargo. Ferry ports as a place for

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ferry ships to dock are very necessary to connect the islands in Indonesia that are separated by waters. So there are many ferry ports in the territory of Indonesia. One of them is the Bolok Ferry Port.

Bolok Ferry Port is a port that connects various islands. This port has a big role in distributing logistics and basic necessities for the community as well as a means for passengers to board and disembark from ferry ships. One of the things that must be considered in the operation of a ferry port isin the security of the port facilities. The condition offacilityThe port must be in good condition, and according to needs. So that it can guarantee the safety and security of passengers. One of the facilities available at the port is the berthing facility. The berthing facility is one of the important facilities in a port. Where this facility plays an important role when the ship is about to dock. The parts included in the berthing facility are fenders and bolters.

Based on the research conducted, the berthing facilities at the Bolok Ferry Port are in poor condition. This makes the comfort and safety of the ship's berthing process less than optimal. As for the berthing facilities in the form of fenders and bolters, the researchers found that the fenders at the Bolok port did not appear strong enough to withstand collisions from ships, causing damage to the dolphin wall (can be seen in Figure 1 below).

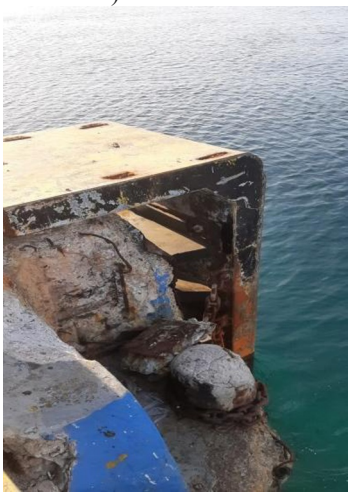

Figure 1. Conditions*fender*

Furthermore, from the results of the researcher's observations, it was found that the fenders at the Bolok Ferry Port were not in perfect condition, so they did not provide maximum function in withstanding collisions that occurred.

Based on the explanation of the background above, the research undertaken by the author will discuss the evaluation of the feasibility of fenders at the Bolok Ferry Port.

2. RESEARCH METHODOLOGY

In collecting data, researchThis uses primary and secondary data collection techniques. Where the data will be explained as below:

1. Primary Data
   a. Observation
      Observation is an observation that is carried out directly and systematically which is then recorded. The activities carried out are conducting a survey to obtain an accurate picture of the object of observation and the existing problems. The observations carried out are focused on visually observing the condition of the fender.
   b. Measurement
      Measurementconducted to obtain information about the size of the pier and its facilities that do not comply with existing regulations so that they can affect ship services and safety. The data obtained includes the characteristics of the fender at the Bolok Ferry Port.
2. Secondary Data
   a. Literature Method (Library)
      The method comes from literature or books available in the library of the Palembang River, Lake and Ferry Transportation Polytechnic and other books related to this research.
   b. Institutional Method
      This method is related to data collected from various agencies related to this research. Data collected from various agencies related to the research.

3. RESULT AND RESEARCH

1. Data Presentation
   a. KMP Characteristic Data. Accident
      This data is used to calculate the impact energy of the ship used to determine the type of fender. The following is the characteristic data of the KMP ship. Lakaan:
      Table 1. Characteristics of the KMP. Lakaan Ship

Description	Information
Ship Name	KMP LAKAAN
Call Sign/Call	YBS12
Ship Type/GRT	Ro-Ro Ferry / 1689 GT
Ship Type/NRT	808 NT
Owner	PT. ASDP Indonesia ferry
Manufacturing Shipyard	PT. Indonesian Ship Industry Makassar
Production year	2015
Ship Classification	Indonesian Classification Bureau (BKI)

Ship Speed	10 Knot
Size	
Length Overall (LOA)	64.52 meters
Length (LBP)	50.50 meters
Width (B)	14.00 meters
Main Deck Height (D)	2.70 meters
High Load (d)	2.70 meters
Ship Speed	11 knot
Machinery	
Main Engine	Yanmar, Heavy Duty / 2X 1100HP
Type	Heavy Duty 0681 and 0682
Power	2 x 1100 HP
RPM	1500-1900
Auxiliary Machine	Perkins
Type	6TG2AM
Power	2x100 HP
RPM	1500
Load Capacity	
Ship's crew	21 People
Number of Passengers	VIP Class: 40 people Class I: 96 people Economy Class: 80 people Total Capacity: 216 people
Vehicle	25 units

2. Data analysis

a. Existing Fender Condition Analysis

Bolok Ferry Port currently has a total of 13 fenders with the type of V fenders whose conditions are different at each pier. The condition of the damaged fenders is at pier I of Bolok Port and at the dolphin at pier I which is already visibly damaged due to the fender not being able to withstand the impact of the ship to its full potential. The condition of the fenders and dolphins at pier I can be seen in Figure 2.

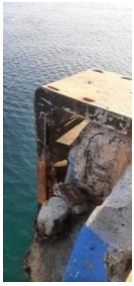

Figure 2. Conditions*Damaged Fender*

Due to the condition of the fender which is unable to withstand the impact energy from the ship to the maximum, this has caused damage to the dolphin at Pier I of Bolok Port.

b. Fender Type Needs Analysis

1) Type of Fender to be Used

To determine the type of fender that is suitable and will be used, it is necessary to first know the ship's displacement and then find the impact energy caused by the ship.

a) Calculating Ship Displacement

To find out the amount of impact energy obtained, first find the displacement. Obtaining displacement can be done using the following formula:

$$\Delta = LBP \times B \times d_{max} \times Cb \times \rho_{air} \quad (1)$$

Information :

Δ : Displacement

LBP : Waterline length of ship (50.50 m)

B : Largest ship width (14 m)

d : Largest ship draft (2.7 m)

Cb : Block Coefficient of RoRo ships (0.7)

ρ : Water density (sea water used 1.025 tons/m3)

$$\Delta = LBP \times B \times d \times Cb \times \rho_{air}$$

$$\Delta = 50{,}50\ m \times 14\ m \times 2{,}7\ m \times 0{,}7 \times 1{,}025\ ton/m^3$$

$$\Delta = 1.369{,}636\ Ton$$

After getting the displacement, you have to find the ship's DWT which can be found using the following formula:

$$\Delta = LWT + DWT \quad (2)$$

Information :

Δ : $Displacement$

LWT : Light Weight Tonnage

DWT : $Dead\ Weight\ Tonnage$

Due to not having ship LWT data, first find the ship LWT in order to find the ship DWT. To find the ship LWT, you can use the following formula:

$$LWT = LBP \times B \times d_{min} \times Cb \times \rho \quad (3)$$

Information :

LBP : Ship Waterline Length (50,50 m)
B : Largest Ship Width (14 m)
admin : Lowest draft (0.7 m)
Cb : Block Coefficient (0,7)
ρ : $densitas\ air\ laut$ (1,025 ton/m^3)

So the LWT value can be found as follows:

$$LWT = 50{,}50\ m \times 14\ m \times 0{,}7\ m \times 1{,}025\ ton/m^3 LWT = 507{,}272\ ton$$

Then after that, DWT can be found as follows:

$$DWT = \Delta - LWT \quad (4)$$

$$DWT = 1.369{,}636\ ton - 507{,}272\ ton DWT = 862{,}364\ ton$$

b) Calculating Ship Docking Speed

In the planning of docks and fender systems, the ship's docking speed is one of the important factors and can be determined from the measurement value. The ship's docking speed can be seen from table 2.

Table 2. Ship Docking Speed

Ship size (DWT)	Docking speed	
	Port (m/d)	Open sea (m/s)
Up to 500	0.25	0.30
500-10,000	0.15	0.20
10,000-30,000	0.15	0.15
Above 30,000	0.12	0.15

Source: Triatmodjo, B (2009)

The DWT of the ship operating at Bolok Ferry Port is 862,364 tons and is included in the 500-10,000 ton category so that the ship's docking speed at the port is 0.15 m/s. After the ship's docking speed is obtained, the next step is the ship's docking speed in a direction perpendicular to the side of the pier which can be found using the following formula:

$$V_x = V\ sin\ \alpha = 0{,}15 \times sin\ 10° = 0{,}026\ m/s$$

c) Calculating Impact Energy

After obtaining the large displacement, the impact energy can be found using the following formula:

$$E = \frac{WV^2}{2g} \times Cm \times Cs \times Cc \times Ce \quad (5)$$

Information :

w :*displacement*tonnage (ton)

V : The perpendicular component of the ship's velocity at the time of impact with the pier (m/s)

g : Acceleration due to gravity (9.8 m/s^2)

Cm : Coefficientmass

Cm $=1 + \frac{\pi}{2Cb} \times \frac{d}{B}$ (6)

Information :

π : 3.14

d : maximum draft of the ship

B : The greatest width of the ship

Cm $=1 + \frac{3,14}{2(0,7)} \times \frac{2,7\ m}{14\ m} = 1 + 2,24 \times 0,19$

$= = 1,4251 + 0,425$

Cs : Hardness Coefficient (taken 1)

Cc : Shape coefficient of the mooring (taken as 1)

C : Eccentricity coefficient

$=\frac{1}{1+(\frac{l}{r})^2}$ (7)

Information :

l : Distance along the water surfacepier from the center of gravity of the ship to the point of mooring of the ship (m)

l $=\frac{1}{4} LOA$ (8)

$=\frac{1}{4}(64,52\ m)$

= 16.13 m

r : radius around the ship's center of gravity at water surface (m)

r = 0,24 LOA (9)

= 0,24 (64.52 m)

= 15,48 m

$$C = \frac{1}{1+(\frac{l}{r})^2}$$

$$= \frac{1}{1+(\frac{16,13}{15,48})^2}$$

$$= \frac{1}{1+(1,04)^2}$$

$$= 0.479$$

$$E = \frac{WV^2}{2g} \times Cm \times Cs \times Cc \times Ce$$

$$E = \frac{1.369{,}636\ ton \times (0{,}026\ m/s)^2}{2\left(9{,}8\ \frac{m}{s^2}\right)} \times 1{,}425 \times 1 \times 1 \times 0{,}479 E = 0{,}0322\ ton/m$$

So, from the calculation results above, the impact energy produced by the ship is 0.0322 tons/m. The type of fender is determined from this value. From the research results, the type of fender V is chosen, the characteristics of which can be seen in table 3.

Table 3. Type Characteristics*Fender V*

Fender Type	CA		CB	
	RF . (ton)	EA (ton-m)	RF (ton)	EA (ton-m)
KVF 200 H	15.35	1.0	12.60	0.75
KVF 250 H	19.52	1.6	15.30	1.18
KVF 300 H	23.07	2.2	17.48	1.60
KVF 400 H	30.37	4.0	24.12	3.00
KVF 500 H	38.40	6.2	30.01	4.60
KVF 600 H	45.59	9.0	34.30	6.50
KVF 800 H	60.74	16.0	48.17	12.00
KVF 1000 H	75.96	25.0	60.29	18.00

Source: Triatmodjo, B (2009)

In table 3, the V 200 H type fender was chosen because it best suits the impact energy studied.

B. Discussion

1. Existing Fender Condition

Bolok Ferry Port currently has a total of 13 fenders with the type of V fenders whose conditions are different at each pier. The condition

of the damaged fenders is at pier I of Bolok port and at the dolphin at pier I which is already visibly damaged due to the fender not being able to withstand the impact of the ship to the maximum.

Due to the condition of the fender which is unable to withstand the impact energy from the ship to the maximum, this has caused damage to the dolphin at Pier I of Bolok Port.

2. The Right Fender Needs

So, from the research results, the impact energy produced by the ship when docked is 0.0322 tons/m. So the appropriate fender type from the research is the V 200H type fender with an upper limit value absorbed of 1.0 tons-m. With the suitability of the fender with the research results, the fender can last longer and work more optimally and can minimize damage caused by ship collisions.

4. CONCLUSION

1. The existing condition of the fenders at the Bolok Ferry Port, East Nusa Tenggara Province is as follows:
   a. The existing condition at the Bolok Ferry Port with a total of 13 fenders at the Bolok Port, with the condition of the fender at Pier I being damaged and the dolphin already cracked due to the fender not being able to withstand all collisions from ships, can be seen in Figure 3.

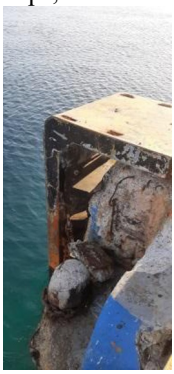

Figure 3. Conditions*damaged fender*

2. Based on the research conducted, the following types of fenders were obtained that are appropriate to the characteristics of the ships operating:
   a. Based on the results of the analysis conducted, the largest ship operating at the Bolok Ferry Port is the KMP.Lakaan ship with an impact energy of 0.0322 tons/m. So that in the study it was found that the appropriate fender type is the KVF 200H type fender with an upper limit of impact energy of 1.0 tons-m.

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