

## THE IMPORTANCE OF MATHEMATICS LEARNING IN EXPERTS' REPORT OF MARITIME AVERAGE

Izv. prof. dr. sc. Tatjana Stanivuk, prof., email: [tstanivu@pfst.hr](mailto:tstanivu@pfst.hr)

Marina Laušić, mag. math., email: [msarac@pfst.hr](mailto:msarac@pfst.hr)

Luka Bitunjac, student, email: [lukbit55@pfst.hr](mailto:lukbit55@pfst.hr)

Faculty of Maritime Studies in Split, University of Split, Split, Republic of Croatia

**Abstract:** *Mathematics is all around us, affecting different aspects of our lives, although we are often not aware of it. Without mathematics there would be no technology, which means we would live in a very different world. Mathematics is the basis of all technical knowledge, and therefore also of maritime affairs. Mathematics as science as well as maritime affairs as maritime activities were created almost at the same time, precisely because of the human need for performing various activities. In the event of maritime accidents, mathematics is and indispensable science in the process of forensic marine investigation and estimation of the damage. This paper is just an insight into examples of the application of mathematics in forensic investigations.*

**Key words:** *Mathematics, sea damage, practical examples, forensic marine investigation.*

## 1. Introduction

Maritime accidents happen on a daily basis. The human need for the security of their property has caused the emergence of insurance companies and companies. In modern transport, minimal insurance is legally required and without it the ship cannot be used. Insurance companies offer a variety of shelves for all types of vessels. The policies vary in the amount of the premium, the level of insurance and the cases of damage. When damage occurs on board, it is reported to the insurer. The Insured is obliged to take all measures in order to preserve the current state and to prevent further damage to the vessel. The insured is also obliged to report to the harbor master's office or the police if the damage was caused by a criminal act (theft, retaliation ..). The insurer arranges for damage assessment in agreement with the insured. The Insured is obliged to maintain the same condition and use measures to reduce further damage until the arrival of the damage assessor.

It is difficult to imagine at all any human activity where at least basic mathematics is not encountered. In assessing damage, elementary mathematics is indispensable. Most commonly used are simple addition and multiplication operations and percentage calculations. Therefore, every expert must have a basic knowledge of mathematics. At first glance, marine math and math have nothing in common. However, if attention is paid to the consequences resulting from the accident, it should be noted that the consequences had to be measured and that the results obtained had to be recorded in order to reach conclusions. In this case, the measure will be money. Ships are usually extremely

expensive, even the smallest ones, so almost every damage is extremely high. Insurance companies therefore pay great attention to damage to ships. Each insurance company individually has a number of expert assessors who go to the field and determine the facts on the spot. Later, in the process, they express their opinion on the level of damage and the most favorable repairs for their company.

## 2. Maritime accidents

The notion of maritime accident in technical and legal sense has evolved in the past from the many hazards inherent in maritime navigation. The exact origin of the term itself is difficult to determine because it is attributed to various sources by linguists and historians. Today, however, the same or very similar term is used in the languages of almost all maritime nations. A maritime accident means any extraordinary damage, loss or expense that affects a maritime property (ie ship, cargo and / or freight) for the duration of the maritime voyage, ie from boarding and departure to the port of destination and disembarkation, or to any other place where this voyage was terminated prematurely.

The main characteristic and typical feature of maritime accidents is their extraordinary nature. It is an event, damage or expense that was not anticipated or accounted for in the regular development of the navigation course. It is the extraordinary nature of such events that separates accidents, in legal and economic terms, from all other fixed and variable costs that the shipowner, by the nature of his business, must count for (eg fuel consumption, port fees, pilotage, towing), or costs or losses. which have been

regularly burdened during transport by sea (eg freight, partial wastage of bulk cargo, kalo, livestock feed). It should be stressed that the character of the accident may also incur a seemingly regular expense (eg fuel consumption), if incurred in extraordinary and unforeseen circumstances (eg during a diversion to an unplanned port to repair damage that occurred during navigation).

### 3. Damage caused by misjudgment

The vessel on which the damage occurred is Bavaria 46 vision. The inspection revealed damage to the fins due to a keel strike to the seabed.

It is recommended to remove the boat to dry berth and repair damage according to the rules of the profession.



Figure 1. Damage to the keel (Source: Authors 2018)

TABLE 1: ESTIMATED COST OF WORK

Work (1hour = 200kn)	Work hours	
Dismantling and installation of keel	30	6.000,00 kn
Dismantling and installation of interiors	75	15.000,00 kn
Repair of damaged rib part	105	21.000,00 kn

Security (setup and download)	25	5.000,00 kn
Cleaning	25	5.000,00 kn
Mast (disassembly and assembly)		7.500,00 kn
<b>TOTAL</b>		<b>59.500,00 kn</b>

TABLE 2: ESTIMATION OF MATERIALS AND ADDITIONAL COSTS

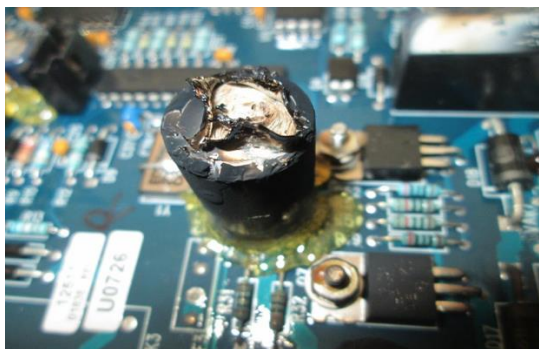
Material	
Repair material	15.000,00 kn
Additional costs	
Manipulation according to the official price list in the marina and berth	5.500,00 kn
Crane (keel and mast)	5.600,00 kn
<b>TOTAL</b>	<b>26.100,00 kn</b>

The adverse event and damage to the vehicle in question was due to a wrong estimate of the maneuvering of the boat where the boat struck the seabed with the keel.

The injured party is obliged to immediately report any damage noticed during the repair in order to make a supplementary report of the damage.

### 4. Damage caused by lightning

Figure 2. Damage to circuits (Source: .Autors 2018)



The vessel damaged by the lightning strike was Jenneau Prestige 46. The inspection found damage to electronic and electrical equipment and equipment. It is recommended to repair and replace according to the rules of the profession.

**TABLE 3: ESTIMATION OF THE DAMAGE REPAIR COST**

Engine repair on request (work + material)	76.828,12 kn
Electricity on offer (work + material)	13.413,75 kn
Electronics on offer (work + material)	103.934,70 kn
<b>TOTAL</b>	<b>194.176,57 kn</b>

Note (cost estimate made on the basis of offer for repair):

**TABLE 4: COST ESTIMATE**

Repair	Offer	Amount (excluding VAT)
Drive motor	R marina d.o.o.	76.828,12 kn
Electrical equipment	Elmar d.o.o.	13.413,75 kn
Electronic navigation equipment	Rados Eletronic d.o.o.	105.734,70 kn *

\* The following items have not been calculated from the offer:

U26 - fault detection - 900 kn

U20 - writing insurance report - \$ 900

Subtract 1,800.00 kn (VAT excluded) from the total amount.

Therefore, the calculated amount is 103.934,70 kn (without VAT).

## 5. Damage from propeller impact

The vessel that was damaged in this case was Adriana 36. The damage was caused to the gearbox (prop) of the engine and propeller. It is recommended to remove the boat to dry berth and repair damage according to the rules of the profession.



**Figure 3. Damage to the engine clamp (Source: Authors 2018)**

**TABLE 5: LABOR COSTS**

Work (1 hour = 200kn)	Work Hours	
Damage repair	16	3.200,00 kn
<b>TOTAL</b>		<b>3.200,00 kn</b>

**TABLE 6: MATERIAL COSTS AND ADDITIONAL COSTS**

Material	
Reducer - by bill	28.222,00 kn
Propeller propeller - by bill	1.800,00 kn
Additional costs	
Manipulation - by account	2.142,00 kn

**TOTAL****32.164,00 kn**

An adverse event and damage to the vessel in question was due to the propeller hitting the rocks during rotation. during his work.

## 6. Total damage

The technical data is taken from the official website of the HRB. Ship documentation is not available because it sank with the ship.

<p>1) <u>Technical information about the ship:</u>  <u>Length: 19.65 m</u>            Width: 4.36 m            Bt: 49            Gaz: 0.867 m            Hight: 1.76 m</p>	<p>2) <u>Hull and hull equipment:</u>            Hull and deck construction material: wood            Number of decks: 1 (2)            Drinking water capacity: 2x 2000 l            Fuel capacity: 2x 1500 l            Rudder machine: hydraulic            Anchor winch            Anchors: 1 piece</p>
<p>3) <u>Engine room of the ship:</u>            Propulsion machine: 2 pieces            Manufacturer: Ford (Mermaid Mariner)            Type: D 5049</p>	<p>4) <u>Navigation equipment:</u>            GPS – Garmin            Radar            VHF            Navigation lights            Magnetic compass</p>

Number of engines: 8145 (left engine)  
 Engine power: 95 kw (130 HP)  
 Year of production: 1974.  
 Portable generator: 6 kw

Figure 4. Ship MB (Source: ship owner 2018)



Estimation of the value of the ship was made on the basis of data from the official web site of the Croatian Register of Boats and photographs of the vessel before sinking, which was sent by the shipowner.

According to the photographs obtained from the owners and according to the official HRB data, as well as the prices on the market of ships of such characteristics (size, equipment, age, construction material and safety), this valuation was made. So, based on the photographs that were obtained from the owner, it is a solid ship that could safely navigate within the documents (authorizations) that he owned. The specification and valuation of the equipment was made on the basis of the specification submitted by the owner, the



photograph and the average equipment of the vessel of such characteristics in use.

The details of the ship's equipment and their value are shown in the following tables.

**TABLE 7: Equipment A**

GPS navigation equipment	500,00 €
Compass	100,00 €
VHF	150,00 €
Navigation lights	100,00 €
Radar	1.000,00 €
<b>TOTAL</b>	<b>1.850,00 €</b>

**TABLE 8: EQUIPMENT B (INOX EQUIPMENT, OPERATING EQUIPMENT, INVENTORY...)**

Deck equipment	15.000,00 €
Rescue equipment and PP equipment	2.500 €
Housing inventory	12.000 €
<b>TOTAL</b>	<b>29.500,00 €</b>

**TABLE 9: VESSEL VALUE ASSESSMENT**

Hull and deck with equipment	110.000,00 €
Power motors with equipment	30.000,00 €
Equipment A	1.850,00 €
Equipment B	32.500,00 €
<b>TOTAL</b>	<b>174.350,000 €</b>

The market value of the ship at the time of the sinking was approximately € 174,350,000, VAT was not included in the price.

## 7. Conclusion

Mathematics is a scientific discipline that has existed for thousands of years. It is present in almost all spheres of human activity. In some industries, it is necessary to know more complex mathematical concepts, while in others it is sufficient to know only elementary mathematics, which includes basic mathematical operations.

Maritime accidents and their estimations belong to those fields in human life that could not be solved without the knowledge and application of mathematics. This paper presents practical examples of maritime accidents and provides an insight into how an assessor performs an expert evaluation on a damaged vessel and how he / she gives his / her expert judgment on the damage caused. Through the examples described, it can be seen that it is of great importance to have a good expert education and it would not be possible without mathematical background.

The prices of the vessels are high, and therefore the prices of repair and replacement parts follow the same. require large financial investments. This is why the expertise of the assessor performing the expert evaluation is of great importance. He must, among other things, be familiar with the construction side of the ship, the seafaring industry, monitor the market prices of replacement parts, compare the monetary amounts of offers received from repairer companies, evaluate those offers and be able to identify and choose the most favorable ones. In fact, there are many factors that a quality and well-trained expert must adopt in order to do his or her job better.

It is well known that neither economic nor technical knowledge goes without mathematics. Therefore, while math may not seem very important at first, it should start from the beginning. from the very construction of the ship and the technical drawing, through various calculations and financial investments to logical conclusion. And it is well known that mathematics is the basis for all of the above.

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