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Review

Case study of masts damage of the sail training vessel POGORIA

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ABSTRACT

The paper presents description and investigations related to an accident of the Polish barquentine "Pogoria" with 50 crewmembers onboard during Tall Ships Race in the first half of July 2009, when all three masts were broken and destroyed.

Fundamental circumstances of the occurred accident – the process of the mast destruction, the analysis of the mast crack places, and the structural and technological causes of the mast weakening are presented. Strength analysis of the applied model of destruction is used for explanation of the failure reasons.

Macroscopic analysis of destroyed parts of masts revealed significant local corrosion losses and – as a result – reduction of effective load carrying section. Such corrosion was a result of bad welding procedure applied. Strength calculations confirmed an increase in critical stress level of almost 10 times in corroded regions. Presence of founded local, deep corrosion places require of the new surveying approach of the steel masts during exploitation.

1. Introduction

At the entrance to the Gulf of Finland (the Baltic Sea), a Polish barquentine Pogoria with 50 crewmembers onboard had an accident during Tall Ships Race in the first half of July 2009. All three masts were broken and destroyed both the running and standing riggings (Fig. 1). Any significant consequences for the crewmembers did not come into existence.

Nevertheless, the accident focused considerable attention of the people and media interested in sail training. They formulated the following questions related to causes of mast fracture:

- source of releasing such huge destructive loads,
- factors triggering off the 'domino effect',
- damage explanation of all mast which should be the strongest in the entire chain of sail propulsion: sails-running riggings-standing riggings-mast.

To explain all the aspects of the mentioned accident an investigation was conducted by Marine Chambers in Gdynia. It is the Polish legal institution to carry out monitoring and analyzing marine accidents from the navigational safety point of view. Its verdict laid the blame neither on the crew nor on the ship-owner.

Nevertheless, answers for such formulated questions became important and urgent for persons, who are permanently involved in the field of sail training. Therefore, attempts have been made to try and explain all aspects of the aroused doubts.

The paper deals with fundamental circumstances of the occurred accident. Particularly, the process of the mast destruction, the analysis of the mast crack places, and the structural and technological causes of the mast weakening are presented.

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Fig. 1. A snapshot of "Pogoria" made just after the accident.

2. Accident cases of sailing vessels

In the last years, we can notice the increased interest in the sail propulsion of many kinds of vessels, including trade vessels [1]. At the present time, this kind of propulsion is mainly used in training, tourist and research vessels. Recently, the increased attention to the sea tourism is noticed. Ship-owner competition in this area forces to search the new attractive offers for customers of passenger ships. Ship-owners have begun to build large touristic sailing vessels. As a rule, old sailing vessels were altered and adapted to passenger purposes. The modern design of large sailing vessels with the automated service of sails came up on many seas. Since the eightieth years of the last century, tens of large sailing vessels have been built.

Races organized once a year by Sail Training International, well-known under the name of Tall Ships Races, group the most beautiful sailing vessels from the whole world. The races of the largest tall ships making up 'A' class are the most spectacular. Relying on the wind strength and own sailing skills, crews of such tall ships compete against each other, as it had taken place during time of the legendary tea clippers.

As in every homogeneous group of ships, sailing vessels are exposed to various misfortunes, including incidents with human victims, e.g. falls from rigs, man overboard. In majority, such incidents are connected with so-called human factor.

The sailing vessel stability losses make up a different group of incidents for example capsizing of STV Concordia. She went down off the Brazilian coast in middle of February 2010. The crew and all the passengers were rescued. According to the report of the crewmembers, the main reasons of the accident were both the strong wind and the high waves. This sailing vessel had very similar parameters to Pogoria. Similar accidents of tall ships had happened earlier many times. Case studies of such accidents can be found in [1].

Coming back to the Pogoria accident, cases of mast damage on sailing vessels of such size are not known to the authors. At present time, several sailing vessels of similar design and built by the same shipyard are in operation. Therefore, the complete explanation of the causes of this event is very important in order to avoid similar accidents in the future.

3. Description of destruction process course of masts

The sailing vessel STS Pogoria is a barquentine. She has three masts, which are all fore and aft rigged, except the foremast which is fully-rigged and carries square sails. The wind strength was about 6° in the Beaufort scale at the moment of the accident. Pogoria sailed a close-hauled course in relation to the wind direction and carried sails typical for such weather conditions, that is she had the full rig without a few sails, namely course, main topgallant stay, main royal stay and main gaff-top sails – Fig. 2.

In our opinion, the direct cause of the fracture of foremast in its upper part was the combination of two main factors:

- substantial weakness of the mast shell material at the analyzed cross-section,
- periodical action of dynamic loads triggered off by upper foremast sails called flying and outer jibs respectively.

Explanation of the first factor will be presented in the further part of the paper. The second factor is connected with a way of sailing according to the close-hauled course which means that Pogoria had the sails trimmed for sailing as close to the wind as possible. In the case of not very careful steering, this course can cause a sudden 'down casting' and 'filling out' upper