Development of a Robust Fire Boat to Operate at Fishery Harbours

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Abstract— Fires on board of fishing craft at fishery harbours in Sri Lanka have occurred frequently during the last two decades, and in most instances, these spread to nearby fishing craft as well, resulting in heavy damage to property and the lives of the fishermen on-board. The traditional shore-based extinguish methods used to quench the fires proved unsuccessful in every instance. The drawbacks were identified for the existing methods of extinguishing a fire on board of a fishing craft. The most feasible and reliable method was to develop an in-shore patrol craft to hook and tow out the fishing craft on fire away from the other craft, and extinguish the fire with a major firefighting system designed for and installed in the rescuer craft. Thus, a floating fire extinguishing platform was designed and developed in accordance with the international and local fire regulations. The study comprises the designing of the fire main system with the mathematical calculations associated with the designed system and the stability of the craft.

Keywords: *existing methods, fire main system, fishing craft*

I. INTRODUCTION

Sri Lanka consists of 23 fishery harbours including 12 in prominent yet incorporated protective water breakers for the basins. Each and every fishery harbour is registered with minimum of 100 fishing boats and most of them are made of glass reinforced fibre. Approximately 20-30 fishing boats are secured at any given time in a harbour. However, there is no reliable system to extinguish a fire if it occurred onboard a fishing craft. The only available method is seeking assistance from the fire service of a municipal council or the Sri Lanka Navy and they are providing their assistance from the land. It takes time to reach the fishery harbour and to attack the fire. Within that period, in most instances, the fire has converted to a major fire and it did spread out to neighbouring fishing boats due to the windy condition in coastal areas. It has created divastated damage to the rest of the secured fishing boats at the harbour. During the last decade, a large number of fire incidents onboard fishing craft have been reported in many fishery harbours. Figure 1 shows that the fire occurred onboard a fishing boat at Galle fishery harbour[1] (*Sri Lanka Navy*, no date) and trying to extinguish by the fire team of Sri Lanka Navy. In addition to that, few recent incidents are depicted in Table 1 below;

Table 1: Recent fire incidents at fishery harbours

Fishery Harbour	Date	Damaged boats
Cod bay	18th June 2018	05
Tangalle	26th June 2019	20
Galle	09th April 2020	09
Dikowita	30th March 2021	04

Source: (*Department of Fisheries and Aquatic Resources*, no date)

Figure 1: Fire at Galle fishery harbour
Source: (*Sri Lanka Navy*, no date)

Department of Fisheries and Aquatic Resources and Ceylon Fishery Harbours Cooperation had to find a viable solution to counter fire incidents onboard fishing craft. Thus, the institutions had arranged a combined effort with the municipal council at the respective area with the fishery harbour by introducing an emergency telephone number for fire calls onboard fishing craft secured at the harbour. However, it was identified that damages to the fire caught craft and neighbouring craft could not be minimized by fighting the fire by

land based approach, in spite of established fire points equipped with portable fire extinguishers at fishery harbours in the early 2010s. Director General Manager (Harbour Operations)(Personal communication, May 15, 2020) reveals that one reason was identified, as failure to above approach as non availability of sufficient capacities of portable fire extinguishers to extinguish the fires once occurred and leads for an exponential spread in most instances.

Recently, the Department of Fisheries and Aquatic Resources had a discussion with Sri Lanka Navy (SLN) regarding this matter. SLN has been taken up the matter to study in depth. SLN has identified the necessity of a floating platform to hook and tow out the fired craft from the fleet of fishing craft and to carry out the fire extinguishing process in a close quarter periphery in the bay.

Inshore Patrol Craft (IPC), one of the small craft with length 14.5 meters in the Sri Lankan Naval fleet operate in shallow waters effectively and efficiently to prevent anti-smuggling and poaching activities and give security protection for harbour mouths, mainly for Colombo, Galle, Hambanthota, Trincomalee, and Kankasanthurei. IPC is propelled with 250 hp 04 OBMs and achieved the speed of 25 knots at its full load consisting of 2450 litres of fuel. The craft is depicted in Figure 2.

To ensure craft survive and keep floating, moving and fighting, it is highly essential to lay emphasis on fire prevention, keep extinguishing and protection with optimum operation at all times. Therefore, it has been identified the requirement to have a meticulous floating firefighting platform for efficient management of fire fighting operations onboard fishing craft at harbours.

Figure 2: Inshore Patrol Craft in Sri Lanka Navy
Source: Sri Lanka Navy

The research problem statement of the study is non availability of a suitable floating platform in close quarter to extinguish the fires that occured onboard fishing craft secured at fishery harbours. The scope of the study is to develop an Inshore Patrol Craft with a designed major firefighting system that is suited to throw the water flow to extinguish the fire that occurred onboard a fishing craft located at fishery harbours in Sri Lanka. The significance of the research was identified as to fill the gap, once a fire occurs onboard fishing craft secured at fishery harbours, the approach was unsolved until recently for the Department of Fisheries and Aquatic Resources and to the Ceylon Fishery Harbours Cooperation.

II. METHODOLOGY AND EXPERIMENTAL DESIGN

In order to enhance the realism in the firefighting environment simulated onboard IPCs, it is developed a major fire fighting system onboard inshore patrol craft to assist the fishing craft secured at the harbour in an emergency of fire.

It is required to be in par with the international and the local regulatory requirements in designing a fire main fighting system onboard a small craft. Therefore, it has complied with the laid down standards listed below.

a. Merchant shipping act for small craft – craft code 12.6.7
b. Merchant shipping act for small craft – craft code 4.10.4
c. Lloyd's Register – Rule finder part 5, Chapter 1, section 5 2.14.2

Inshore patrol craft has been taken into the consideration to identify the adequacy in operating with a major firefighting systems on afloat conditions. IPC has been designed and built with the following parameters as depicted in Table 2.

Table 2: Design parameters of an IPC

Description	Specification
Length overall	15 m
Beam	3.5 m
Hull material	Glass Reinforced Plastics
Fwd draught	0.7 m
Aft draught	0.6 m
Maximum cruising speed	25 knots at full load
Propulsion system	04 x 250 hp OBMs
Fuel capacity	2450 litres

Source: Sri Lanka Navy

It has been identified the exact location to have the sea chest without obstructing the stream water flow for the hull. Further, there is no disturbance to the water flow for the 04 No's OBMs due to sea chest.

Design parameters were considered to maintain the minimum distance of 20 metres in between two craft and to throw the water column with the required volumetric flow and pressure. Therefore, OEM's fire pumps selection part catalogue has been followed to meet the required specifications for the fire pump. The authors have plotted the system head curve considering the pump head and the flow rate. The pump selection has been carried out by matching the pump head curve and system head curve which is provided by the manufacturer. The details are depicted in Figure 3.

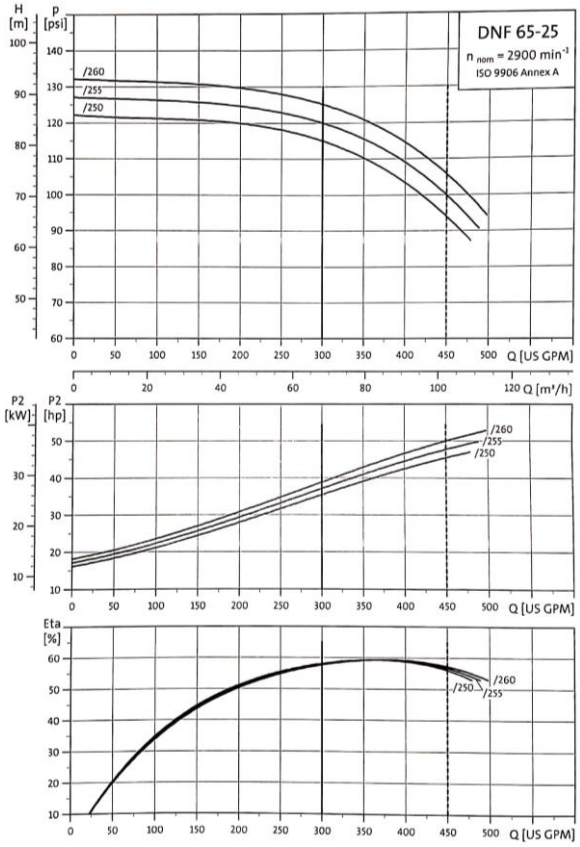

Figure 3: Selection of system operating point
Source: NFPA standard for installation fire pumps

Further, the location has been designed to install a diesel fire pump and its effect on the Longitudinal Center of Gravity (LCG) due to the weight factor of the pump. The stability calculations were carried out to find the stability variations of the craft. The displacement of the IPC is 9 Tons and the actual GZ for the IPC is indicated below in Figure 4.

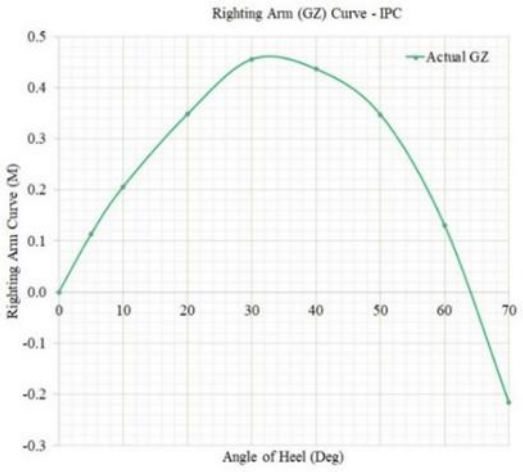

Figure 4: Righting arm curve - IPC
Source: Developed by Authors

The material selection has been carried out in par with the small craft – craft code 12.6.7 and marine quality pipes were selected as per the laid down pipe schedule. In addition, discharging the water has been arranged through a 50 mm branch pipe consisting of a jet and spray nozzle. And also, a branch pipe is installed on the strengthened mount with a rotation of 120 degrees. The authors have designed a single line firemain system to install an onboard fire boat to extinguish a fire that once occurred in a fishing craft at the harbour.

III. RESULTS AND DISCUSSION

Mainly, it has been focused to develop an Inshore Patrol Craft with a designed major firefighting system that is suited to throw the water flow to extinguish the fire that occurred onboard fishing craft located at fishery harbours in Sri Lanka.

A. Fire pump pressure head and flow rate

The discharge velocity of the flow is calculated by Bernoulli's equation.

$$P + 1/2\,\rho V^2 + \rho g h = Constant \ldots. (1)$$

Thereby, the volumetric flow rate is calculated using the following equation.

$$Q = \upsilon A \ldots (2)$$

Where, Q = Volumetric flow rate, υ = Flow velocity and A = Cross sectional area

Considering the minimum distance of 20 metres in between two craft, the output pressure and the flow rate is calculated. The pressure head = 68 psi and flow rate = 244 GPM.

Therefore, it has been analysed the condition with the performance curves of the pump head curve, power curve and efficiency curve and selected the pump with a pressure head of 70 psi with a flow rate of 250 GPM to cater for the minimum requirement. However, the pump should have a sufficient pressure head and flow rate to extinguish the fire. Since the pump is producing 300 GPM and 120 psi at 255 mm diameter impeller and also near to the maximum efficiency, selection has been done as per the curves in figure 3. Further, it was able to maintain the required distance and continuous water flow rate to extinguish the fire.

As per the Merchant shipping act for small craft – craft code 4.10.1, marine quality steel was selected and the seawater suction line outer diameter was 112.5 mm according to the pipe schedule. The associated 2 valves also matched with the steel. A 65 mm diameter jet and spray branch pipe was installed at the mount to maintain the distance in between the craft during the fire extinguishing operation.

B. Stability of the craft

The effect of the addition of the weight of the pump for the stability of the craft has been studied while changing the pump location at the forecastle area of the craft. The aft of the craft is not considered for pump locating to get the maximum advantage while engaging with the fire. The authors designed the pump bed after calculating the stability of the craft and changes of LCG and the Vertical Center of Gravity (VCG). The change of VCG is 0.2 m and it is a positive value. Therefore, VCG increases. Further, Change in LCG is 0.01 m and stability remains as previous. The comparison of righting arm (GZ) curve is depicted in Figure 5 below.

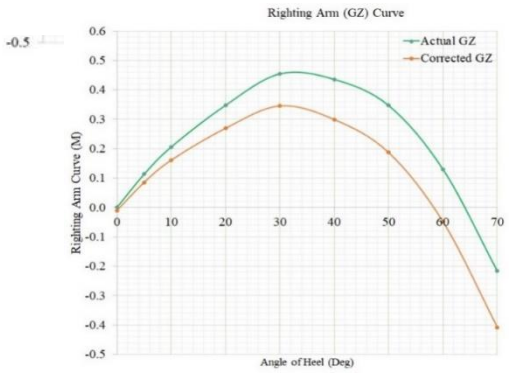

Figure 5: Righting arm curve
Source: Developed by Authors

IV. CONCLUSION

The fires onboard fishing craft at fishery harbours was an unsolved problem for the last two decades. Though, it has been taught many lessons learnt from those incidents, all of them were failed to provide a lasting sustainable solution. The development of an Inshore Patrol Craft with a designed major firefighting system which is suited to throw the water flow to a minimum distance of 20 meters to extinguish the fire that occurred onboard fishing craft. It will fulfil the gap of the requirement of a viable fire extinguishing method onboard fishing craft at harbours in Sri Lanka. With that, authors have pointed out the benefit and the suitability of the floating platform as an Inshore patrol craft to extinguish a fire once occurred onboard fishing craft and to prevent the spread of fire to neighbouring fishing craft.

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