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Title: **Suez Canal Rudder**

(Fleet Management Maritime Education Academy / A Caravel Group Company)
L&T Seawoods Grand Central, units 1001 -1004, Level 10, Tower II, Wing E&F, Plot R-1, Sector 40,
Nerul, Navi Mumbai 400076 India.
daviddsylva@elegantship.com

Abstract –

This is a conceptual design of a maneuvering aid for large vessels to navigate through the Suez or any similar canal at high speeds safely. The main system consists of a rudder-like fitting placed at the bulbous bow to divert water, thereby steering the forward end of the vessel, and assists in maintaining the bow in the center of the canal. The manipulation of this appendage can be controlled autonomously or manually if an override is desired. The autonomous control will be programmed by waypoints, and AI will make the required adjustments, thereby reducing the load on the Master for controlling two rudders. This innovation will assist with the precise positioning of the bow in the canal and will be more effective at high speeds, thus increasing the efficiency of the canal system. Traffic through the canals can be increased significantly compared to the present levels, and both transit time and waiting time will be reduced.

Keywords: Manoeuvring-Aid; Canal; High-Speed; Safely; Increased; Efficiency.

Introduction- In the recent past the shipping world has experienced many incidents caused due to difficulty in controlling the vessels while navigating large vessels through narrow canals.

There are many hydrodynamic effects acting on the vessel, which are different at forward and aft ends of the vessel, for example bank cushion effect on the bow and Bank Suction Effect on the stern, in order to correct the heading of the vessel in conventional vessels the rudder is used to apply a torque on the stern end of the vessel, the stern has to move to the opposite side to the required correction of the heading, in narrow canals the vessel may have insufficient or restricted room to swing the stern sufficiently to achieve the required change of heading.

(Refer to Fig. 1) Using this rudder like device as a manoeuvring-aid, which is fitted on the forward end of the vessel, causes a torque on the forward end of the vessel without requiring the stern to swing towards the bank of the canal, and hence will assist in positioning the bow of the vessel towards the centre line of the canal, without having to swing the stern towards the bank of the canal as required by conventional vessels.

Since this device without benefit of the propeller wash will be most effective at higher speeds, it will exert a lesser torque on the hull as compared to the rudder, thereby causing small and gentle corrections to the position, and heading, which will be safer than making large corrections in a narrow canal.

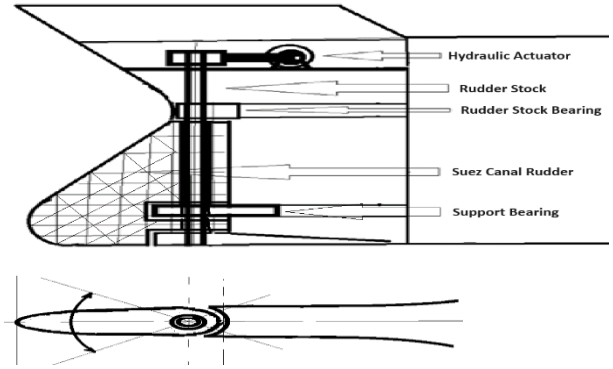

Fig 1. The Suez Canal Rudder at Bow of the Vessel

Objectives-

- To enhance the control over large vessels
  while navigating narrow canals ay high speed.
- To avoid the stern of the vessel moving too close to the bank of the canal, thereby avoiding possibility of the bank suction effects
- To enable large vessel to navigate safely at higher speed through canals and thereby increasing the capacity of the canals and reducing the waiting time at entrance of canals.
- To Enhance Safety of vessels and infrastructure of canals,
- To enable the combination of conventional rudder and the Suez Canal rudder to bodily move vessel transversely without a large change of heading.
- To have precise control on vessels bow position in the narrow canal at speeds between 7 to 15 Knots.
- To have a redundant control surface in case the stern rudder fails either due to contact with jetty, collision or damaged in war like situation if stern control surface is immobilised the Suez Canal Rudder at bow may provide 'Get home' steering capability. Thereby saving Lives and Time.

Methods Considered, Results and Findings-

The conventional rudder fitted at stern has limitation of providing transvers torque at the stern of the vessel, this transverse thrust is acting at the stern of the apparent pivot point, as pivot point moves towards the forward of the vessel, when vessel moves in forward direction, the stern must swing in a longer arc to change the heading, thereby bring the vessel's stern close to the canal's bank, therefore increasing the possibility of experiencing bank suction effects.

The Conventional Bow Thruster is not effective if vessel speed is above 3 or 4 Knots. And only very effective when vessel is stationary. It also consumes very high electric power to produce transverse thrust,

Tabs Projecting from the Bulbous bow was considered but the mechanism for actuation was found complicated, and area available for control was less.

The Suez Canal rudder as per the fig. 1. Is very simple to construct, it is hollow and buoyant, and at sea provides the function of a bulbous bow, It is most effective while vessel is moving at high speed and is manipulated by a conventional hydraulic actuation system just like a conventional hydraulic steering gear system, the technology is well proven, either a 2 ram, 4 ram or Vane actuator may be used depending on the size of the vessel.

Working Principle of the Suez Canal Rudder

Refer Fig 2. When torque is applied to the forward end of the vessel, the hull will pivot around the pivot point and the hull will also tend to move bodily to the side, in direction of the applied torque, therefore the arc of swing at stern is relatively reduced for the required

correction to the heading, compared to if only stern rudder was used. Therefore, relative distance of the stern from the bank of the canal can be maintained at a safe distance to avoid the bank suction effects.

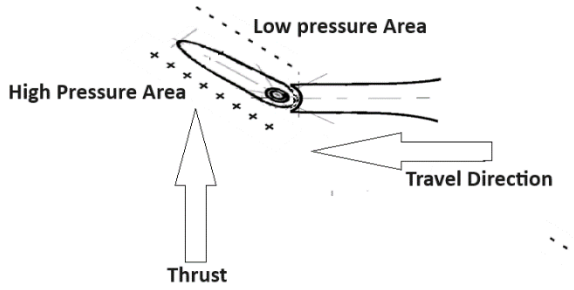

Fig 2. Suez Canal Rudder

Control and Operation

Refer Fig. 3. This "Suez Canal Rudder" can be operated and controlled in in single autonomous mode, using the waypoints and limits of the canal banks, which are inputted, on an ECDIS like screen into the control system. The AI (artificial Intelligence) will generate setpoints to control the helm angle of 'Suez Canal Rudder' and make required corrections. Inputs from sensors like heading, GPS position of bow and stern, course made good, vessel speed, wind speed & direction,

And the stern rudder position will be inputs to the control system AI unit. While navigating a canal.

At sea the manual mode will be in use and position of the 'Suez Canal Rudder' will be set to amidship.

While Manoeuvring in a canal the master may also use the device in manual control mode if required but not recommended.

Problems that maybe encountered.

As use of this additional control surface is a new tool, the vessels Master, Navigators, and Pilots will require to learn and be trained in new techniques for ship handling.

Training Simulators for ship handling will be required to match manoeuvring characteristics of vessels fitted with this new device.

Classification Societies will require to set standards for construction and performance of the new device.

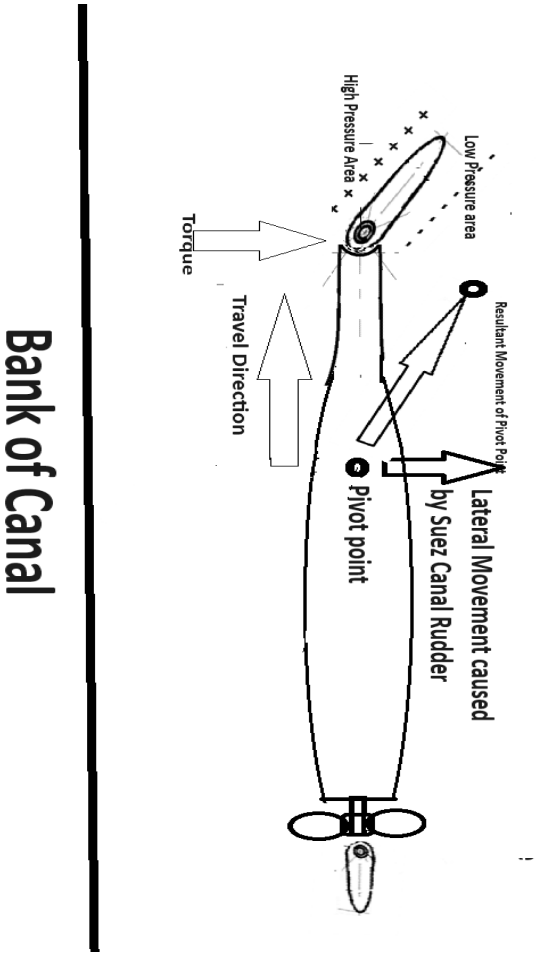

Fig.3 Showing Lateral Movement of the vessel away from the bank of the canal.

Figure 4. Shows that distance between vessels stern and bank of canal is reduced if only conventional rudder is used.

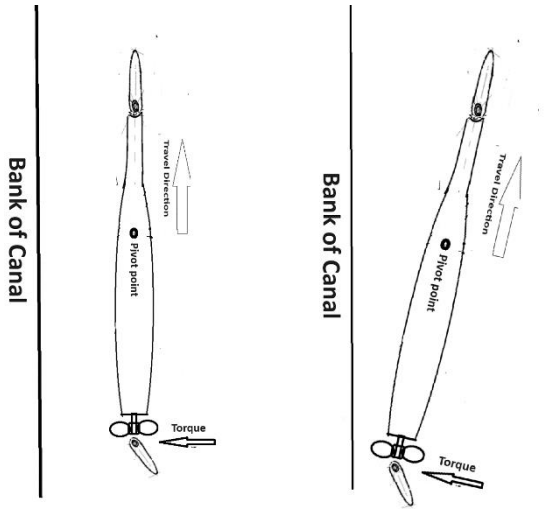

Fig. 4

Figure 5 shows how, when the Suez Canal Rudder is used the distance between the bank of the canal and the stern of the vessel will not be reduced while correcting the vessels heading.

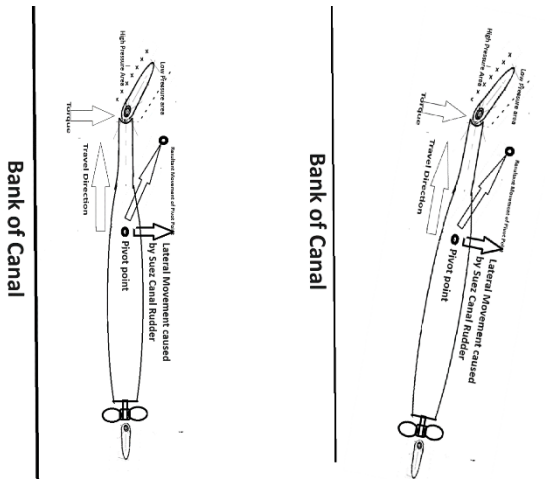

Fig. 5.

Fig 6 compares the vessels track while using a Suez Canal Rudder, verses using the conventional rudder at between 7 to 15 knots through a narrow canal. The Suez Canal rudder helps the vessel to keep the stern away from the bank while correcting the position and heading of the vessel.

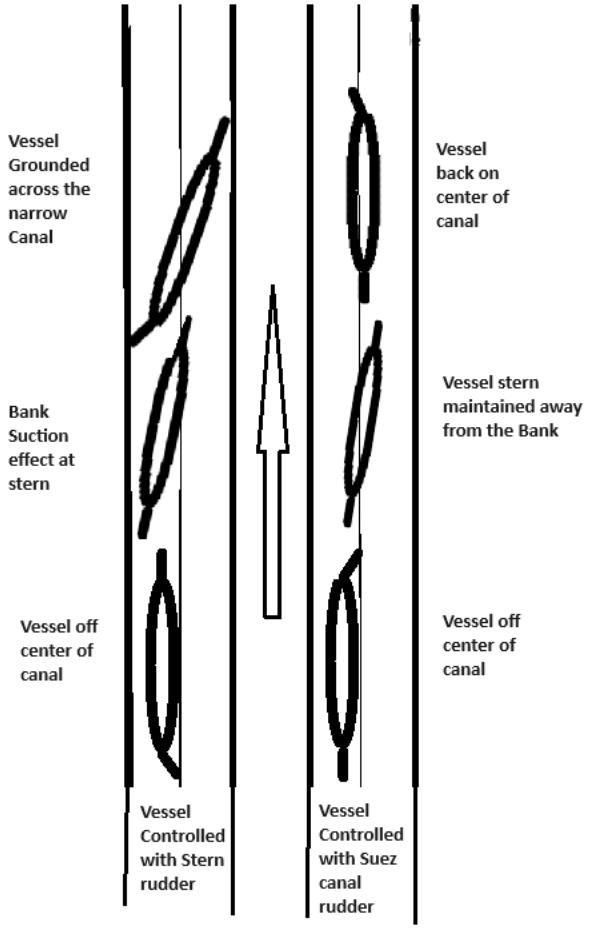

Fig 6.

Conclusion and Recommendations

Having an additional control surface at forward will increase the maneuverability of the vessel in narrow canals, enhancing safety of the vessel by keeping the vessel away from the bank suction effects. The many advantages listed in the objectives will be achieved.

Acknowledgments

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