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Abstract: Around 3 million tons of cargo is transported over the Nile River between Alexandria, Cairo and Aswan yearly. This transport is expected to increase considerably when the planned container terminal projects and other infrastructure projects in the Nile Delta are completed. Also, It is of great concern to the responsive authorities are the more than 290 Nile Cruise ships (Floating hotels) with a total capacity of 26,673 passengers, operating between Luxor and Aswan. Therefore, the Egyptian government has declared a high priority to the improvement of safety of navigation on the Nile River. The main condition is that the transport companies have certainly about the depth of the river and the draft for the ships, independent of time of the year and for both day and night navigation. The reduction in fright costs, increased safety and certainly of water depth will cause positive effect and has been proven world-wide to increase the amount of traffic. There is currently no navigation infrastructure, no Hydrographic survey nor are there any bathymetric charts available. This research work describes the main steps that should be followed now and in the Future to achieve safe navigation in the Nile River based on IHO (International Hydrographic Organization) standards for hydrographic survey. After executing these steps it will be impossible to construct any berths unless the main navigable channel is established and connected to other routes to facilitate berthing and departure of vessels.

Keywords: Navigation, Nile River, Hydrographic survey, Bathymetric charts.

1. INTRODUCTION

Transport on the Nile River is primarily for two purposes: 1- Goods and materials such as heavy equipments, steel, coal (there is an electrical power plant in Aswan), wheat and suger. 2- Tourists and passengers. Safe visual navigation means implementation of hydrographic survey and cost effective solar-powered visual aids to navigation and a simple vessel tracking system for Nile cruise ships for lock passage planning and ememrgency cases. Together with further development of infrastructure works along the Nile River, such as the projected river container terminals and jetties for the Nile cruise ships, the safe visual navigation could be further extended with more advanced technology such as a vessel traffic management and information system available, for instance, the Nile cruise ships.

2. PROBLEMS OF NAVIGATION

The flow of cargo has never been as low as today in Egypt. The reasons for this are mainly:

1. Long duration of transport due to daylight navigation only.

2. Unreliability of the river; no technical means for safe navigation in the navigable channel.
3. Management is unable to improve quality of services.
4. Unreliable delivery times due to grounding or technical failures of the barges.
5. Poor quality of barges.

Accordingly, the aims can be identified with respect to the development of inland water transport:

1- Introduction of competitive river transport compared to other means of transport and through stimulating multi-model transport "door-to-door".

2- Development of river transport connecting the seaports with the navigable water way.

3. AIM OF THE WORK

At this time no aids of navigation and no vessel traffic information service is available on the Nile. Therefore, the first phase of save visual navigation has to be basic and according to world-wide accepted and applied systems. Also, It should improve the quality of shipping in general. The aim of this research work is to define and design the main steps that should be followed now and in the future to achieve safe visual navigation on the Nile River considering IHO standards for hydrographic survey.

4. THE PRESENT SITUATION

On the 28th of July 2000, the Minister of Transport has signed a contract with the Egyptian Company “Egytrans” for the Cairo based container terminal on a BOT basis, including the transportation of at first 75,000 containers yearly to start with. Therefore a vessel traffic control system has to be established in order to organise arrivals and departure of vessels on sound basis according to common practice both operational and technical.

4.1 Bathymetry and Navigational Charts

Hydrographic surveys have been executed by Nile Research Institute, over a total length of 25 km out a total length of 953 km (Cairo- Aswan). Other survey activities are primarily executed for civil works only like bank protection, bridges, and dams. Use has been made of topographical maps, which were produced by Kenting Earth Sciences from Canada in 1978. The scale of these maps is 1: 10,000. The Datum is Spheroid Helmert 1906, Transverse Mercator Projection. No water depths are indicated on these maps. All heights on these maps are relative to Lowest Low Water Spring in Alexandria, Mediterranean Sea.

4.2 Navigation, Signalling, Buoyage System

The Nile does not have a marking system or any positioning system for vessels. Floating markers have only been identified near dredging operations, to mark underwater obstacles and anchors.

4.3 Radio Communication

The locks are equipped with VHF channel 12 for use by RTA (River Transport Authority) only. The RTA vessels have VHF channel 12 on board. Nile Cruise Ships communicate on one channel (for secuirty reasons only) under the responsibility of the Ministry of Interior. Barges do not have any communication facilities on board.

5. THE PRESENT NAVIGATIONAL WATERWAYS IN EGYPT

The waterway between the Greater Cairo and Alexandria port is nowadays the major corridor for river transports in the Delta. With an annual 700,000 tons of cargo which represents about 23% of the total river transport in Egypt. The Damietta branch, which is currently not navigable due to major river rehabiliation works, can be considered as the future cargo corridor between cairo and the Mediterranean sea ports, Damietta and Port Said. The other waterway in the Delta is the canal system of Beheiry and Noubaria canals, constructed nearly 27 years ago. This canal system between the port of Alexandria and the Delta barrage has been in use by inland barges of both private and public sectors.

5.1 Cairo – Alexandria Waterway

The navigable waterway between Cairo and Alexandria consists of the Nile up to Delta Barrage at EL-Qanater, the Beheiry canal, the Noubaria canal and a stretch of 20 km through Lake Maryut. The width of the Nile river in the Cairo area is over 300 m, whilst the navigable width on the Beheiry and Noubaria canal varies between 50 m and 40 m. Daily water levels in the Nile, the Beheiry and Noubaria canals depend on the actual river discharges and water intake requirements along the navigation route. The minimum navigation depth has been guaranteed at 1.6 m for an uniterrupted period of 335 days. This depth implies that inland vessels can sail with an allowable draft of 1.4 m and keel clearance of 0.2 m. As a minimum, all navigation is stopped for a 3-week period during the low water period, generally in January. However, a non-navigation period of 30 days has been included. During such period containers would have to be transported by trucks.

5.2 Cairo – Damietta Waterway

The navigable waterway between Cairo and Damietta consists of the Nile up to Delta Barrage at EL-Qanater and the Damietta Branch between the Delta lock and the Port of Damietta. The navigation channel on the whole Damietta branch is presently being improved by capital dredging and will have a minimum channel width of 40 m. The final 12 km of the navigation route to Damietta Port is via an artificial canal. This canal has a water depth of 4 m and a channel width of 40 m at bottom level, sufficient for two-way traffic container vessels. Also, for this navigation route it has been guaranteed minimum depth of 1.6 m (and according to the design specifications for the navigation channel the minimum water depth for navigation is even 2.3 m) for an uniterrupted period of 335 days.

5.3 Cairo – Rossetta Waterway

Rosetta branch is not navigable all the year. The development will be done through connecing Rosetta branch with the Beheiry Raiyah at Kafr Boleen via development of a navigational link and constructing a new lock.

5.4 Cairo – Aswan Waterway

It is a very popular navigational route all year around for navigational units and tourism cruises especially between Aswan and Luxor. The development will be done through solving the navigation problems in this reach according to the next proposed plan.

6. THE PROPOSED PLAN FOR SAFE NAVIGATION

In order to achieve safe visual navigation, day and night, on the Nile River, the following steps should be done according to the next details:

1. Execution of a Hydrographic survey
2. Producing navigational charts
3. Design of the navigational path
4. Construction, supply and installation of navigation aids(buoys and beacons)
5. Vessel traffic management and communication
6. Maintaining the system

6.1 Execution of a Hydrographic Survey

The Nile River with total legnth of nominal 953 will be considered for bathymetric survey across the river at 50 m interval. Along each cross section bathymetry will be measured continuously, using the echo sounder. The horizontal positioning of the locations will be controlled by DGPS with the on-line PC Hydrographic survey software on board. For the DGPS positioning there are beacons every 5 km along the river with X and Y co-ordinates in WGS 84. Water levels will be read from 56 staff gauges available along the Nile River and interpolated for the surveyed stretches in between. Also, tidal corrections will be carried out for the measured bathymetric data. The depth wil be plotted in the form of bathymetric map in UTM co-ordinates (WGS 84) according to RTA (River Transport Authority) of Egypt. The actual survey has to be updated continuously, depending on the stability of the river stretch. Every ten years the whole stretch of the river has to be re-surveyed. The survey work is a continuous operation, the charts have to be updated accordingly and will be renewed on a regularly basis. The vessels need to be obliged by law to have up to date charts on board of the stretch in which they operate.

6.2 Producing of Navigational Charts

The (X-Y-Z) data will be used for producing contour maps of 0.5 m interval. The chart size will be 70 x 50 cm at scale 1:2000, suitable firm paper enabling to make frequent annotations and erase them again without damaging the image. A hrmonious colour scheme will be adopted. A law has to be introduced to oblige the vessels on the Nile River to have nautical charts on board of the section of the river were the vessel operates. Also, a subscription to

monthly issued notice to mariners (users) has to be part of the obligation to have and use the charts and to up-date the charts regularly.

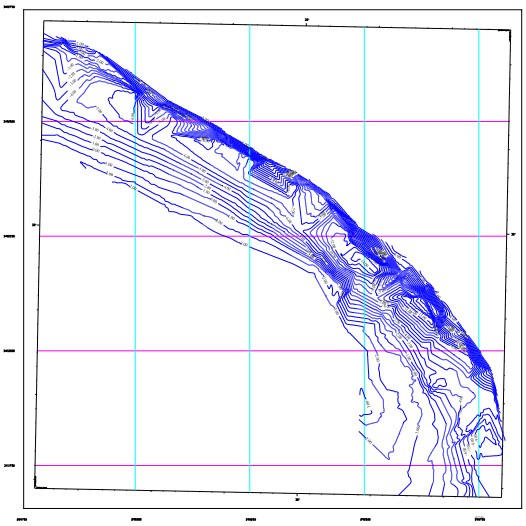

Fig. 1 Typical shape of a contour map of the River Nile

6.3 Design of the Navigational Path

6.3.1 Design of The Navigable cross section

In this cross section two laden ships will meet at normal speed, and a laden ship can be overtaken, with caution, by another such vessel. This cross section is used where traffic density is high (15,000 passages a year or over). In case of the Nile River in Egypt there are more than 290 Nile Cruise ships with a total capacity of 26,673 passengers yearly. The minimum required water depth is 2.3 m as defined by RTA of Egypt according to the following conditions:

1. Minimum navigable channel width is 100 m
2. The minimum draft for ships is 1.8 m
3. Minimum clearence underneath the ships is 0.5 m
4. Side slope of the channel is 5 horizontal to 1 vertical

These values were estimated for the designed cross section to fufill these requirements:

1. The waterway should be deep enough to ensure good steerability of the ships and to prevent bottom touches.
2. The waterway should be sufficiently wide to enable the standard traffic flow to pass safely and at normal speed.
3. Vessels should be able to reach a reasonable speed to keep down the cost of transport.
4. The cross section should not be too large and therefore uneconomical.

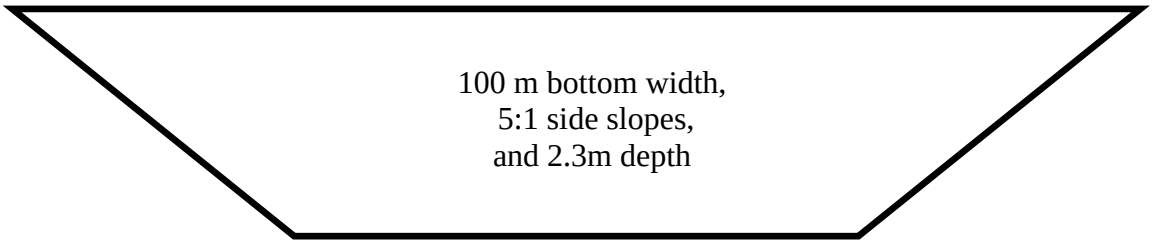

Fig. 2 Typical shape of a navigable cross section

6.3.2 Width allowance for Cross Section

On waterways with frequent and substantial cross wind (average speed over 4.5 m/sec), as the case of the Nile River, a width allowance has to be added to the width of the navigable cross section bottom width.The size of the allowance depends on the nature of the terrain, the pre-dominant wind direction, wind speed, shape of the cross section, shiptype and traffic density. The maximum allowance needed in the Nile River will usually be about the same as the vessel's width.

6.3.3 Width allowance for Bends

In bends the canal profile needs adaptation (enlargement) depending on the curvature (bend raduis). There are fairly large numbers of bends based upon the ratio between bend radius (R) and length of ship (L). For the case of Nile River this ratio is proposed to be 6. It is assumed that in sharp bends no overtaking manoeurves are permitted. If (R / L > 10) no width allowance is applied. While because of topographical limitations, a very sharp curve with ratio (R / L = 1.5-2) has to be accepted. Most ships can negotiate such a sharp bend if they sail with very low speed, and the flow velocity is less than 0.25 m/sec.

6.3.4 Space around the waterway Cross Section

A narrower zone around the waterway kept free of buildings or other permanent elements which may limit the safe outlook from ships or may make impossible inspection and maintenance of banks. The safe outlook length should be at least five times the ship length. In a bend with irregular curvature this open space can be determined very easy in a graphical way. In a circular bend the width W_b of the free space can be calculated with:

$W_b = R – R \cos(5L / R) (90 / \Pi) – B$

Where

Wb : width of bank strip to be kept free (m),

L : design-ship length (m),

B : design-ship width (m).

This requirement of free outlook does not regard buildings, but also high embankments, bredge abutments and vegetation.

6.4 Aids to Navigation

It will be quite far away from the main depots, barges will ship the buoys and material. They will load the buoys and take them to the working area. The marking sysytem of buoys and beacons (traffic signs) will be implemented according to the International Association of Lighthouse Authorities, IALA system A, red to port, as adopted by Egypt. The use of a polyethylene buoy (PE) is proposed as they are of lightweight and easy to maintain. The anchor system for those buoys can also be of lighter material. Polyethylene buoys are unsinkable. Collided buoys are no hazard to shipping and /or hinder to shipping and dredging operations and will avoid claims. Priority will be given to the installation of lighted buoys in

order to allow the safe visual navigation on the waterways during 24 hours a day, between Aswan, Cairo, and Alexandria.

6.5 Vessel Trafic Management and Communication

6.5.1 Operational Objectives

The main purpose of the proposed system is to provide planning data to the lock and berths manager to make a more efficient and fuel saving planning of the arrivals at the destination. As future optional capability the system can provide an overview of the location of the Nile Cruise Ships to the Floating Hotels Association. The other very important issue is to have direct access to the position of the vessel in case of problems and emergency for the Search and Rescue organisation. The availability of positional data together with navigational aids for sailing during the night will provide a tremendous increase in capacity and reduction of transportation time for cargo vessels. Also the Nile Cruise Ships could benefit from being not always bound to daylight hous.

6.5.2 Basic System

1. The non-critical areas will be covered by automatic low-frequent position reporting via GSM.
2. Planning data to be sent to a selected group of users via GSM to improve the efficiency of navigating on the river.
3. Channel 12 is already in use by the RTA for the locks. The RTA service vessels are equipped with VHF Channel 12. Furthermore the police will keep also one channel in use.

6.5.3 Display of the Presented Data

The presented data for all positions will at least be:

On-board display:

1. Outline of the geographical map of the river
2. Important locations
3. Actual GPS track position (own vessel only)
4. Last reported estimated time of arrival at next way point
5. Cleared time of arrival as received fro next way point

Presentation at locks and berths

At locks and berths the planning data as received from the vessels via the GSM will be displayed including the position of the vessels. The lockmaster will have the capability to enter the CTA (Cleared Time to Arrival) for a vessel. The CTA will be reported back to vessel via GSM.

6.5.4 Recording and Replay

The system will have the capability of recording track data and communication on a 24 hours basis. The replay function will have the capability to replay the tracks and voice synchronously on the emergency position.

6.6 Maintaining the System

The Hydrographic Survey Equipment has to be kept in good functional condition, it has to be maintained and regularly renewed.

7. CONCLUSION

The development of the Nile navigable route will increase safety of the cruise vessels sailing the Nile. It will enable them to sail for a longer period per day and thereby increase the efficiency at the river's bottlenecks, such as the locks and moorings berths. Consequently the efficiency will improve in the general scheduling of the cruise programs. A clear navigable channel with a secured minimum draft will increase the reliability of transport. Taking into account all the steps of the proposed plan for safe navigation, The Nile tourism requirements, meaning a rise of the capacity with 25% in the near future. Consequently, the total capacity is estimated to be 375 Nile cruise vessels at an average of 85 beds/vessel. Cargo transport over water will increase from only 1% of the local trade traffic to 8%. Also, the share of the trade traffic from and to the seaports will increase from 4% at present to 15% in the near future. Finally, the navigation on the Nile River will be more safe, efficient and the environmental pollution will be reduced. The equipment and facilities necessary to realise these objectives will make it possible to sail during the night. This in turn will improve the economics of the Nile River as a mean of transport.

8. RECOMMENDATIONS

The government of Egypt should establish the legal justification for:

1. The use of the aids to navigation system
2. The compulsory use of up-to-date navigation charts
3. The compulsory use of specified equipment, which will allow for vessel tracking
4. The introduction of the use of a ship reporting system to traffic centers in co-operation with the security police.

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