CRITICAL CONDITIONS OF THE SHIP INSIDE THE LOCK CHAMBER DURING FILLING AND EMPTYING FOR END FILLING SYSTEM

By

El-Alfy, Kassem S.[1], Sobeih, M. F.[2], Talaat, A.M.[3], Fahmy, A.[4], Kamel, M[5]

1- Associ. Prof., Irrigation & Hydraulics Dept., Faculty of Engineering, Mansoura University.
2-Associ. Prof., Civil Engineering Dept., Faculty of Engineering, Minufiya University.
3-Prof., Irrigation & Hydraulics Dept., Faculty of Engineering, Ain Shams University.
4-Prof., Director of Nile Research Institute, National Water Research Center.
5-Ph.D., Researcher in Hydraulic Research Institute, National Water Research Center.

ABSTRACT

An experimental model was constructed to simulate the forces affecting upon ships inside the navigation locks under a relatively new method of filling and emptying process laid in the chamber floor. The tests were carried out for three different positions of the ship affixture inside the lock chamber with respect to the filling system. In each position, both the longitudinal and the lateral forces affecting upon the ship were measured by using advanced electromagnetic system of pressure transducers connected with a data logger and personal computer for the two cases of the ship orientation. In the first case of orientation, the bow faced the openings of the filling system, while for the second one the stern of the ship faced the filling system. The study illustrated that the longitudinal forces on the ship were much more greater than the lateral ones. It was found also that the forces affected upon the ship in case of filling process was much more greater than that in the emptying one. The analysis of the results showed that the critical position of the ship affixture inside the lock chamber occurred when the ship was closed to the filling system. Also, the stern of the ship was more critical than that of the bow when facing the openings of the filling system.

Manuscript received from Dr. Sobeih M. M. F.
Accepted on : 26 / 9 / 2001
Engineering Research Journal Vol 24,No 4, 2001 Minufiya University, Faculty Of Engineering , Shebien El-Kom , Egypt , ISSN 1110-1180

In many countries, the transportation by ships through the inland navigation is an economic way compared with the other types of transportation, Kooman et al [9]. The inland waterways consist of navigable rivers, canals or lakes while the self-propelled ships or barges, which are used as means of transport, Boogaard [1]. The inland waterways may be classified according to the dimensions and the tonnage of the traditional standard vessels. According to this classification the types of the inland shipping should be known, De Heer et al [4].

The Nile river of 953 km length is the main and almost the only water source for the different demands in Egypt, where most of the Egyptians are living along its banks. The navigable way in the Nile river is divided into four reaches extend from Aswan to the Delta Barrages. The first reach extends from downstream (D.S) the Aswan Dam to the upstream (U.S.) of Esna Barrages. The second reach starts from D.S of Esna Barrages to the U.S. of Naga Hammadi Barrages. The third reach extends from D.S. Naga Hammadi Barrages to the U.S. of Assuit Barrages, while the fourth reach starts from the D.S. Assuit Barrages to the U.S. of Delta Barrages. In the Delta region, the main navigation ways are the Beheri Rayah and Nubaria canal. There are numerous water control structures and locks which are distributed along the navigable line. These structures manage the navigation process and control the water releases for other purposes, like irrigation, municipal, and industrial demands, Schaberg [16].

Several old locks have narrow heads and wide lock chambers, because the gates and the heads are expensive in comparison with lock chamber. Davis [3] stated that, the lock chamber should not be wider than the gate opening. The design of locks necessitates many types of engineering studies for improvement of navigation on the waterways of the world. One of the most important studies concerns the design of the lock filling and emptying system was carried out by Kalkwijk [7]. There are many types of filling and emptying systems, each was designed to meet predetermined requirements, Pianc [13]. The filling system may be valves or small gates in the lock gates, which can be used only for relatively low lifts locks, John [6]. Also, filling and emptying processes may be done by using short separate culverts, which were used in many locks all over the world. In Austria a modification of this system was used in the Attenworth lock (24 x 230 m), which had a lift of 17 m and a filling time of 14 minutes. The same system is used in the Wallsee-Mitterkirchen lock, which has a lift of 10 m, Pianc [12]. It is noticeable that longitudinal culvert systems are used in new lock construction in Germany and Holland, Pianc [12], it is of course most expensive, but its function of providing a filling and emptying processes with a rapid and quiet lockage is useful. Recent studies at the government laboratory in Berlin indicate that culverts around and under the gates of smooth and increasingly larger cross sections are the best, Kolkman [9]. An alternative to the side culvert system is by the use of transverse culverts, which extend across the bottom of the lock chamber connected alternately to one or other of the wall culverts. An example of recent design is the Holt lock on the Black Warrier river in the U.S.A. The lock is about 33.5 m wide and 182.9 m length with a minimum depth of 3.96 m and has a lift of 19.39 m. This lock is filled in about 11 minutes, Richardson [15]. This system can be used for intermediate lift locks depending on certain limits. As in the previous case, the use of this system depends on the combination of lift, size, and filling time, Novak et al [11].

Another type of lateral bottom of filling/emptying system was used on the Ice Harbour lock on the Snake river in the U.S.A., John et al [5]. It has a lift of about 32 m, chamber dimensions of 206 x 26 m, a depth on the sill of 5.4 m and a filling time of about 11.5 minutes. In this system the lateral culverts are not intermeshed, but they were placed in two separate groups centred at about 1/4 and 3/4 of the length of the lock chamber. The system is known in the U.S.A. as a split lateral system. Filling through one culvert or lack of synchronisation in opening the filling valves in the two wall culverts produces very poor distribution of flow into the lock chamber, Chanda et al [2].

A filling system with symmetric distribution of flow may be used in filling/emptying process. In this system, flow from the intake enters across culvert at the midpoint of the lock chamber from where it is conveyed upstream and downstream by longitudinal culverts under the floor of the lock. These two longitudinal floor culverts discharge into manifolds also under the lock floor) that distribute the flow into the chamber. This system is satisfactory for moderate lift locks such as Millers Ferry lock on the Alabama river in the U.S.A., Pianc [13]. The chamber is 183 x 26 m with 14.6 m lift, and filling time of about 11 minutes through manifolds which had extended over the central and one third of the lock chamber. An end-type filling or emptying system may be defined as one that fills the lock chamber at the upstream end and empties it at the downstream end. One type end control may be used for filling the lock chamber, while another type may be used for emptying the chamber. This filling system often used for navigation locks in tidal areas. In the Netherlands this type is used as a filling system, Vrijer [17]. All the locks on the Danube in Austria built after 1966, use the end filling and emptying system from the floor of the lock chamber, Rescher [14].

EXPERIMENTAL SET-UP

The laboratory model of the navigation lock illustrated in Figure (1), consisted mainly of an upstream basin, a lock chamber, a downstream basin, and a filling/emptying duct connecting the dissipation and distribution port with the upstream and the downstream basin. Both the upstream and the downstream basins represented the constant head pond water level conditions, and the tail water conditions, respectively. The lock chamber dimensions were 9.0 m length, 0.85 m width, and 1.2 m height. The dimensions of the upper basin were 7 m length and 5 m width, with a spillway of 7 m long. The lower basin was 6 m long and 3.5 m wide, with a spillway of 6 m. Each basin had a

level gauge to control the water ...
downstream. Re-circulation of discharges was used in the basins during the tests to maintain the pre-scribed water levels.

The dissipation/distribution system of the filling/emptying was located in the floor of the lock chamber close to the downstream gate. It was connected to the upstream basin by an inflow duct and to the downstream basin by an outflow duct. At the location of the filling and emptying gate, the cross section of the duct was 22.5 cm height and 17.5 cm wide. The duct was provided with a valve connected to a variable speed motor to control the passing discharge. The variable speed motor enables valves to be opened within a range of 27 to 80 seconds. The opening and closing process of the valve was maintained during all tests as a linear function. The dissipation and distribution port consists of a chamber arranged below the lock chamber floor, which in upstream direction was connected by gradual transition to the filling duct, and in downstream direction to the emptying duct. At the intersection of the dissipation port to the lock chamber two perforated decks were arranged for dissipation energy during filling and uniform distribution of flow during emptying. The lower deck consisted of a perforated slab with rectangular block-outs. The upper deck was slotted to achieve the desired gradient in velocities. The chamber was longitudinally separated by a wall which also serves as support to the lower dissipation and distribution deck. The model was provided with a pump with a capacity of 200 L/s. The water was pumped from a sump close to the model to a pipeline of 30.5 cm diameter. The pipeline was split into two pipelines with 25 cm and 15 cm diameters. The upstream basin was fed by the first pipeline, while the downstream basin was fed by second pipeline.

The dimensions of the model ship used during this study was representative of the Nile cruise and these dimensions and other data were selected in co-ordination with the General Authority of Navigation and Transportation (GANT). The dimensions of the model ship were 3.6 m length, 0.675 m width, 0.180 m height, and 0.09 m draft.

The following instruments were used in measurements in the laboratory model:

A- An electromagnetic flow meter was used to measure the discharge in each of the filling and emptying ducts;

B- An electronic water level gauges with high dimensional resolution were used to record continuously the rising and dropping of the water level in the lock chamber;

C- An electromagnetic force transducers of the range (0 to 60) Newton were used to measure the longitudinal and transverse forces acting on the ship inside the lock chamber during filling and emptying processes. The transducers were repeatedly calibrated before and during the tests;

D- Electromagnetic current meter manufactured at Delft Hydraulics were used to measure the velocity near the ship during filling and emptying processes; and

E- A multi-channels data logger was used for recording the data from the force transducers and the water level gauges. During the hydraulic model tests the data logger stores the signals from each instrument with time intervals 1.0 second. The data logger was connected to a personal computer. The signals from the data logger were scanned and directly stored separately into the computer for each run.

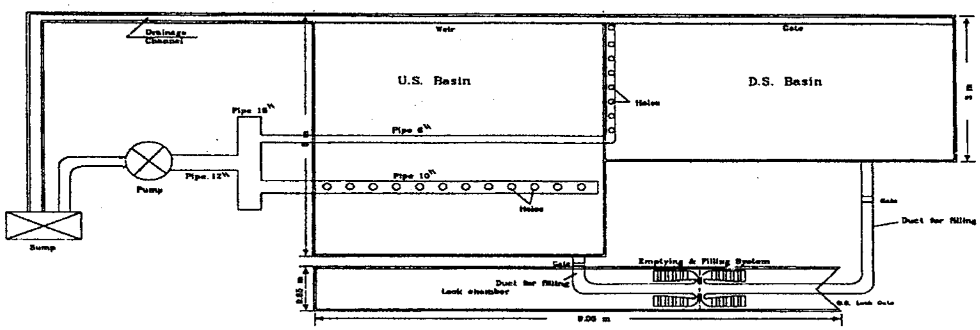

Figure (1) The general layout of the experimental model

ANALYSIS AND DISCUSSION OF THE RESULTS

The tests under transient conditions of filling and emptying were carried out to determine the most critical conditions cause the highest values of the forces affecting on the ship inside the lock chamber. Tests on the new proposed system of filling/emptying were carried out for three different positions of the ship inside the lock chamber under the two possible orientations for each position, under different times of valve opening of the filling ducts (27,40,54 and 80 sec).

1- POSITION (1), CLOSE TO THE FILLING SYSTEM

1.A- SHIP BOW FACING THE FILLING SYSTEM (Position 1-A)

WATER LEVEL AND DISCHARGE DURING FILLING/EMPTYING PROCESS

Figures (2), (3) and (4) show the time series of the valve area (linear valve opening), the water depth and the filling discharges during filling cycles of the lock chamber. Figures (5) and (6) show the time series of both the water level and the discharge during emptying cycle of the lock chamber. The aforementioned figures show that, the filling\emptying discharges were increased as the valve opening area was increased to reach the maximum value at full area of the valve opening, then the discharge was decreased to zero at the end of the filling\emptying time. This could be explained by the fact that the filling\emptying discharge was influenced by the opened area of the valve and the difference in water level between the lock chamber and the upstream\downstream of the navigable waterway. At the beginning of filling\emptying cycles, the valve opening area had more influence on the

the water level in the lock chamber and upstream\downstream basin. This will lead to the increase in the filling\emptying discharge with increasing the opened area of the valve. After the valve was completely opened, the filling\emptying discharge was influenced by the reduced head difference between the water level in the lock chamber and in the upstream\downstream basin. This will lead to a decrease in the filling\emptying discharges to zero values at the end of filling\emptying time. Also, during emptying\filling cycles a steeper slope of the filling\emptying discharge was observed during the linear opening of the valve than during the complete valve opening as illustrated in Figures (3) and (6). This indicated that a rapid increase in the filling\emptying discharge occurs at the beginning of filling\emptying cycles in a short time, then the discharge was decreased slowly to reach zero. The decrease in the discharge during emptying cycle was relatively slower than that during the filling cycle, which could be observed from the slopes of the filling\emptying discharge in Figure (3) and Figure (6), respectively.

LONGITUDINAL FORCES DURING FILLING AND EMPTYING PROCESSES

Figure (7) shows the longitudinal forces affecting upon the ship for the position (1-A) during filling cycle. The figure shows that, during filling cycle the maximum longitudinal force occurs at a view period from the beginning of the filling cycle. This could be explained due to the surge, which had its maximum value after a very small period from the beginning of valve opening. The slope of water surface caused by the surge in direction to the upstream of the lock chamber was responsible on the affecting longitudinal forces on the ship. A general decrease in the longitudinal force was observed by increasing the water level in the lock chamber as a result to the decrease of the water surface slope. A minor fluctuations of the longitudinal force around zero was observed for some time after the maximum water level in the lock chamber was reached as a result of the inertia of the filling water. The longitudinal force during the filling cycle had positive values in the flow direction and negative values in the opposite direction. Also, the longitudinal forces were produced by the dissipation of the dynamic energy in the lock chamber and the produced surge during the filling cycle.

Figure (8) shows the longitudinal forces affecting on the ship for position (1-A) during emptying cycles for valve opening time equals to 27 sec. During the emptying cycle, the longitudinal force on ship was much less than that in case of filling cycle. This could be explained due to the dissipation of the dynamic energy in the downstream of the lock chamber, but in filling process it was dissipated inside the lock chamber, in which the ship was existed.

TRANSVERSE FORCE DURING FILLING AND EMPTYING PROCESSES

Figure (9) shows the lateral forces affecting on the ship for position (1-A) during filling cycles, while Figure (10) shows the lateral forces during the emptying cycles for the valve opening time of 27 sec. The aforementioned figures showed that the lateral forces affecting upon ship in case of filling\emptying cycles were small compared with the longitudinal ones. The lateral forces resulted from the asymmetry flow through the dissipation chamber around the longitudinal axis. The small lateral forces on the ship indicated that the asymmetry of the flow along the longitudinal axis of the lock chamber was small. Table (1) shows the maximum longitudinal and transversal forces affecting upon the ship and the time required for filling and emptying the lock chamber for different values of valve opening time. Comparing both the longitudinal and transverse forces obtained for a linear valve opening time of 27, 40, 54 and 80 sec, it could be concluded that the forces upon the ship was decreased as the time of the valve opening was increased for both the filling and emptying process.

Table (1) The forces affecting upon the ship during filling/emptying process in position (1-A)

Criterion	**Valve Opening Time**			
	27 secs.	40 secs.	54 secs.	80 secs.
Maximum longitudinal force during filling	7.10 N	3.89 N	2.08 N	1.87 N
Maximum longitudinal force during emptying	3.3 N	1.45 N	1.25 N	1.0 N
Maximum transversal force during filling	0.9 N	0.54 N	0.47 N	0.39 N
Maximum transversal force during emptying	0.74 N	0.38 N	0.24 N	0.13 N
Filling time of the lock	80 secs.	85 secs.	93 secs.	120 secs.
Emptying time of the lock	88 secs.	91 secs.	96 secs.	122 secs.

1.B SHIP STERN FACING THE FILLING SYSTEM (Position 1-B)

Figures (11) and (12) show the longitudinal forces affecting upon the ship inside the lock chamber during filling and emptying cycles for position (1-B) (the stern of the ship was directed to the vents of the filling system). Figures (13) and (14) show the transverse forces affecting upon the ship inside the lock chamber during filling and emptying cycles for the same position. The aforementioned figures illustrated that there was a general increase in the longitudinal forces on the ship than that in position (1-A). This could be attributed by the fact that, the flow from the filling openings was blocked by the ship stern. The water pressure of the surge affects on the stern of the ship of the flat surface, which produced high values of longitudinal forces. As was observed in position (1-B), the longitudinal and transverse forces on the ship in case of filling cycle was higher than that in case of emptying cycle. Also, as illustrated in Table (2), the forces was decreased by increasing the time of the valve opening (27, 40, 54 and 80 sec), respectively. The figures showed that the lateral forces on the ship in position (1-B) were smaller than the longitudinal forces during filling cycle.

longitudinal force versus time at the two possible orientations of the ship (bow/op and stern/op) in case of filling and emptying process, respectively. Comparing the ship positions (1-A) and (1-B), significantly higher longitudinal forces on the ship were observed in position (1-B) than that in position (1-A) for both filling and emptying process. This could be explained due to the rounded shape of the ship bow, which reduces the flow resistance on the ship. The reduction of the flow resistance results in smaller longitudinal forces on the ship. The sharp edged flat face of the stern increased the flow resistance on the ship, which increased the longitudinal forces on the ship. As observed for position (1-A), the longitudinal forces on the ship during filling were higher than that produced during emptying, which were decreased with extended valve opening.

Table (2) The forces affecting upon the ship during filling/emptying process in position (1-B)

Criterion	**Valve Opening Time**			
	27 secs.	40 secs.	54 secs.	80 secs.
Maximum longitudinal force during filling	8.16 N	4.58 N	2.50 N	2.34 N
Maximum longitudinal force during emptying	3.7 N	1.71 N	1.50 N	1.26 N
Maximum transversal force during filling	1.13 N	0.73 N	0.65 N	0.55 N
Maximum transversal force during emptying	0.93 N	0.50 N	0.41 N	0.18 N
Filling time of the lock	80 secs.	85 secs.	93 secs.	120 secs.
Emptying time of the lock	88 secs.	91 secs.	96 secs.	122 secs.

From the data tabulated in Tables (1) and (2) and Figures (15) and (16), it could be concluded that the longitudinal force was critical than the transverse force and the filling process was more critical than the emptying process. Also, it could be shown that the critical orientation of the ship inside the navigation lock occured when the stern faces the filling openings.

2- POSITION (2), AT THE MIDDLE OF THE LOCK CHAMBER SHIP STERN FACING THE DISSIPATION CHAMBER

In position (2), the ship located at the middle of the lock chamber upstream the dissipation chamber. As previously explained, it was found that the critical orientation of the ship occured when the stern faces the filling system, so this orientation was only studied in this position. Table (3) presents the maximum longitudinal and lateral forces on the ship during filling and emptying cycles for the time of valve opening equaled to 27, 40, 54 and 80 sec, and the time required to fill or empty of the lock chamber.

Table (3) Position (2) of the ship with critical orientation at filling and emptying processes

Criterion	Valve Opening Time			
	27 secs.	40 secs.	54 secs.	80 secs.
Maximum longitudinal force during filling	6.63 N	3.69 N	2.08 N	1.97 N
Maximum longitudinal force during emptying	3.35 N	1.62 N	1.40 N	1.21 N
Maximum transversal force during filling	0.98 N	0.59 N	0.54 N	0.46 N
Maximum transversal force during emptying	0.82 N	0.45 N	0.36 N	0.17 N
Filling time of the lock	80 secs.	85 secs.	93 secs.	120 secs.
Emptying time of the lock	88 secs.	91 secs.	96 secs.	122 secs.

Figures (17) and (18) show the time series of the longitudinal and transverse forces during the filling process for the valve opening time of 27 secs. (critical filling time). The foregoing figures showed that a general decrease in both the longitudinal and lateral forces during filling cycle compared with the corresponding results obtained in position (1) of the ship inside the lock chamber. This could be explained, as the increasing distance of the ship from the filing openings results in decreasing the surge effect, which caused decreasing the longitudinal forces on the ship. Also, Figures (19) and (20) show the time series of the longitudinal and transverse forces during the emptying process on the ship for Position (2) for the valve opening time 27 secs. The same trend of both the longitudinal and lateral forces in position (1) was observed in position (2). The longitudinal and lateral forces on the ship inside the lock chamber during filling cycle were higher than that in emptying ones. As illustrated in Table (3), both the longitudinal and transverse forces were decreased as the opening time of the system increases. Also, it was noticed that the lateral forces were relatively small compared with the longitudinal forces.

3- POSITION (3), AT THE END OF THE LOCK CHAMBER FAR FROM THE FILLING SYSTEM.

The ship was situated at position (3), at the end of the lock chamber far from the dissipation chamber close to the upstream gate with the stern of the ship faced to the filling openings during filling/emptying cycles (critical orientation). Table (4) presents the maximum longitudinal and lateral forces on the ship during filling and emptying cycles for 27, 40, 54 and 80 secs. of the valve opening and the time required to empty the lock chamber.

Figures (21) and (22) show the time series of the longitudinal forces during the filling and emptying process for the third position of the ship for the valve opening time of 27 secs. It could be seen that a general decrease in the obtained from both position (1) and position (2). Table (4) illustrates that the lateral forces on the ship for position (3) were less than the longitudinal ones. The same trends in positions (1) and (2) were observed in position (3) for the other parameters.

Figures (23) and (24) show the relationship between the distance along the lock chamber measured from the center line of the ship to the openings of the filling system and the maximum longitudinal force in case of filling and emptying cycles. Also, Figures (25) and (26) show the corresponding transverse forces. The figures show that the forces were decreased as the ship became far from the openings, so the critical position of the ship inside the navigation lock was considered as the admissible nearest position from the filling/emptying system.

Table (4) Position (3) of the ship with critical orientation at filling and emptying process

Criterion	Valve Opening Time			
	27 secs.	40 secs.	54 secs.	80 secs.
Maximum longitudinal force during filling	5.10 N	2.80 N	1.65 N	1.60 N
Maximum longitudinal force during emptying	3.0 N	1.52 N	1.30 N	1.15 N
Maximum transversal force during filling	0.83 N	0.45 N	0.43 N	0.38 N
Maximum transversal force during emptying	0.70 N	0.40 N	0.30 N	0.16 N
Filling time of the lock	80 secs.	85 secs.	93 secs.	120 secs.
Emptying time of the lock	88 secs.	91 secs.	96 secs.	122 secs.

CONCLUSIONS

From this study, the following can be concluded:

1- During filling and emptying cycles a steeper water surface slope were observed during the linear opening of the valves than during the complete valve opening.
2- A general decreases in the longitudinal force was observed by increasing the water level in the lock chamber.
3- The longitudinal force during the filling cycle had positive values in the flow direction and negative values in the opposite direction.
4- The longitudinal force affected upon the ship was decreased as the time of the valve opening increased.
5- The longitudinal force affected upon the ship inside the lock chamber during the emptying cycle was much less than that in case of filling cycle
6- The lateral forces were resulted from the asymmetry flow through the lock chamber along its longitudinal axis.

7- The lateral forces affecting upon the ship in case of filling and emptying cycles were very small compared with the longitudinal ones.

8- The small lateral forces upon the ship indicated that the asymmetry of the flow along the longitudinal axis of the lock chamber was relatively small.

9- The same trend of both the longitudinal and the lateral forces in position (1) were observed in both position (2) and position (3).

10-The longitudinal forces during filling/emptying cycle in position (3) were small compared with the results obtained from positions (1) and (2), respectively.

11-The forces decreased as the ship became far away from the filling system, so the critical position of the ship inside the navigation lock was the admissible nearest position from the filling/emptying system.

12-The critical orientation of the ship inside the lock chamber occurred when the stern of the ship faced the filling/emptying system.

REFERENCES

1-Boogaard A., " Navigation locks dimensions and layout", IWT course, February, 1992.

2-Chanda A. J. and Perkins L. Z., "Intake manifolds and emptying valves for lower monumental lock, snake river, Washington", May 1975

3-Davis, J. P., "Problems of inland waterway lock dimensions", Journal of the Waterways and Harbors Division, ASCE, May 1970.

4-De Heer R. J., "Lecture notes on inland navigation works", HRI, Egypt, 1996.

5-John P. Davis and Thomas E. Murphy, "Experimental research on lock hydraulic systems", Journal of the Waterways and Harbors Division ASCE February 1966.

6-John P. Davis, Martin E. Nelson and Richard E. Patton " P.I.A.N.C. Congress", Stockholm 1965.

7-Kalkwijk, J.P.Th. "Hydrodynamic forces and ship motions induced by surges in a navigation lock", Dissertation, Delft university of Technology, The Netherlands,1973.

8- Kamel, M., "Prediction of the forces induced on ships inside the navigation locks" a thjesis submitted for the award of the degree of Ph.D. in Civil Enginerring, Faculty of Engineering, Minufiya University, 2001.

9-Kolkman, P.A., "Ships meeting and generating currents", Proceedings of the Symposium on Aspects of Navigability of Constraint Waterit Including Harbour Entrances, Delft Hydraulic Laboratory, (1978).

10-Kooman, C., De Bruin P.A., "Lock capacity and traffic resistance of locks" Government Publishing Office, The Netherlands, 1975.

11-Novak, P. and Cabelka, J., "Models in hydraulic engineering; physical principles and design application", Pitman, London, 1981.

12-PIANC, "Final report of the international commission for the study of Locks" Brussels, 1987.

13-PI.ANC, "Practice in design of lock filling and emptying Systems" 19th. Congress, London 1957.

14-Rescher Othmar j., "Kraftwerk freudenau nordschleuse versuchsbericht",

Hydraulic Model Investigations), Technische University, February 1990.
15-Richardson George C., "Filling system for lower granite lock" Journal of Waterways and Harbours Division, August 1969.
16-Schaberg. J., "International workshop on the development of inland water transport in Egypt" May 1993.
17-Vrijer A., "Criteria for the mooring forces of ocean going ships in locks" International Association for Hydraulic Research Delft hydraulics Laboratory, The Netherlands, 1983.

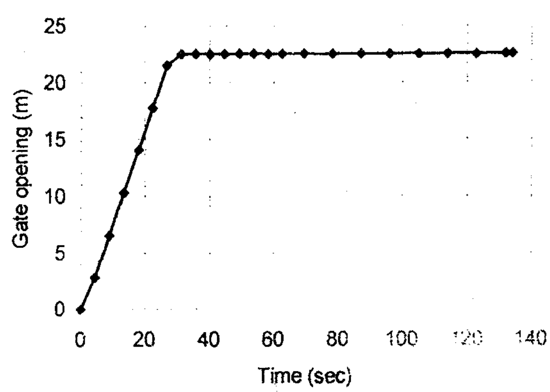

Fig. (2) Gate opening time

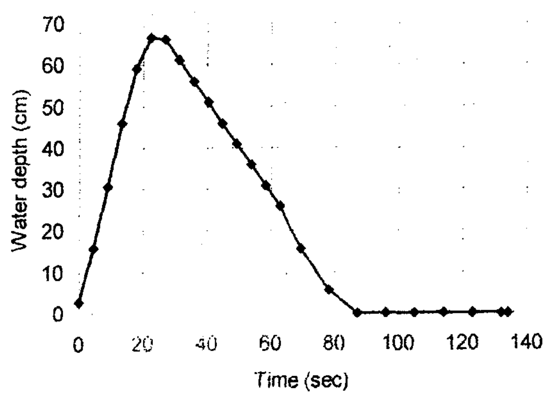

Fig (3) Discharge inside the lock chamber during filling process.

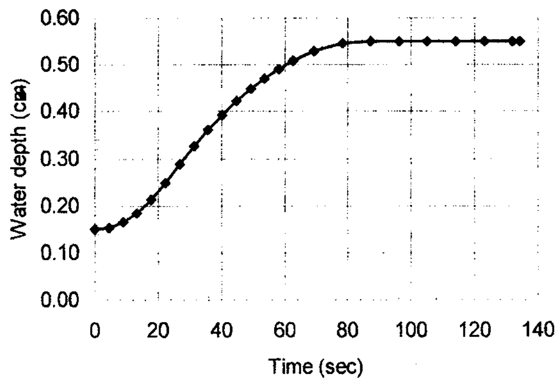

Fig. (4) Water level inside the lock chamber during filling process.

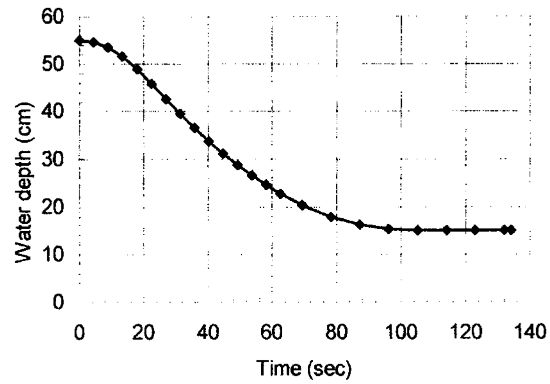

Fig. (5) Water level inside the lock chamber during emptying process.

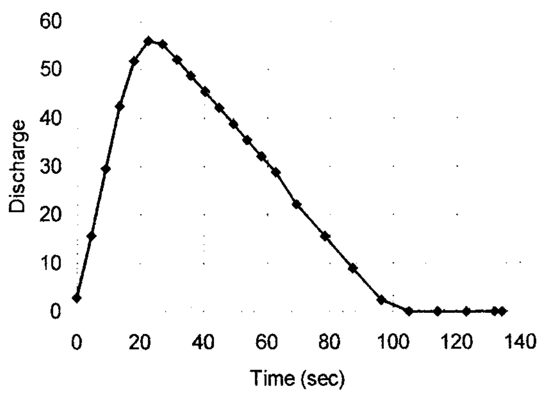

Fig. (6) The discharge from the lock chamber during emptying process.

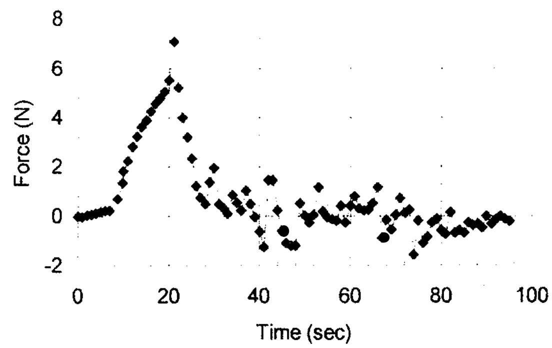

Fig. (7) The time series of the longitudinal forces on ship inside the lock chamber during filling process.

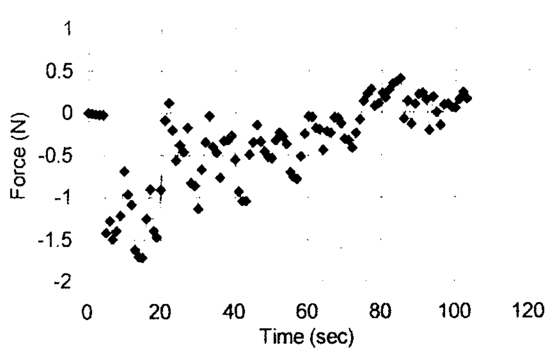

Fig. (8) Time series of the longitudinal forces on the ship inside the lock chamber during emptying.

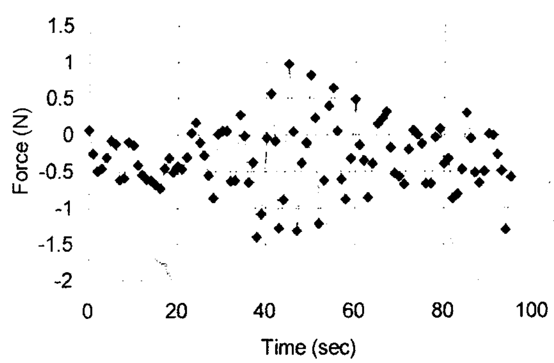

Fig. (9) The time series of the transverse forces on ship inside the lock chamber during filling process.

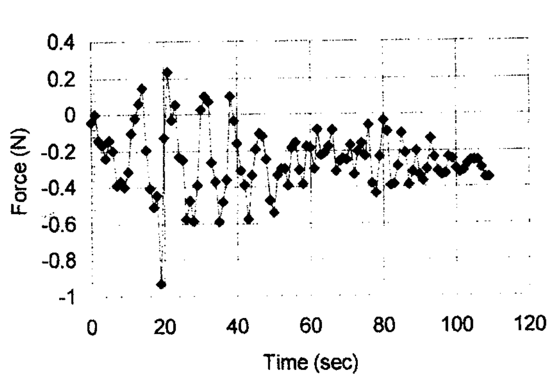

Fig. (10) Time series of the longitudinal forces on the ship inside the lock chamber during emptying.

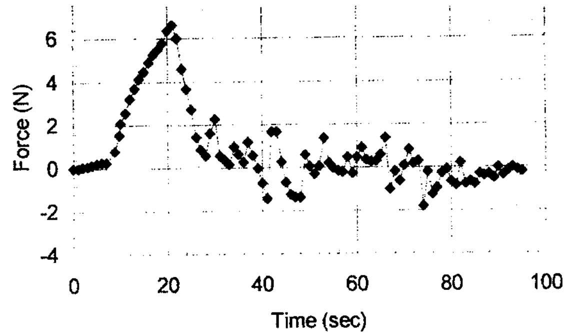

Fig. (11) The longitudinal forces on the ship during filling process.

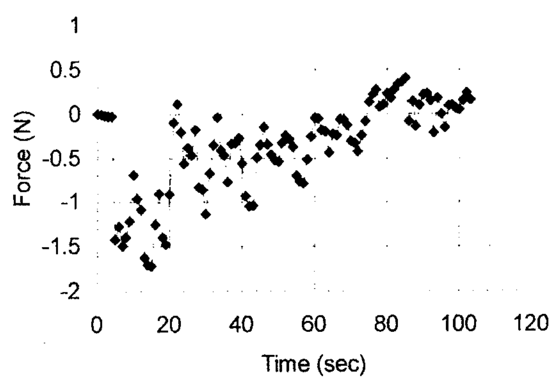

Fig. (12) The longitudinal forces on the ship during emptying process.

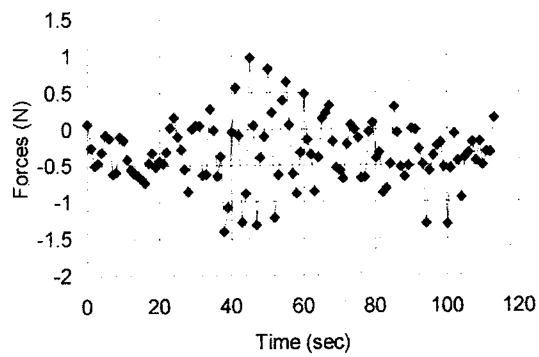

Fig. (13) The transverse forces on the ship during filling process.

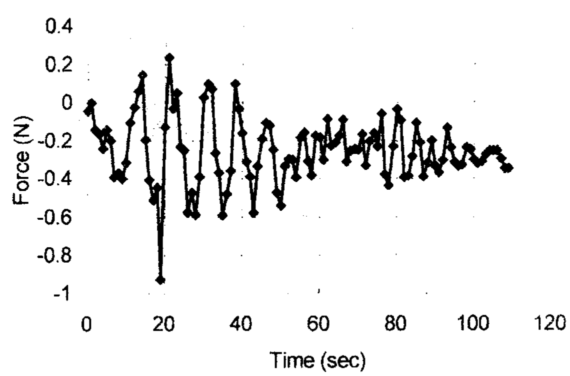

Fig. (14) The transverse forces on the ship during emptying process.

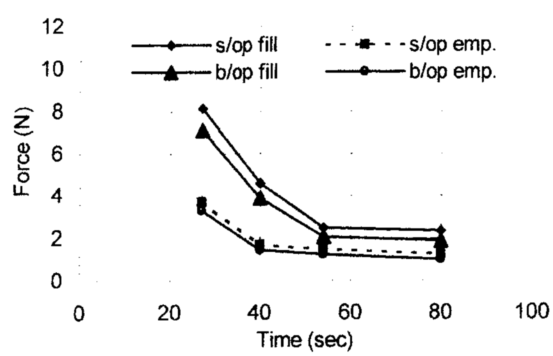

Fig. (15) Comparison between max. longitudinal force for two orientations of the ship during filling & emptying.

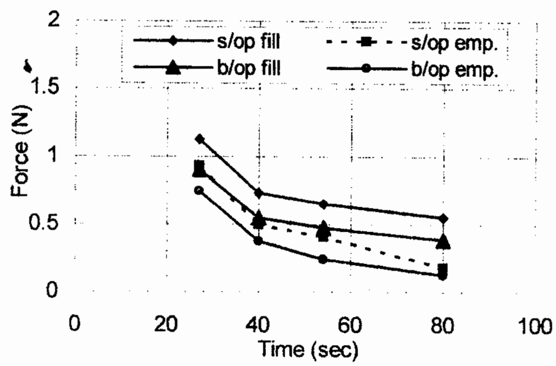

Fig. (16) Comparison between max. transverse forces for two orientations of the ship during filling & emptying.

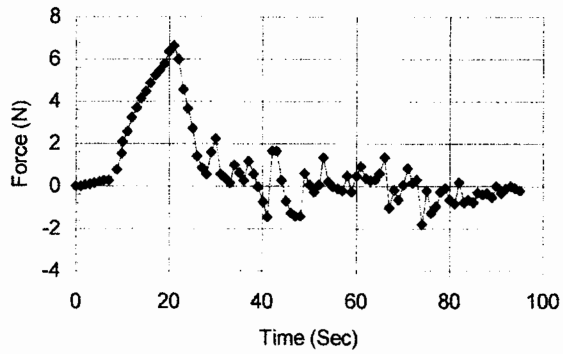

Fig. (17) The longitudinal forces on the ship inside the lock chamber during filling process.

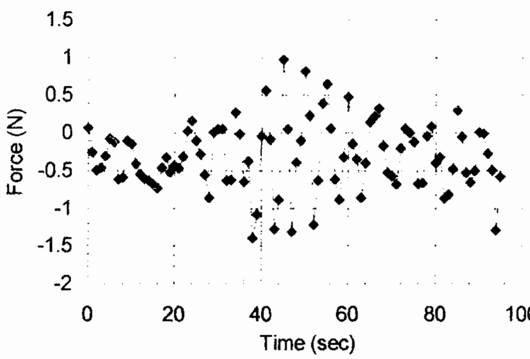

Fig. (18) The transverse forces on the ship inside the lock chamber during filling process.

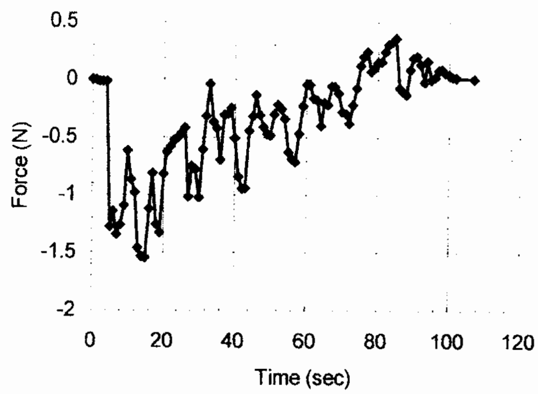

Fig. (19) The longitudinal forces on the ship during emptying process.

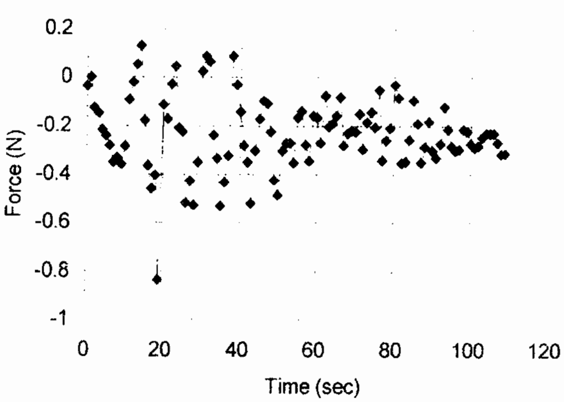

Fig. (20) The transverse forces on the the ship during emptying process

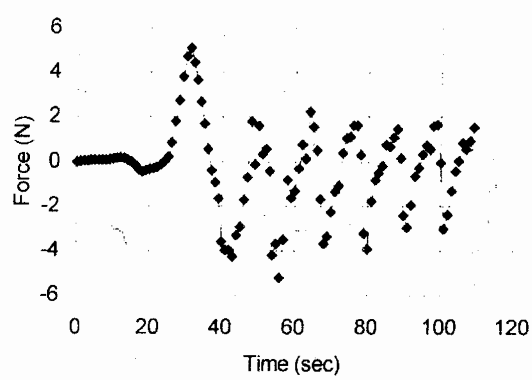

Fig. (21) The longitudinal forces on the ship during filling process

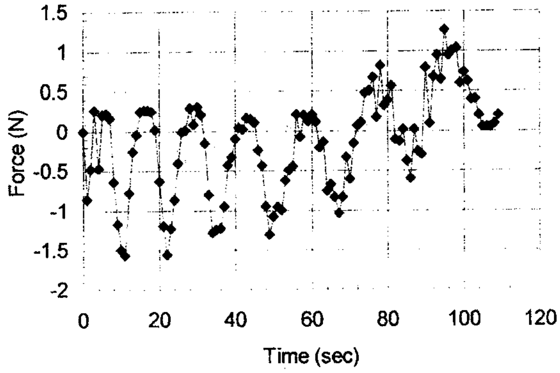

Fig. (22) The longitudinal forces on the the ship during empyting process .

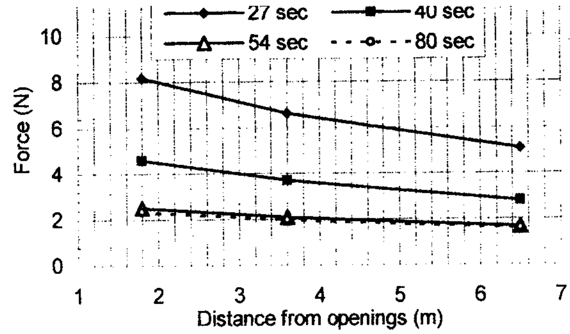

Fig. (23) Comparison of the max. longitudinal forces during filling for different positions of the ship .

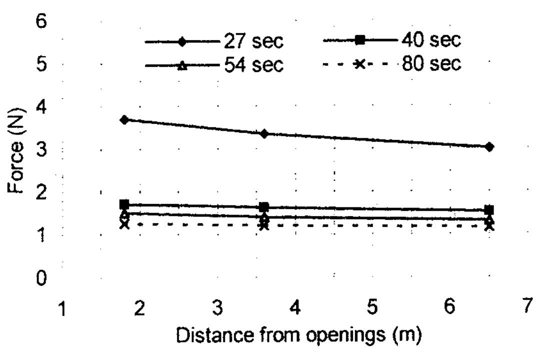

Fig. (24) Comparison of the max. longitudinal forces during emptying for different positions of the ship.

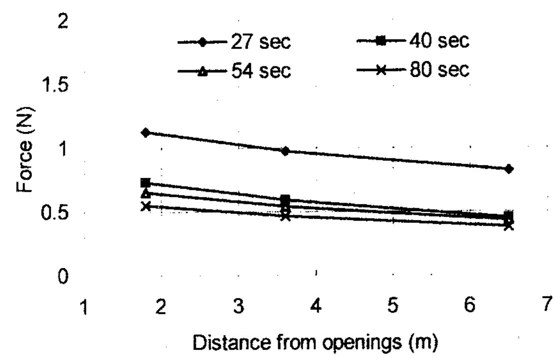

Fig. (25) Comparison of the max. transverse forces during filling for different positions of the ship .

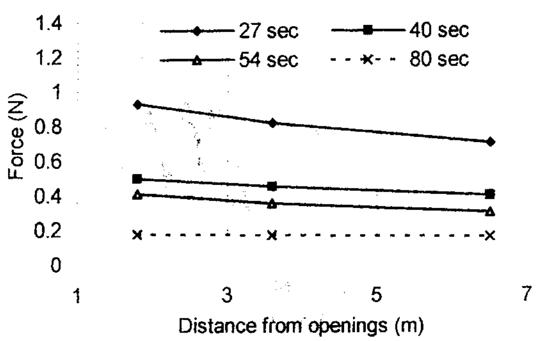

Fig. (26) Comparison of the max. transverse forces during emptying for different positions of the ship.

الظروف الحرجة للمركب داخل حوض الهويس خلال عمليتي الملأ والتفريغ باستخدام نظام الملأ من نهاية حوض الهويس

أ.م.د/ قاسم صلاح عبد الوهاب الألفي   أ.م.د/محمد محمد فؤاد صبيح
أ.د/على محمد طلعت   أ.د/أحمد فهمى   باحث /محمود كامل

الخلاصة:

فى هذه الدراسة تم بناء نموذج معملي لتمثيل القوى المؤثرة على البواخر داخل الأهوسة الملاحية و ذلك باستخدام طريقة جديدة للملأ و التفريغ مدفونة داخل الفرش. و قد أجريت التجارب لثلاثة مواقع مختلفة لتثبيت السفينة داخل حوض الهويس بالنسبة لنظام الملأ. و في كل وضع من أوضاع التثبيت تم قياس كل من القوى الطولية والعرضية الموثرة على السفينة و ذلك باستخدام نظام كهرومغناطيسي متقدم من pressure transducers متصل بجهاز data logger المتصل بالكمبيوتر وذلك لحالتي التوجيه لكل موضع من أوضاع المركب، حيث أنه فى حالة التوجيه الأولى تكون مقدمة المركب هى المواجهة لنظام الملأ و التفريغ بينما فى الحالة الثانية تكون مؤخرة المركب هي المواجهة له. و لقد بينت الدراسة أن القوى الطولية المؤثرة على المركب تعتبر كبيرة جدا مقارنة بالقوى الجانبية. كما وجد أيضا أن القوى المؤثرة على المركب فى حالة الملأ أكبر بكثير من تلك الناتجة فى حالة التفريغ لحوض الهويس. كما أوضح تحليل النتائج أن الوضع الحرج لتثبيت المركب داخل حوض الهويس عندما تكون قريبة من نظام الملأ و التفريغ كما أن الوضع الحرج لتوجيه المركب عندما تكون مؤخرة المركب هى المواجهة لنظام الملأ و التفريغ.