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Review of lift locking of ships

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ABSTRACT: *A Lift-Lock is a device used for raising and lowering boats and ships between stretches of water of different levels on river and canal waterways. The distinguishing feature of a lock is a fixed chamber in which the water level can be varied. There are several other locks in which chamber itself rises or falls. One such example of a fixed chamber is 'The Three Gorges Dam' in China. The construction of dam is intended to increase river shipping annually with transport cost by 30% to 37%. Another example of Lift-Locking in which the complete chamber itself rises or falls is 'The Peterborough Lift-Lock' in Canada in Trent canal. It is a dual lift structure and is the highest hydraulic boat lift in world. The lock has two identical ship caissons in which vessels ascend and descend. Both caissons are enclosed at each end by pivoting gates.*

Keywords: *caisson, chamber, hydraulic, lift-lock, gates.*

I. INTRODUCTION

A lock is a device for raising and lowering boats between stretches of water of different levels on river and canal waterways. The distinguishing feature of a lock is a fixed chamber in which the water level can be varied; whereas in a caisson lock, a boat lift, or on a canal inclined plane, it is the chamber itself (usually then called a caisson) that rises and falls. Locks are used to make a river more easily navigable, or to allow a canal to take a reasonably direct line across land that is not level. When a stretch of river is made navigable a lock is required to bypass an obstruction such as a rapid, dam, or mill weir — because of the change in river level across the obstacle. In large scale river navigation improvements, weirs and locks are used together. A river improved by these means is often called a Waterway or River Navigation (see example Calder and Hebble Navigation).Early completely artificial canals, across fairly flat countryside, would get round a small hill or depression by simply detouring (contouring) around it. As engineers became more ambitious in the types of country they felt they could overcome, locks became essential to effect the necessary changes in water level without detours that would be completely uneconomic both in building costs and journey time.

Fig 1. Panama Canal

II. LITERATURE REVIEW

As per statistics, it is estimated that the Panama Canal will reach its maximum sustainable capacity between 2009 and 2014. When it reaches this capacity it will not be able to continue to handle growth in demand, resulting a reduction in competitiveness of the Panama maritime route. As approved by the Panamanian people, construction for the expansion project is slated to conclude by 2015. Thus Dagett strategized to use all possible means to stretch capacity until the construction of the third set of locks will allow it to capture the entire demand project through 2025 and beyond. Together, the existing and new locks will approximately double the capacity of the present canal. [1]. The project will build two new locks, one each on the Atlantic and Pacific sides. Each will have three chambers with water saving basins, Excavate new channels to new locks, Widen and deepen existing channels, Raise Gatun Lake's maximum operating level. [1]

For this purpose some kind of navigation locks would be needed. Accelerated growth of waterway traffic, the use of larger tows, the need for faster lock operation, and the use of higher lock lifts have greatly increased the demands for hydraulic design on many features of modern locks. Detailed hydraulic studies of filling and emptying systems, conditions in lock approaches, valve operation, and height and arrangement of guide walls are required to ensure safe and reliable operation of modern locks.

Davis presented the results of research, design studies, and operation experience for guidance of hydraulic engineers in design of navigation locks. He also gave information and data that would be useful to all activities having responsibility for design of civil works projects. [2]

However all the designs lead to the problem of congestion at locks. Due to the varying nature of the traffic and lockage times (especially the need to split long tows to pass through smaller locks), long queues may form at the locks. Campbell studied various issues such as evaluation of lock and traffic management policies, development of a detailed multi-lock simulation model, evaluation of decision rules for sequencing vessels in queues, and development of a prototype GIS-based vessel tracking system. Conclusions made were that a range of traffic and lockage management alternatives could be deployed and several queue re- sequencing policies using current and increased levels of demand could be evaluated in detail. To evaluate these rules developments were made for a detailed simulation model that accurately captures the dynamics of operations on the UMR. Also, a prototype vessel tracking system for the UMR to demonstrate the types of capabilities that could be deployed to assist in broader scale traffic management was developed. [4]

From design point of view some experiments were also conducted on the hydraulic characteristics of culvert valves for the Three Gorges Project (TGP). Qinqin formulated the results regarding the testing methods, selection of tainter (curve) valve arrangement in the valve region and its corresponding hydraulic characteristics, cavitation, selection of valve structure types, hydraulic loads acting on the trunnion, loads and load variations on the valve hoist caused by flowing water, and geometric optimization of the valve to reduce the hoist loads.[3] Some differences exist in the hydraulic characteristics between high head and middle or low head culvert valves. These differences should be paid sufficient attention in hydraulic design of culvert valve. The hydraulic characteristics of the high head culvert valve were presented by Qinqin along with the experimental results in TGP's lock culvert valve hydraulic research and are referential to similar design or research.

Lift Locking Of Ships

3.1 Various terminologies and details
Rise
Pound
Chamber
Paddle
Gates
Snubbing posts
Paddle gear
Turning a lock
Lock mooring

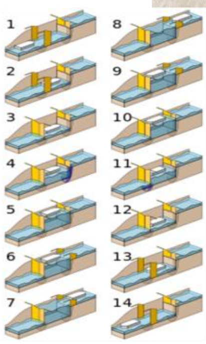
1-2.Boat enters the lock.

3.The lower gates are closed.

4-5. Water is filled in lock from upstream .

6. The upper gates are opened.

7. The boat enters another lock or pound.



8-9. The boat enters the chamber.

10. The upper gate closes.

11-12. Water is drained to a lower chamber.

13. The lower gate opens.

14. The boat enters another lock or pound.

Fig 2: Details of a lock

Fig 3. Mechanism of lift-locking

3.2 Mechanism of lift-locking

The principle of operating a lock is simple. For instance, if a boat travelling downstream finds the lock already full of water: The entrance gates are opened and the boat moves in. The entrance gates are closed. A valve is opened; this lowers the boat draining water from the chamber. The exit gates are opened and the boat moves out. If the lock were empty, the boat would have had to wait 5 to 10 minutes while the lock was filled. For a boat travelling upstream, the process is reversed; the boat enters the empty lock, and then the chamber is filled by opening a valve that allows water to enter the chamber from the upper level. The whole operation will usually take between 10 and 20 minutes, depending on the size of the lock and whether the water in the lock was originally set at the boat's level.

III. CONCLUSION

Lift locking permits easy transportation and navigation across long stretches of water bodies which otherwise was expensive and time consuming. Through high development of this mechanism, enhancement of international as well as national trade and communication would be possible. These systems could be deployed in a wide range of site conditions where a short stretch consists of larger difference in the water level.

Along with aid in transportation, it facilitates the surrounding region of becoming a tourist spot thus boosting its economy. With appropriate construction of reservoirs whose level are intermediate between upper and lower pounds, it is possible to conserve the water that goes unutilised during each cycle of lift locking. It is an excellent method of water control and management. This in turn would help reduce the probability of the canal running dry.

All in all the cost of water transport has come down substantially, thanks to the lift locking mechanism.

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