CHAIN FENDERS IN THE LOCKS OF THE PANAMA CANAL*

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WHEN the alternative plans for the Panama Canal were under discussion, advocates of the sea-level type laid great stress on the dangers to navigation inherent in a lock canal. Such dangers undoubtedly exist, although experience has shown that the risk of serious accident is very small in locks that are properly designed and carefully operated. Even at the Soo where the traffic, for many years, has been extremely heavy, only one serious accident is on record since the first lock was opened in 1855.

In comparing the two types in the case of Panama, it should be borne in mind that the broad and deep channels provided by Lake Gatun possess elements of safety which would have been absent in the smaller cross-sections of a sea-level canal.

On the other hand, the accidental destruction of certain of the lockgates would not only involve the risk of injury to vessels but might also set free the water impounded in Lake Gatun and lower its level so much as to stop navigation for a long period of time.

In working out the detailed plans of the locks, it was thought wise to take all possible precautions against injury to the gates and to provide special safeguards against further damage in case, after all, one or more gates were accidentally destroyed.

The safeguards adopted with these ends in view are the following:—

(1) Electric locomotives for towing all vessels through the locks. These travel on a rack railroad close to the edge of the lock walls and have, so far, proved entirely satisfactory in controlling vessels and keeping them centered in the lock chambers.

(2) Chain fenders for protecting the most important gates.

(3) Duplicate gates in certain parts of the locks. There are the usual "guard gates" at both ends of each lock flight and besides these a second pair of lower operating gates is provided in Pedro Miguel lock and the upper chamber at Gatun and Miraflores.

(4) Emergency dams of the drawbridge type at the upper end of each lock for shutting off the flow of water in case of serious injury to the gates.

The first of these devices forms a part of the machinery used in normal locking. As long as it functions properly no further safety mechanism comes into operation.

The second device, the chain fender, protects the gates when, for any reason, a vessel is not under the control of the towing system.

The third safeguard, the duplicate gate, in its turn, does not come into play until the fender protecting it has failed to fulfil its proper function, and finally,

The emergency dam is needed only after all the preceding safety appliances have failed so that it becomes necessary to check the current of water flowing through the locks.

A full description of the various safety appliances is given in a series of papers on the Panama Canal written by the members of the engineering staff responsible for the different parts of the work and presented to the International Engineering Congress at San Francisco in 1915. (Transactions of the International Engineering Congress, 1915. The Panama Canal Vol. II. Also published separately by the McGraw-Hill Publishing Co., New York, 1916.)

They are also described in a concise but readable and comprehensive article published in Engineering and Contracting, January 7th, 1914, which is the best general account of the Panama Canal known to the writer. Reference should also be made to an excellent paper ("First Year's Operation of the Locks of the Panama Canal," F. C. Clark and R. H. Whitehead. Journal of the Western Society of Engineers, Vol. xxi., No. 4, April, 1916), which records the experiences obtained in the actual operation of the locks since the opening of the canal.

The chain fenders, the second of the safeguards mentioned above, were adopted at the suggestion of the writer who was in immediate charge of their design and construction. While similar fenders have been used in English locks for a number of years, they are believed to be inferior in strength and reliability to the Panama design.

The fenders were placed in the upper and lower approaches to the lock flights, thus protecting the upper and lower guard gates, and also just above the intermediate and lower gates in the Pedro Miguel lock and the upper chamber at Gatun and Miraflores.

Description of Fender Machinery

The fenders consist of heavy chains, which normally span the lock chambers near the top, being lowered to the lock floor when a vessel is about to pass. Each gate and its protecting fender are interlocked electrically, so that the chain cannot be lowered until the gate is opened, and hence is no longer in danger from collision.

The chain is arranged to pay out under stress when it is struck by a vessel, so that the energy of the vessel is absorbed and it is brought to rest without damage. The machinery must, therefore, not only make provision for lowering and raising the chain in daily operation but must also include some reliable means of putting the chain under stress when it is stopping a vessel. Evidently the success of the entire fender depends upon the mechanism for producing a suitable resistance to the travel of the chain in its emergency action.

In the English fenders, mentioned above, the friction of the chain about a horizontal cast-iron cylinder placed on one of the lock walls, is depended upon to give the necessary resistance. A small hoisting engine on the other wall raises and lowers the chain.

The writer examined one of these fenders at Avonmouth, near Bristol, in 1908, and discussed their details with the designers and builders, Messrs. Brown, Lenox & Co., of Pontypridd, Wales. They are simple in construction but the frictional resistance is likely to be variable in amount. It is also believed that lowering the chain from one end only is undesirable, as it often forms a loop at the bottom which may foul vessels in the lock. As far as could be learned, no tests in actually stopping vessels have ever been made with these fenders.

It is proper to add that the Panama designs were well in hand before the writer had heard of the English fenders, although their inspection proved of much interest. He would also like to record here his indebtedness to his friend, E. H. McHenry, M.Can.Soc.C.E., for most valuable suggestions in connection with the first inception of the Panama chains.

The adopted design was the result of an extended investigation. Frictional resistance of different kinds were studied, also the use of heavy weights for stopping the

*Abstracted from paper on tests of these fenders, presented to the Canadian Society of Civil Engineers.