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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.


## BEARING OF THE SOO CANAL ACCIDENT ON PANAMA.

It was inevitable that the recent accident to the Soo Canal locks on the Canadian side would be cited by those who are opposed to the building of a lock canal at Panama, as affording the strongest kind of evidence of the truth of their contention that to construct a canal with locks at Panama is to invite a similar disaster and render the future security and permanence of the canal very precarious. We are quite willing to admit that, if the Panama locks were designed on the same plan, and if ships were to be allowed to pass through the locks under their own power as they do at the Soo locks, the point would be well taken, and it would be possible for a blunder upon the part of either the captain or engineer of a ship that was passing through to wreck the whole canal and put it out of commission for many months and possibly for one or two years.

In drawing the plans for the locks at Panama, however, the engineers have taken care to make certain provisions against disaster, both in the locks themselves and in the manner of controlling vessels that are passing through, which will render it practically impossible for an accident similar to that which occurred on June 9th in the Canadian lock to be repeated. To be convinced of this we make a brief *résumé* of what actually took place in the recent disaster.

The lock on the Canadian side is 900 feet long, 60 feet wide, and has a lift of 20 feet. At the time of the accident two ships were in the lock on their way down the canal. The waters in the lock were therefore on the same level as the upper reach of the canal. The upper gates were open, and the lower gates, being closed, were subject to the full head of twenty feet of water. At the same time, approaching the lock from below, was a steamship, the "Perry G. Walker." The captain had given orders to reverse the engines and stop the ship, but through some misunderstanding the engineer continued to go ahead. Before the ship could be stopped, her bow struck the lower gates, which were holding back under a head of twenty feet the waters of the lock and canal above, and smashed them down. Immediately the lock was changed into an open channel-way with a fall of twenty feet in nine hundred, and the whole mass of water in the upper reach of the canal commenced to sweep through in a raging torrent, wrecking the three ships that were concerned in the disaster.

Now the locks at Panama have been designed with a special view to the elimination of just such a disaster as this. In the first place, no ship will be allowed to approach or pass through the locks under the power of her own engines. On reaching the locks, either from above or below, she must be stopped several hundred yards from the structure. Then she will be taken in hand by powerful electric towing locomotives, running on tracks laid on the brink of the canal, some in front for towing, and others astern for checking the ship's way. The vessel, which will move at slow speed through the locks, will thus be held in absolute control. This will eliminate the present danger of a misunderstanding of signals between the captain on the bridge and the engineer below, either through a misreading of signals or a failure of the engine-room telegraph to work properly.

As a further provision against carrying away the gates, they will be built in duplicate with a wide stretch of water between; so that if by any chance the vessel should touch and break down the first gate, the water will be held by the gates beyond. These emergency or collision gates will be built of such strength that it will be impossible for a ship to break through them and reach the gates beyond.

Still another provision has been made against the escape of the waters of the lake, in the remote contingency of the ship getting away from the powerful towing engines and carrying away both the collision and water gates proper in succession. This consists in a massive swinging gate at the upper entrance, which, normally, lies up and down stream in a pocket formed in the side walls of the canal. The gate consists of a massive skeleton frame, carrying a line of sluice gates which, normally, are in the raised position. In case of an impending accident, the gate would be swung around across the channel and the gates rapidly lowered until they completely shut off the water. If no accident occurred, well and good. Should a lock gate be damaged, there would be a loss simply of the water in the locks, and the whole lock structure would be left dry and open for inspection and repairs. Even the most incredulous must admit that, with such provisions, with proper care, the possibility of the escape of the whole lake is not even remotely possible. It could take place only through the grossest negligence.

In the discussion of this problem we shall hear doubtless a great deal about the accidents which have taken place in past years both in the Soo Canal and in the Manchester Canal. It is true that on more than one occasion ships have collided with the locks and put the canals temporarily out of service; but we believe in almost every case disaster has been due to the always dangerous arrangement of separating the man who controls the ship from the man who controls the engine, and providing only an automatic means of communication between them. The elimination of this feature at Panama and the absolute handing over of the ship to the lock officials, who will have her in sight all the time, and will handle her from the shore by appliances whose motive power will be ample to control her speed and stop her at short notice, will render passage through the Panama locks a safer operation than that of many great engineering works which run from year to year without the least dislocation or disaster.

## QUEENSBORO BRIDGE A SAFE STRUCTURE.

A few months ago we had occasion, in company with several other technical journals, to criticise the Bridge Department of this city, because the boards of engineers appointed to investigate the Queensboro Bridge found that, under the assumed maximum loading of 16,000 pounds per lineal foot, certain members in the bridge would be overstressed from 20 to over 40 per cent. These conditions were due to several causes, prominent among which was the addition of two elevated tracks on the upper floor of the bridge and certain changes in the paving of the roadway, etc., which together had made a considerable increase in the dead weight of the structure.

There can be no doubt that the public anxiety about the bridge, which had been very naturally awakened by the fall of that other great cantilever structure, the Quebec Bridge, was greatly aggravated by the facts presented in the reports of Prof. Burr and Messrs. Boller and Hodge, above referred to. In the interval since these reports were made public, the Bridge Department has followed the suggestion made by these engineers for reducing both the dead weight of the bridge itself and the live load which it will carry. The two additional elevated tracks have been removed; the footwalks, which were to have extended outside the trusses, have been placed above the stringers of the discarded railroad tracks; the enormously heavy concrete paving, which was not contemplated in the original plan, has been greatly reduced in thickness and lightened up. The result of these changes is that, if the traffic is subjected to the restrictions as to spacing of trains and crowding of teams, which obtain on other bridges, the stresses in the structure will be kept down within the limits of safe engineering practice.

In view of the fact that the bridge has now been formally opened to traffic, unusual interest attaches to a recent report on the structure made by Mr. F. C. Kunz, the chief engineer of the Pennsylvania Steel Company, who built the bridge. It is accompanied by a supplementary report by a commission consisting of two past presidents of the American Society of Civil Engineers, the engineer of bridges of the Pennsylvania, and the consulting engineer of the Baltimore & Ohio and Erie railroads. The commission draws attention to the fact that since the failure of the Quebec Bridge, public confidence has been disturbed as regards the safety of bridges of unusual magnitude, and that the distrust has been aggravated by the opinion expressed in the report of the Royal Commission which inquired into the cause of failure of the Quebec Bridge, who stated that "under extreme conditions the Quebec Bridge stresses are in general harmony with those permitted in the Blackwell's Island Bridge"—an "unwarranted remark," in the opinion of the commission.

Although there has never been any question of the excellent character of the steel and of the work of erection as done by the Pennsylvania Steel Company, both of the city's expert reports having pronounced the work to be "first-class," the present report may be regarded as an "apologia" of American principles of bridge design in structures of great size, with a criticism of the faulty application of one of these principles as applied in the present structure. It is impossible within the limits of the present article to give even a brief *résumé* of the report, nor is it necessary; but we wish to dwell upon one, and perhaps the most important, point made by Mr. Kunz, when he affirms that in adopting a theoretical live load of 16,000 pounds per lineal foot over the whole bridge as part of the basis data for the design, the Bridge Department erred on the side of caution. They adopted a loading which could never by any possibility occur in practice; which would involve a congestion so close that the movement of the traffic would be impracticable, a condition, in a word, which could only be realized by costly preparation and the assembling of the multitude of cars, vehicles and people by some carefully-thought-out plan.

In designing a bridge and calculating the amount of stress which must be provided for in each of its members, it is necessary for the engineer to determine what will be the weight of the structure itself and what the weight of the moving traffic and the wind and snow loads which it must carry. The first, which is known as the dead load, can be determined with great exactness, but the second is necessarily problematical. Not only will the amount of traffic on the bridge vary at different times, but it will vary in distribution. On some days it will be heavy, on others light, and on the same day and at the same time it may be heavy on one part of a bridge of the magnitude of the Queensboro and relatively very light on some other part. For these reasons the engineer has to assume or "guess at" the probable live loading of the structure. The customary and most reasonable plan in bridges of great magnitude is to assume the largest practicable or "working" load that could possibly be accommodated and kept moving on the bridge. This is known as the assumed live load. It is added to the known dead wind and snow loads, and the sum of these, as thus ascertained, is used in determining the proper size and strength of the various members of which the completed bridge will be made up.

Now it is considered by Mr. Kunz and the commission that in assuming the live load of the Queensboro Bridge at 16,000 pounds, or no less than eight tons, on every foot of the bridge, the figure was placed altogether too high. To produce a load of 16,000 pounds per foot, it would be necessary to load all the four elevated tracks with eight-car subway trains, with each train touching the one ahead of it; load the four trolley tracks with the heaviest surface cars placed bumper to bumper; load the 35-foot roadway from side to side and throughout the whole of its length with the heaviest motor trucks in use in the city, weighing nine tons apiece; and to crowd the footwalk with a mass of people packed together twice as closely as the crowd at the forward end of a North River ferryboat when it is approaching the slip.

Now since it is not conceivable that any condition, even of extreme panic, could induce a congestion approaching this, it is evident that had the Queensboro Bridge, as designed by the Bridge Department, been found to be able to carry such a load with safety, it would have been stronger, heavier, and more costly than the requirements of traffic could possibly call for. We do not say this to excuse the blunders of the Bridge Department; for having adopted a certain loading and a certain maximum unit stress, it was their duty to design the bridge compatibly with these requirements. In a matter of such serious moment as the design of a bridge of this character, the engineer cannot afford to play fast and loose with his data.

Although the errors were made and are quite inexcusable, it is in a sense fortunate that so high a live loading was assumed, since it has made it possible by taking off a certain amount of dead load to keep the stresses throughout the bridge well within the limits of what is considered to be conservative engineering practice.

In conclusion, then, the citizens of Greater New York may rest satisfied that, in spite of the mistakes which have been made, they possess in the lately opened structure a bridge which, although it does not possess the full capacity corresponding to the amount of material and money cost that has been put into it, nevertheless is perfectly safe for the loads under which it will henceforth be operated.

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Arthur Wright has invented an electrical device for evaluating algebraical formulæ and equations. The device consists in the combination of special rheostats attached to slide rules and a Wheatstone bridge, by which quantities can be multiplied, divided, added, or subtracted simultaneously, and by which complicated algebraical expressions or equations can be evaluated or solved with an accuracy comparable with that attainable by ordinary slide rules.