(*Paper No. 2183.*)

**“Demolition of the North-East Wall of the Gallions Basin,
Royal Albert Docks, on the 23rd of April, 1886.”**

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IN 1883 the directors of the London and St. Katharine Docks Company decided to construct a second entrance from the Thames into the Gallions basin. The Bill giving the necessary powers received the Royal Assent on the 12th of May, 1884. The works were then taken in hand, and it is not intended in this Paper to give any account of them. At some future time, perhaps, an opportunity may be sought to lay a brief statement of any points of interest before the Institution. Here, it is only necessary to say that the works consist of a new entrance, with a wharf stretching from it 1,120 feet down the Thames, and of an extension of the existing basin, Plate 10, Fig. 1; and that in order to connect the new with the old part of the basin, and to give access from the new entrance into the basin and so into the Royal Victoria and Albert Docks, the wall shown on plan had to be removed.

This wall was 520 feet long, and, like the rest of that surrounding the basin, was 38 feet deep, 19 feet wide at the bottom, and 5 feet wide at the top. The face had a batter of 1 in 27 for 25 feet, then of 1 in 6 for 6 feet, and then sloped forward for 3 feet at an angle of 45° , with an apron 14 feet wide and 6 feet deep. The back of the wall was thickened by four steps; the first 2 feet wide, and 3 feet from the top; the next two steps, each 2 feet 4 inches wide, and 7 feet deep; the last, 2 feet 4 inches wide, but only 3 feet 6 inches below the third step. The wall was then straight to the bottom, Fig. 2. It was made of concrete composed of 6 parts gravel and 1 part Portland cement, and was of great hardness and strength. The water, at Trinity high-water, was 6 feet below the top of the wall; the ground was level with it behind, and formed the quay. At 40 feet from the edge stood a corrugated-iron warehouse, 264 feet long by 60 feet wide, the roof supported on piles, and having railway lines in front and rear, Fig. 2. This warehouse, being in the way, was removed at an early period of the works, but the piles were left which had supported the roof in front.

The Gallions basin was incessantly in use, the largest steamers trading to the Port of London—such as the Peninsular and Oriental, the British India, and similar lines—passing close to the south end of the wall when being docked and undocked, the entrance to the lock being within 130 feet of this end. The loading-berth of the Orient line adjoined the north-west end of the wall; at the other side of the basin were two loading-berths for similar steamers, and craft in large numbers were constantly present. The inner lock-gates of the existing lock and of the new lock were within 180 feet. The office and stores of the Orient line, a two-storied corrugated-iron building, were within 70 feet of the north-west end, the Gallions Railway Station within 160 feet, and the Gallions Hotel within 260 feet. Adjoining the office and stores was a corrugated-iron warehouse, 264 feet long, and 60 feet wide, lighted by a skylight extending the whole length of the roof; a large pumping-station was about 450 feet distant; and the dock-masters houses about 630 feet. Two corrugated-iron sheds, of similar dimensions to that above named, were about 500 feet off, on the side of the basin opposite to the wall, and there were other minor buildings in the vicinity.

The problem was, effectually to crumble away the wall without any interruption to the dock business, without damage to the adjacent premises, and without injury to those employed at the docks, or to the public.

The directors had entrusted the execution of the works to Mr. Robert Carr, M. Inst. C.E., the Company's Engineer, and Mr. Joseph Thomas, the Company's Assistant-Engineer, with the supervision of the Author. When the time arrived to consider how best to remove the wall, several conferences were held, and the result was the following plan, the main burden of carrying it out falling on Mr. Thomas, by whom most of the following details have been supplied:—

A line of timber sheet-piling, 14 inches square, was driven about 4 feet from the back of the bottom of the wall, thus revetting the earth from quay level to the bottom of the wall, and forming a sort of inner dam. A second row of piles was driven about 24 feet in rear of the sheet-piling, but 12 feet apart, the piles which had supported the roof of the warehouse at 24 feet apart coming here again into use. A line of waling was fixed near the top and along the front of the sheet-piling, and another line of waling along the back of the rear piles, and the whole was tied together by tie-rods 2 inches in diameter with 9 inches cast-iron washers (Plate 10, Figs. 3 and 4).

As soon as a sufficient part of the revetment had been completed, the excavation of the earth between the wall and the revetment was commenced, and gradually extended until men were at work along the whole length of the wall. Simultaneously with the excavation of the earth, the off-sets of the wall were cut away perpendicularly, till it stood throughout its entire length and depth at a mean thickness of about 6 feet (Plate 10, Fig. 3). The first off-set was removed by charges of about $\frac{1}{2}$ lb. of powder each, in holes about 2 feet deep. Subsequently such charges were employed as sufficed just to break the off-sets away, the fragments varying from 2 tons downwards, the average being about 1 ton. These charges were placed in holes bored perpendicularly in the off-sets, from 2 to 5 feet in depth, and from $1\frac{1}{2}$ inch to 3 inches in diameter. The charges varied from $\frac{1}{2}$ lb. to $1\frac{1}{2}$ lb. of powder or compressed cartridge; the dynamite was used in $\frac{1}{2}$ lb. charges. About seven to nine charges were fired at one time. Warnings were given by bugle calls before any charges were fired.

For thinning the wall as above stated, the number of holes drilled was three thousand one hundred and twenty-seven, of a total length of 11,765 feet. The explosives used in these holes consisted of 1,900 lbs. of J. Hall and Son's pebble powder, L. G. B., 1,050 lbs. of J. Hall and Son's patent compressed powder cartridges, and 105 lbs. of Nobel's patent gelatine dynamite. The fuze employed was Bickford, Smith and Co.'s patent gutta percha fuze, No. 13. The powder and compressed cartridges were used in preference to dynamite, as being less likely to shake the part of the wall which it was desired to leave intact until the end, except where the holes were wet, and for the purpose of trying the effect of the dynamite on this wall.

The drainage of the space between the wall and the revetment was very effectually maintained as follows:—A sump was formed at each end of the wall, and at the bottom of each sump a 15-inch iron pipe was connected with the 15-inch earthenware pipe which carried the water from the works to the main sump. Each pipe was fitted with a 15-inch valve, so that in the event of any in-rush of water from the basin these valves could be closed, and the water cut off from the works.

Protecting piles were driven 14 feet in front of the wall in the basin, with a waling running from end to end to prevent craft striking against the wall as the work progressed. As the excavation proceeded, lines of waling were run along the back of the wall, and five rows of struts were placed from these to corresponding walings in front of the revetment. These struts were 9 feet 3 inches

apart, and extended over the whole length and depth of the wall (Plate 10, Fig. 3). They assisted the wall to withstand the pressure of the water in the basin, as the tie-rods helped the revetment to resist the earth-pressure. The whole system stood admirably, but the struts had to be carefully watched, and at one time some of the upper ones had to be removed, as there were indications of too great pressure against the top of the wall from the earth. It was found by careful theodolite observations that variations in the weather sensibly affected the ground and struts, so much so, that the revetment sometimes gave as much as $2\frac{1}{4}$ inches near the top, and the wall in the centre moved in response to it.

A considerable quantity of water came through slight cracks in the wall, and increased or decreased with any movement in it. But this percolation was easily kept back by the following means:—A small box filled with stable manure, breeze, and sawdust, and fitted with a sliding cover, to which a lever was fixed, was let down into the water over the face of the crack. As the cover was removed, the mixture filled the crack, and so stopped the water.

The arrangements for the final demolition of the wall were as follow (Fig. 5):—Holes were first drilled vertically into the centre of the coping about 3 feet deep, and then as the thinning of the wall progressed holes were drilled in the back of it, partly by hand and partly by Ingersoll rock drills. These holes were 4 feet apart, and placed alternately beneath one another. They were driven at an angle of 45° towards the water, with the object of throwing the wall in the first instance forward, as it measured in front about 525 feet, and in the back about 515 feet only, and it was desired to avoid anything like a jam at either end. To ensure the wall being broken off tolerably straight at the ends, it was pierced to within 1 foot of the face by holes drilled down the back at intervals of about a foot apart, so that the rear of the wall to be demolished resembled at each end a magnified postage stamp. These holes were not charged. The number of holes drilled for the final demolition was one thousand four hundred and fifty, of a total length of 6,381 feet. This, added to the length already stated, gives a total length of holes drilled of 3 miles 34 chains 62 feet, approximating to 4 miles.

The explosive used was Nobel's patent gelatine dynamite; the quantity employed was about 2,900 lbs., in charges of from $\frac{1}{2}$ lb. to 3 lbs., with one row of 6 lbs. The fuzes were Sir Frederick Abel's high-tension electric fuzes, supplied by Messrs. Powell of Plumstead, of an average resistance of 3,000 ohms. Each fuze was carefully tested before being used.

The following arrangements were adopted in charging the holes:—As considerable apprehension existed that some of the gelatine dynamite, which freezes at 40° Fahrenheit, might be frozen, as indeed proved to be the case, warming-pans were provided, and great care was taken to render the dynamite pliable and fit for loading the holes. One of Abel's high-tension electric fuzes, with a detonator containing 10 grams of fulminate of mercury, was soldered to two 10-foot lengths of insulated copper wire, which passed through two perforations in an india-rubber bung, the bung being fastened close to the head of the fuze by the wires being cemented in with Chatterton's cement. A waterproof bag containing a cartridge of about 1½ oz. of gelatine dynamite having been prepared as a primer, and a hole made in the gelatine by a "former" for the reception of the fuze, the bung with the fuze attached was then fitted into the waterproof bag, the mouth of the bag and the bung having previously been smeared with india-rubber cement to render the whole waterproof. Each hole, as it was charged, was carefully tamped with dried clay.

The 6-lb. charges were used to overcome the batter of the wall, and also to counteract in part the direct action of the 3-lb. charges above them, and to tilt the wall forward. To assist the force of the explosion, water was let into the ditch at the back of the wall to a depth of 10 feet, but not deeper, for several reasons, among others, that the pressure of the water in the basin was wanted to force the wall, as it fell, against the revetment, and so prevent its spreading into the basin and hindering the navigation. Mr. Toye, one of Messrs. Nobel's inspectors, was employed to superintend the warming of the dynamite and charging and tamping of the holes, and performed this duty very efficiently.

The arrangements for simultaneously exploding the charges were as follow:—The Royal Albert Docks are lighted throughout by electricity distributed from four stations, one of which was within 300 yards of the wall. From this two well-insulated main leads of copper wire were brought into the basin; these, at a point about 75 feet from the wall, branched into six leads, which were connected at each end and in the centre of the wall with the network of wires attached to the fuzes, thus making three distinct connections. This network again was connected in compound series, with about twenty fuzes in a series, connecting the lines of holes perpendicularly, and so duplicated that, in the event of one series failing through a faulty fuze, it would derive its current from the next series, thus preventing the possibility of a whole series missing fire through having a faulty fuze in it

(Plate 10, Fig. 6). The necessary force was provided by one of Siemens alternating-current machines, used for lighting the docks, and giving about 1,200 volts and 16 amperes. The amount of wire in the leads exceeded a mile, with about 6 miles of branch wire, involving about three thousand joints. Every joint was carefully insulated, as three rows of holes were under water at the time of the explosion. The two leads into the basin were connected near the Manor Way bridge, about 570 feet from the wall, with a tumbler-switch or firing-key, which, by pressure upon a button, completed the circuit and fired the charges. The wire for the leads and network was supplied by Messrs. Siemens Bros., by whose representatives, Messrs. Barnes and Kingston, everything connected with this important part of the work was most effectually carried out. The charges were fired by Mr. Albert G. Sandeman, Chairman of the London and St. Katharine Docks Company, at ten minutes past six A.M., on Good Friday, the 23rd of April, 1886. This time was specially selected to minimize the chance of injury to those employed in the docks or to the public, to avoid interruption to the dock traffic, and to infringe as little as possible upon the day. It also gave time to search the basin to see whether any fragments of the wall might lie in the way of shipping.

The explosion produced exactly the intended effect, as the wall crumbled in a heap into the vacant space in its rear, and into the water immediately in its front, none of it projecting more than 35 feet beyond its base (Plate 10, Fig. 4). No interruption took place to the dock business. Two large ocean-going steamers were undocked from the basin at 4.30 A.M., and at 6.10 A.M., as already stated, the charges were fired, and from the reports of the divers, who descended immediately after the explosion, it was evident that the ordinary work of the dock might have been at once resumed. It was resumed the first thing on Saturday morning, Good Friday being a dock holiday. No injury occurred to person or property—not even a window in the Orient store and office, the nearest adjacent building, was cracked. Very little vibration was perceptible, and the report was not louder than the quick firing of two or three Gardner guns, the sound of which it much resembled. Some light boards, used to prevent persons trespassing on the works, were blown from 20 to 30 feet vertically into the air, with a cloud of smoke, dust, spray, and small débris, along the whole length of the wall. A small wave was raised in the basin, perhaps 2 feet high, which was expended before it reached the opposite side. Out of four dummies, made from divers' dresses stuffed with straw, and placed on the ground about 35 feet behind

the face of the wall, three remained unmoved. The centre one was knocked over by a block of the concrete coping, some large fragments of which lay perilously near the others also.

After the explosion, sections were taken by careful soundings, and it will be seen from Fig. 4 within how limited an area the wall fell. The fragments vary from 3 tons downwards; the majority are about 1 ton. The large fragments are from the concrete coping. The action of the 6-lb. charges appears to have been to reduce the concrete to small stuff, capable of being easily dredged by ordinary dredging.

The Author was strongly and persistently urged to fill in the space between the wall and the revetment with water, and to remove the upper part of the wall, so as to place the remainder also under water, and very dismal prognostications were uttered as to what would happen if the wall was demolished in the way adopted.

The theory adopted was that the wall would move at first slightly towards the basin, and then be forced by the water into the vacant space between it and the revetment, and this exactly took place, the whole power of the dynamite being absorbed, as it was calculated it would be, in doing the work it was intended to do.

The Paper is illustrated by several tracings and photographs, from which Plate 10 has been prepared.

Fig: 1.

KEY PLAN.

GALLIONS BASIN WALL.

ROYAL ALBERT DOCKS.

Fig: 2.

SECTION OF WALL PREVIOUS TO OPERATIONS.

Fig: 3.

SECTION BEFORE FINAL BLAST.

Fig: 4.

SECTION AFTER FINAL BLAST.

Fig: 5.

CROSS SECTION OF WALL.

Fig: 6.

BACK ELEVATION, SHEWING WIRES.