Appendix C
"Deadman Island Lock and Dam, Ohio River"
The Military Engineer

Deadman Island Lock and Dam, Ohio River

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DEADMAN Island Lock and Dam, located on the Ohio River 13.3 miles below Pittsburgh, Pennsylvania, has been under construction since May, 1927. The lock has been completed with the exception of the lock gates, operating machinery, power and operating houses, and the emergency dam, all of which are now being installed. The abutment and first section of the dam, embracing 372 feet, have just been completed except for three 20-foot spillway openings, and work is under way in the second cofferdam.

This structure will replace Lock and Dam Number 3, 2.3 miles above, and Lock and Dam Number 4, 5.3 miles below, both of which were completed in 1908. Dams 3 and 4 are the standard Ohio River type movable dams, whereas Deadman Island Dam is a fixed concrete dam of gravity section. It is similar in many respects to Emsworth Lock and Dam, which replaced movable Dams 1 and 2. It is one of a system of dams which, on completion in 1929, will furnish 9-foot navigation on 968 miles of the Ohio River from Pittsburgh, Pennsylvania, to Cairo, Illinois.

In the upper reaches of the Ohio River, the old movable type of dam has proved less desirable than the fixed type. The steep slope of the stream, the rapid fluctuations of stage, the dangers of running ice. and the shorter periods in which open river navigation conditions obtain, all tend to make the operation and maintenance of movable dams difficult. The advantages of open river navigation are at a minimum, and thd disadvantages inherent in the movable type of dam are always present. The fixed type of dam, in providing a fixed pool, at decreased cost, with greater ease of operation and maintenance, will supersede movable Dams Number 3 and 4.

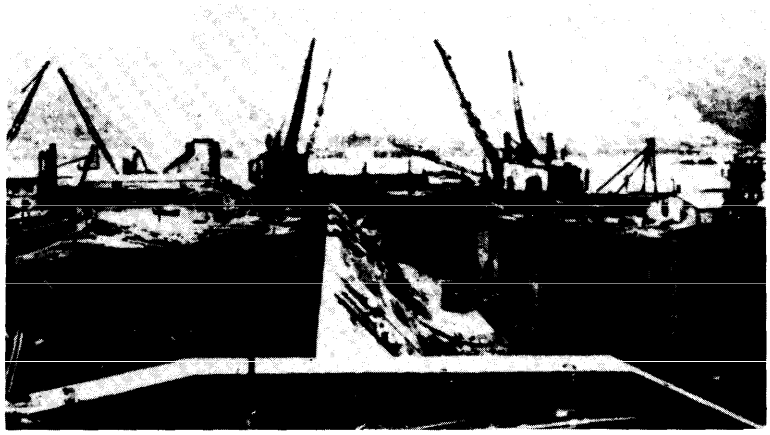
The crest line of the dam is located opposite Shields Station on the Pennsylvania Railroad. The lock is placed ideally on a comparatively straight reach of river. When one considers the typical Ohio River tow—70() feet in length—consisting of a towboat pushing from six to thirteen barges with loads up to 13,()()() tons, the desirability of a straight and easy approach to the lock can he realized, as it eliminates the dangers of being swept out over the dam, such as would particularly attend the location of the lock on a point. It will be notted that the dam is located at a slight widening of the stream, thereby allowing a long spillway-l,583 feet. As a result, a minimum obstruction to the flood flow of the river is provided and the dam only becomes " drowned out" at extreme flood stages.

The locks at this darn consist of the one standard Ohio River lock. 110 by 600 feet, and a smaller one, of the Monongahela River type, 56 by 360 feet, Each. lock consists essentially of a lock chamber, upper and lower gates, a culvert system for filling and emptying, gate - operating machinery, power and power transmission systems, mooring posts, capstans and lights. The lock chambers are filled and emptied by means of a longitudinal culvert system running through the walls with openings to upper and lower pools and to the lock chamber, controlled by butterfly valves. A power house with hydraulic turbine propulsion provides power for gate and valve operation, utilizing oil pressure transmitted through oil lines to the gate- and valve-operating machine. An electric generator, also turbine driven, furnishes current for light and power.

Both locks and dam are gravity-section concrete strulctures founded on rock. A firm sandstone was encountered here at elevations ranging from 654 to 665 along the land wall and at elevations varying only a foot from 654 for the middle and river walls. The crest line of the dam is at 690.

The walls of the lock consist of the land wall, middle wall, and river wall, all of which rise to elevation 705, providing a guard or freeboard of 15 feet above the dam. Each wall has two longitudinal passages or galleries running through it. The upper is a pipe-line gallery containing the oil, air, and water lines required for operation and service. The lower gallery is the culvert for filling and emptying the lock chamber.

The land wall is 1.936 feet in length. This distance includes the upper and lower guide walls, each 600 feet long. The guide walls are founded on concrete piers spaced 20 f'eet center to center, and ranging from 16 to 27 feet high. This construction is less cost]y than a solid retaining wall. and serves as adequately in guiding tows into the lock.



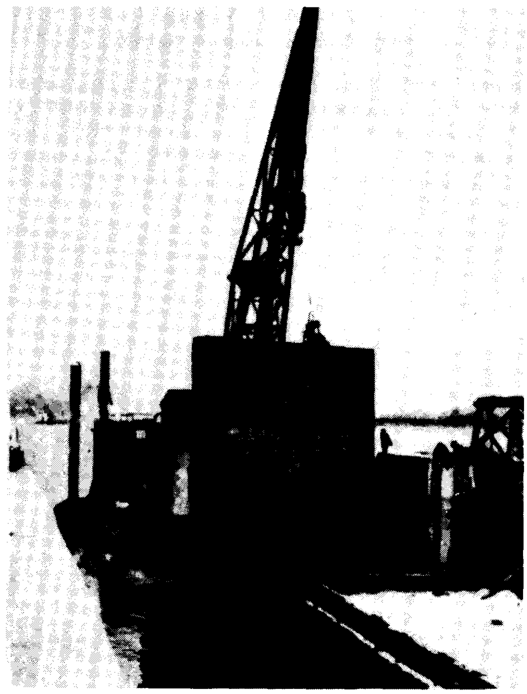
View of Part of the Dam

The middle wall, separating the two lock chambers. is 973 feet in length.

The river wall, 1,239 feet long, is made up of an upper guard wall 356 feet long, a lock wall proper, and a lower guard wall, 283 feet in length. The guard walls, like the guide walls, are also founded on concrete piers approximately 27 feet high, similarly spaced 20 feet center to center. The upper guard wall prevents tows in the upper approach from being swept out over the dam, while the lower guard wall protects a tow in the lower approach from the disturbing currents immediately below the dam.

The width Of base of the walls is 24 feet in the lock walls proper, and 13 feet in the guide and guard walls. The lock faces of all walls are vertical, while the outer faces are battered to give a width of top of 10 feet in the land and river lock walls. and of 5 feet in the guide and guard walls, except where extra space is required for houses, gate recesses, et cetera.

In order to protect the concrete walls from injury by scraping and battering of the present type of steel barges, slightly curved steel armor bands about 1 inch thick and 8 inches wide are embedded in the concrete along the walls where the greatest wear would be encountered. This armor is placed on the upper guide and guard walls beginning at approximately upper pool elevation, and on the lower guide and guard walls at and above lower pool elevation. On the chamber faces of the land and river walls, armor is placed beginning at lower pool elevation over the area extending approximately 50 feet downstream from the upper gate recesses and 50 feet upstream from the lower gate recesses. The upper and lower ends of the middle wall are similarly protected within the lock chamber. All vertical corners are armor protected.



Placing One of the Lower Lock Gates

The Lock Gates

The gates of both locks are of the structural steel mitering type. The upper gates are 27 feet, 7 inches high and the lower gates 40 feet, 10 inches high.

Each gate hangs vertically with its lower quoin end bearing on a pintle while its upper quoin end is held by a large pin. The pin plate is held by a pair of eye-bars (with sleeve-nut adjustment) anchored to the concrete. The gates, when mitered, bear upon the miter sill, a concrete structure founded on and keyed to rock. Guard sills are located a short distance up and downstream, respectively, from the upper and lower miter sills. These structures also act as emergency dam foundations. They are set at an elevation slightly higher than the miter sills, and serve to protect the latter from being struck and damaged by vessels, or protuberances projecting below the project draft allowance. These guard sills are of concrete, founded on and keyed to bed rock. The space between the upper guard and miter sills is filled and paved with 12 inches of concrete to elevation 676, or 14 feet below upper pool level.

The gates for the small lock are horizontally framed. The horizontal members, spaced vertically dependent on the head, are 24-inch, 80-pound I-beams framed to vertical quoin and miter beams of similar section. A diagonal eyebar extends from the upper end of the quoin beam to the lower end of the miter beam. The skin plate, $\frac{3}{8}$ inch thick in the upper sections and 7/16 inch in the lower, is attached on the upstream side. Oak timbers are bolted to the quoin and miter beams for seals. Five horizontal, rectangular, butterfly valves (16 inches by 3 feet, $9\frac{1}{2}$ inches) are placed in the lower end of each upper gate for flushing the lock chamber. Eight-inch oak fender timbers with sloped steel end castings are bolted to the downstream faces, to protect the gate, when open and in the gate recesses, against tows entering and leaving the lock.

The gates for the large lock are of the vertically framed type. Two vertical 48-inch girders, in addition to the 48-inch quoin and miter girders, divide the gate into three sections, each of which is strengthened by a pair of diagonal tension bars and three additional vertical 24-inch I-beams at 4 feet, 10 inches, center to center spacing. When the gates are mitered, the stresses from these vertical members are transmitted through the top girder, a 72-inch built-up section, to the lock walls, and through a 48-inch bottom girder to the miter sill.

Special provisions are necessary in the construction of the miter sill for the large gates. The miter sill is anchored by $1\frac{3}{4}$-inch bars, which extend through the concrete sill foundation $7\frac{1}{2}$ feet into bed rock, in which they are grouted under pressure. After the concrete in the sill foundation has set, and before the sill is finally placed, the anchor rods, which are inclosed in a 3-inch pipe, are subjected to a unit tensile stress of 20,000 pounds per square inch by tightening on the upper sleeve nuts. The rods are then grouted in the 3-inch pipe and the sill placed. Were this not done, cracks would develop in the concrete miter sill due to the elastic deformation (in excess of $\frac{1}{8}$ inch) of the rods in the development of their stress.

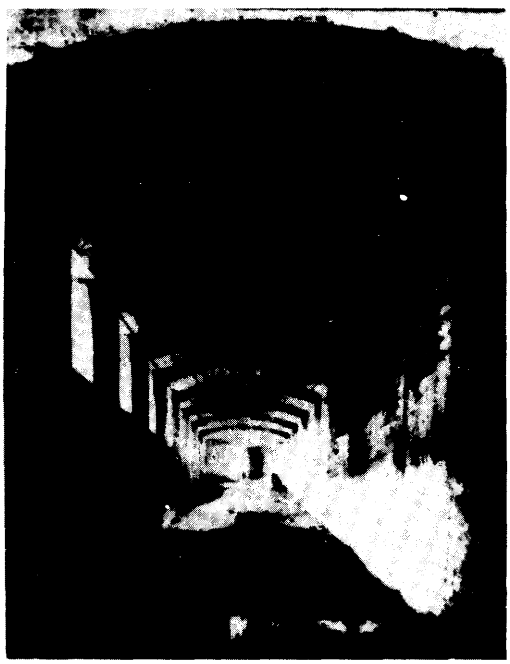
The pintle upon which this gate swings is a 15-inch, semi-spherical nickel steel pin, set on a cast steel shoe. A phosphor bronze cup on the bottom of the gate bears upon this pintle.

Operation of the Lock

A longitudinal culvert system has been adopted in the Deadman Island Lock for the filling and emptying of the chambers. The culvert system had to be of ample size and capacity in order to fill or empty the locks (the larger one 110 by 600 feet being about 1½ acres in area with a normal lift of 13.75 feet) in a minimum of time. Other essentials were that it should equalize the water levels above and below the gates with a minimum disturbance of water in the chamber and the approaches during filling and emptying, and that the system of valves should be reliable, durable, and easily accessible for repair.

The culverts for the operation of the 110-foot lock extend through the land and middle walls while that for operation of the small lock extends through the river wall. Through the walls at the head of each culvert is a series of screened openings, 5 feet square, which taper to 4 feet square as they enter the culvert. The culvert is of sufficient size and structural shape to carry the water through the wall. A large butterfly valve near the head of the culvert below the intakes controls the inflow. A series of similar 3- by 4-foot openings, tapering out to 4 by 5 feet branch off from this culvert into the lock chamber. The culvert diminishes in size toward the center of the chamber as its flow capacity decreases. As the culvert approaches the lower end of the lock wall, it tapers out again to the same size it had at the upper entrance. Here it has a similar butterfly valve and a series of openings branching out from it into the lower lock approaches. The openings are all below draft line. The whole system is designed to fill and empty the lock with a minimum turbulence to water and disturbance to craft in the chamber and approaches. This system will fill or empty the lock in five and one-half minutes.

The valves in the large as well as in the smaller culvert are of the structural steel butterfly type operating on a horizontal axis. They operate on cast steel axles rotating on phosphor bronze removable bearings keyed to cast iron frames embedded in the concrete culvert. The smaller size, 10 by 12 feet, is identical with that installed in Locks 6, 7, and 8, Monongahela River. With the large culvert, consideration was given to the Stoney type of valve, which is more usual in this size, but the butterfly type was adopted for the 13- by 14-foot, 10-inch, culvert also. It should prove more serviceable than one of the Stoney type because of the smaller number of moving parts subject to wear and corrosion.



The Longitudinal Culvert

Recesses for bulkheads with shafts extending to the top of the walls are provided in the culverts just above and below the valves. Thus this portion of the culvert may be pumped out and the valve repaired or removed and replaced through its shaft without obstruction to the lock chamber or approaches. Bearings may be easily replaced. With proper preparation, the replacement of a blade should be accomplished within a day.

A hydraulic system of oil pressure lines is used for the transmission of operating power throughout the lock. Such a system is unaffected by floods and is particularly suitable where large forces and slow motion are encountered. This oil pressure operates hydraulic cylinders at each gate and valve in both locks.

Each gate or valve is operated essentially by a valve controlled piston operating in a hydraulic oil cylinder. To the piston operating the gate is keyed a gear rack which, in turn, propels the gate by a linked mechanism operating on a geared sector. The valve is operated by a piston attached to a rocker arm, in combination with a vertical strut extending down the valve shaft. The link mechanism for the gate is so designed as to give maximum gate travel when minimum force is required and similarly maximum force at slow movement when it is required at the terminations of gate travel. Likewise, the rocker arm and strut for valve operation are designed to give the maximum force near the open position where such force is required with the butterfly valve. The rate and extent of movement of gate and valve are automatically controlled by the operation cylinders.

Control valves are provided on all three walls for several combinations of operation. Normal operation provides for operating both locks from the middle wall. The large lock may also be operated from the land wall and the small lock from the river wall.

The controls for the valves are located at the middle of each lock wall. The controls for the large lock gates are located just downstream and upstream respectively from the upper and lower gate recesses, while those for the small lock gates are located at their gate recesses. Thus the controls are arranged for maximum accessibility considering the requirement that the operator proceed to where he may check proper clearance for gate operation and non-interference of drift. The levers are arranged for simple and instinctive operation, being moved in the direction in which movement is desired. They are automatically locked when placed in the neutral position.

Pipe lines carry the pressure oil, service water, and air from the power houses. They extend from the power plants through inspection galleries above and paralleling the culverts to the facilities where the materials are used. The galleries are drained to lower pool, and are protected against all but highest floods. The pipes are carried on cast-iron brackets on the wall of the gallery. The main pipeline crossings of these lines across the lock chambers are effected through seven, 6-inch, cast-iron, lead-calked pipes, in a trench near the middle of the chambers. The trench is channeled through the bed rock, with small, 12-inch, concrete side protection walls rising to elevation 656.4 on either side. The crossings for the secondary 3-inch oil lines, for gate operation in the large lock, are in recess grooves down the gate recesses and in similar grooves in the miter sills. In the small lock, the oil lines for the gate operation are 2-inch lines in groove recesses down the gate recess and carried on small concrete piers across the lock chamber.

The Large Lock under Construction

The air lines carry air for the operation of air tools and appliances. The water lines serve particularly for flushing and cleaning out the detritus and deposit, left by floods, from the galleries and other parts of the structures.

Two power houses are provided—one for hydraulic power, and one for the standby plant.

The power houses are small, concrete structures of pleasing architectural appearance, located on the river and land walls on a line with the dam. In construction, provision will be made for expansion joints at each monolith to eliminate cracks from expansion.

The power house for water-power operation is located on the river wall. There are three turbines, the independent intakes of which open directly through the river wall into the upper pool. Bulkheads are provided in these intakes for unwatering the turbines for repairs. The power turbines are of the vertical open flume wicket gate type. Two of these turbines operate vertical triplex pumps giving 250 pounds pressure in the oil lines for lock operation. The third, through a vertical shaft and bevel gearing, operates a 25 k. w. d-c horizontal electric generator for power for lighting and operating electric facilities such as capstans. For heads of from 10 to 14 feet between upper and lower pools, either turbine will drive either pump. For heads less than this, both turbines may be connected to drive either pump. Duplication of plant and operation thus provides a reserve against breakdown or trouble.

The power obtained from one pump furnishes only half that required for normal-speed gate operation. An accumulator is provided in conjunction with each pump to furnish the additional power. The accumulator is nothing more than a weight loaded plunger working in a vertical cylinder. When oil pressure is applied underneath this plunger, the weights are raised to the top of the cylinder. Thereafter, until they rest on the bottom again, they will exert the operating pressure on the oil line. Eight air cushions are provided in each accumulator to check the fall of these weights. This accumulates and supplies 179 gallons of oil at 250 pounds pressure, the additional hydraulic displacement required for normal-speed gate-operation.

The entire operation of the turbines is automatic. When power is used, the turbine is brought into operation by the opening of the turbine gates. These are opened by automatic control as soon as the accumulator plunger starts down, through a hydraulically operated piston connected to the gate shaft by a differential gear. The range of gate travel is controlled by a hand-control screw. The turbine remains in operation all the time power is being used and until the accumulator is again filled, when it stops automatically. This power is transmitted to the gate- and valve-operating cylinders on both locks by the high pressure oil lines.

In addition to the oil pumps for the lock operation, there are facilities in the power house for compressing air. A vertical, duplex, single-acting air compressor for 100 pounds pressure is provided which may be operated by either turbine. There is one air tank for storage in this power house, and two in the basement of the Administration Building, on the middle wall.

A vertical triplex water pump which may be connected to either turbine is also located in the power house to furnish water supply to the lock.

As a further power reserve for use, when, for any reason, the turbines can not be operated, a vertical fire tube boiler with a horizontal, duplex, pot-valve, steam-operated plunger-pump is provided in the power plant located on the land wall. The pump will be equipped with a pressure governor to maintain even pressure in the lines. Inasmuch as this plant will be called into very occasional use only, a simple but rugged plant, devoid of refinements, and of low first cost, is used. This plant will be used for initial lock operation during the construction of the dam when no difference in head and hence no water power will be available. Thereafter, it will be used only when the difference in head gets below 6 feet, or when, for any reason, water power is unavailable.

Auxiliaries for water and electric power will also be provided as in the hydraulic plant. A steam-driven, vertical, simplex water pump and a 20 k. w. diesel engine d-c generator furnish these facilities. A 400-gallon oil tank affording a reserve storage of oil, and a work shop are provided in this power house.

The Administration Building is similar in structural appearance to the power houses. It is located on the middle wall where normal operation will be centered. The lockmaster's office, gages, shelter for operators, and storage for equipment and supplies necessary for operation are provided in this building. An air operated water pump furnishes its water supply.

The basement of this building embraces the pipe gallery in that section of the wall, and two large air receivers are emplaced in it for air storage in conjunction with the air compressors in the power plants. Coal is also stored here. A separate water-heating system is provided for each building.

Facilities must be made available in each lock for unwatering it for such repairs as may be required. Provisions for the necessary cofferdam are therefore made in the construction of each lock.

In the smaller lock, recesses are provided in the river and middle walls just upstream of the gate recesses and immediately above the upper guard sills, so that a girder may be placed across the top of the lock at this point. Timbers or needles may then be placed vertically, with their bottoms bearing against the upper guard sill, and their tops against this girder, to form an upper coffer. A foundation for a Poirée Dam of eleven trestles is provided just downstream of the lower gate. The foundation also serves as the lower guard sill for protecting the miter sill from damage by craft of excessive draft. The Poirée dam may be erected by placing steel trestles in the journal boxes, attaching wooden stringers to their downstream side and placing the needles in position. A lower cofferdam may thus be formed and the lock may be unwatered for any required repairs.

The span of the large lock is too great to permit the use of a simple girder as in the small lock. An emergency dam, consisting of a modified Boulée type of dam, is provided. The foundation therefor, which also acts as an upper guard sill to protect the upper miter sill, is located just above the upper gate recess.

The design is similar to that used at Emsworth Dam, except that here the trestles are raised in a direction parallel to the lock walls, whereas at Emsworth they are raised at right angles thereto. The recess for the end trestle, necessitated by the latter method, would interfere with the longitudinal type of culvert adopted. A recess in this location is also subject to severe damage from striking by tows.

There are ten trestles, each of which consists of two members, resting in a groove in the emergency dam foundation. A steel beam with its upstream end hinged to the foundation rests on a steel prop, the downstream end of which is similarly hinged. A chain attached to the free end of the prop passes through eyes in the middle and the free end of the beam. Each such trestle chain is attached by detachable clamps to the operating chain. As this chain is raised, it first raises the beam ahead of its normal raised position, while the prop slides up its under side until it reaches its seat. Light structural steel aprons, which are connected to the upper ends of adjoining trestles by pins, reinforce the structure laterally, and furnish a walkway for a bridge. A railing is also provided.

Two structural-steel derricks are provided to operate on either side of the lock in raising the trestles. The electric capstans will normally furnish the power for their operation.

The derricks are detachable and may be easily dismantled or reassembled. Recesses in the upper ends of the land and middle walls provide storage space above all but high floods for all the removable parts required for the emergency dam.

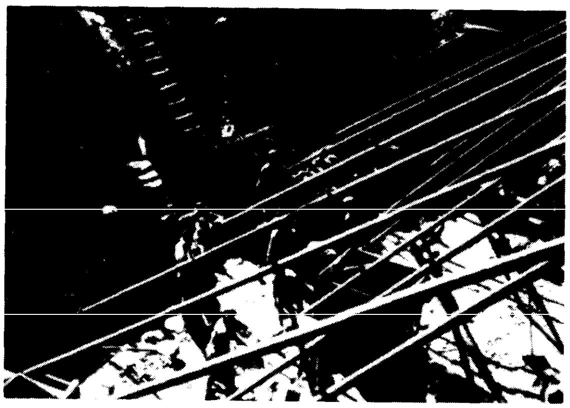
A means of propulsion for moving tows of barges in and out of the locks is desirable for rapid and efficient lock operation. This is provided by electric-driven capstans. One will be placed opposite the lower-gate recess on the middle wall, and two at the upper-gate recesses. The capstan at the upper end are also used for operating the emergency dam for the large lock.

A 3-foot guard fence is to be erected on the outer face of the river wall. This fence is detachable so that it may be removed easily prior to floods. It consists of 1½-inch, galvanized-iron posts, spaced 15 feet apart, to which are fastened two ½-inch, steel guy lines.

Check posts on the tops of the walls, and tiers of line hooks in the faces of the walls, are placed at short intervals through the lengths of both locks to facilitate mooring of tows at any place in the locks or approaches, at any stage, and for any type of craft. The posts consist of 7-inch, double, extra-strong, steel-capped pipe filled with a 2 to 1 grout.

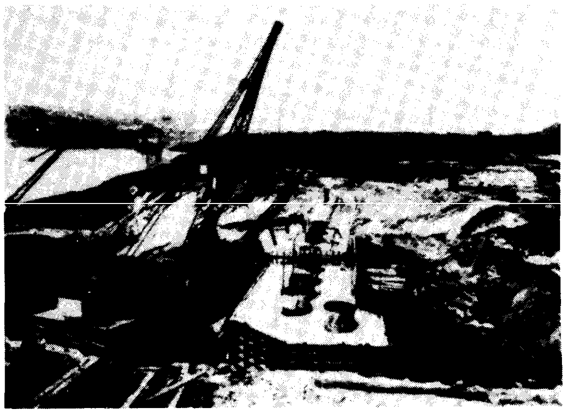
Ladders, consisting of steel bars placed in recesses and embedded in the concrete on either side, are provided at frequent locations where access from the walls to the water is desired. Similar bars, U-shaped and projecting from the concrete, are used for ladders in the shafts descending to the galleries. Such projections are not subject to striking, as would happen in a lock chamber.

The esplanade or space landward of the land wall, has been backfilled to elevation 705, and will be paved with 6- by 6-foot squares of 6-inch concrete over the area extending downstream from the emergency dam foundation to the Poirée dam of the large lock, and on the slope up the rail embankment to elevation 717, thereby preventing scour over this area in high water. A curtain of steel sheet piling is driven to bed rock at the upper end of the esplanade to prevent erosion by seepage. The areas up and downstream of the esplanade will be rip-rapped on slopes of 1 on 1½ and 7 on 11 respectively, to below pool levels.



Construction of the Upper Miter Sill

As an aid to navigation, for tows to tie to while awaiting their entrance into the lock, mooring posts are being installed at about 500-foot intervals on the left bank or lock side, upstream of the lock. These mooring posts consist of massive concrete anchorages (about 150 cubic yards of concrete), with a 6-inch check post embedded in their top. They are placed on a smooth curve at the new pool water line. At Emsworth and on the Monongahela, where similar ones have been placed, navigators have



Construction of the Abutment by the Caisson Method

found them particularly effective, especially in high water when the current is rapid.

Extensive dredging operations have had to be undertaken on this project. Not only did the upper and lower approaches to the locks have to be dredged, including the removal of much of Deadman Island in the lower approach, but a temporary construction channel, 500 feet wide, requiring 34,000 yards of excavation, had to be dredged and maintained between the lock and the dam cofferdams during the construction of the dam and prior to the completion of the lock, in order not to hinder navigation.

Dredging of the upper approach required approximately 107,000 yards over a distance of a third of a mile. This dredging was largely necessitated by the requirement that the locks be made available for operation prior to completion of the dam. This channel, therefore, had to be dredged to accomodate 9-foot navigation on lower pool elevation of Dam Number 4 (elevation 684.4), whereas new upper pool will be at 690. Because of the possibility of Dam Number 4 being down and pool elevation being lowered, this channel was dredged to elevation 674.0.

The lower approach, due to the proposed elimination of Dam Number 4, is being dredged to elevation 668.0, 12 feet below normal low pool. This will be dredged later to elevation 665 to provide a 9-foot depth under low-water elevation 674 existing when Dam Number 5 is lowered. This approach also encountered Deadman Island which added to its dredging requirements. It is estimated this dredging will total 225,000 yards. Dredging will be completed on or about August 1, 1929.

The 500-foot channel was dredged between the lock and the second dam cofferdam. (The dam is being built in successive cofferdams from the abutment side.) It is marked out by buoys and at night by lights. This is taking care of navigation at the present time and will continue to do so until the small lock is put into operation. Then it will be possible for the contractor on the dam to continue with his cofferdams across the river.

Notes on Construction of Lock

A box-type cofferdam embraced the entire work. The bulk of the fill used in the cofferdam was made up of material excavated in the wet by dredges and derrick-boats. A pump-boat housing five 12-inch, electrically-operated centrifugal pumps unwatered the coffer. It also pumped out after each recurrent flood, of which there were many.

Two 2-yard concrete mixers were set up within and at either end of the coffer. Construction sidings were built paralleling the railroad which passed the site and cement storage sheds were erected opposite the mixers and alongside these sidings. Cableways were erected from the cement sheds to the mixers. Sand and gravel were obtained locally in the river from a sand and gravel digger. Sand and gravel were charged into the mixers directly from the barges at each mixer by whirley-type derricks set up on the cofferdam. A reserve pile of sand and gravel was kept near the mixer inside the cofferdam for use when barges were not available.

The specifications for the concrete required for each yard: 5 bags of cement, 25 pounds hydrated lime, not less than 24 cubic feet of gravel, and sufficient sand to yield 15 per cent more mortar than was required to fill the voids of the gravel.

Tests were made frequently of the sand and gravel used. Based on the average of the tests, a mixture of 5 bags of cement to 11 cubic feet of sand and 24 cubic feet of gravel or 1:2.2:4.8 was used for the greater part of the job.

The water content was kept down to the minimum, consistent with getting a uniform plastic mass, and varied only with the type of form. It ranged from about 6 gallons per bag in the mass concrete up to about 7½ gallons in that used in slab or intricate form-work containing reinforcing, where extra workability was essential.

The concrete was transported in buckets carried on standard-gage flat cars propelled by gas locomotives. Whirleys, located at the point where the pour was being made, handled the bucket from the flat into the form. No concrete was allowed to be placed by chuting.

The excavation made in the dry was done by these whirleys as was the placing of forms. Eight whirleys were used during the height of the construction four operated in the large lock, three along the land wall, and one along the middle wall. Two operated in the small lock, and two were emplaced on the cofferdam tending the mixers.

The excavation of the lock chambers to final grades was left until the end of the job. Five dipper dredges were employed in removing the cofferdam and excavating both lock chambers to grade.

The inspection force on the job laid out the entire work, giving lines and grades for the contractor to follow. All metal-work was tested at the mills or shops, where made or fabricated, by the metal-works inspection force of the District Office. Sand, gravel, and such materials were inspected by the force on the job and mixing and placing of concrete were closely checked. Test cylinders of concrete pours were made about twice a week throughout the work.

The concrete tests showed up very well, the average crushing strength of twenty-eight-day cylinders ranging between 2,500 and 3,000 pounds per square inch.

A certain deviation from the plans had to be made in the upper guard and miter sills for the small lock. Inasmuch as this lock will have to be used by navigation prior to completion of the dam, which will result, for a long period, in an upper-pool elevation below the project normal pool of 691.5, it was considered necessary to lower these sills 4 feet. When the dam is completed, they will be raised to project elevation. Also a temporary superstructure had to be added to the top of the upper gates so that they could be hung from the pin plate anchorages 4 feet below their design elevation.

Lock Gates

The *Monallo*, a United States Engineer Department, 50-ton derrick-boat, was rented by the contractor for the placing of the small gates. Due to the current passing through the lock, an emergency dam first had to be erected by placing two large 12- by 18-inch timbers across the lock in the recess therefor, and placing 12- by 12-inch needles abutting on them and the guard sill. It was then a comparatively easy task for the *Monallo* to pick up one of the upper or lower gates, slung in a vertical position, proceed up the lock to the gate recess, and emplace the gate. A diver was used to clean out the pintle which had become filled with drift and deposit. He also checked the placing of the gate on the pintle. It is to be noted that these upper and lower gates for the small lock weigh, respectively, 34 and 45 tons.

Such a procedure with the large lock gates was impossible with the plant available. Instead, box cofferdams have been constructed, by the government, above the emergency dam and below the lower gate. The lock will be pumped out and the large gates will be erected in place.

As has been the usual procedure on all lock construction here, the pipe lines, operating machinery, and powerhouse equipment are being emplaced by hired labor. The personnel employed in the district for this work is skilled and experienced in these particular operations, since the same crew has emplaced practically all work of this type in recent years. Miscellaneous work, such as the emplacing of steel cover plates for recesses, erection of light poles and wiring, and bank protection involving paving of the esplanade will also be done by hired labor and government plant.

Deadman Island Dam

The dam is a monolithic, concrete, overflow, gravity section founded on rock. A comparatively level stratum of firm sandstone underlies the dam, varying between elevations 651 and 654.

The base, including the apron, is 60 feet wide. Beginning 8 feet from the upstream edge, an 8-foot key extends 5 feet into the rock foundation. The crestline of the dam is at elevation 690, thus requiring a dam almost 40 feet high. The apron, poured as an integral part of the dam, maintains an elevation of 657 the whole length of the dam.

The abutment is carried back some 160 feet into the right bank, which consists, at this point, of a high slag fill. The Pennsylvania Railroad has extended its property on this bank riverward by this slag fill to elevation 717. A great amount of excavation was required, therefore, in order to carry the abutment the necessary distance into the bank.

The abutment is an L-shaped structure, with a 154-foot river-arm starting 34 feet above the crestline of the dam, and an upstream arm carried back 72.5 feet from the dam into the bank. Expansion joints are provided where required in the abutment walls to prevent cracks from settlement, expansion, and contraction.

The river face of the abutment is keyed to rock by a 3- by 5-foot key. It rises to elevation 705. Five and one-half feet of the upstream abutment arm rests on rock, the remainder rising on a 1 on 1 slope, in steps of decreasing width to an extreme elevation of 717.5. The wall not on rock is carried on a pile foundation. A curtain of steel sheet piling beginning where the wall leaves rock is driven to refusal or to a maximum penetration of 30 feet.

An esplanade paving of 5- by 5-foot concrete squares 9 inches thick, with bituminous joints, extends from the upstream arm with a slight drainage grade riverward to 40 feet below the crestline of the dam. From here, a 3-foot paving of derrick stone extends downstream on a 1 on 2.33 slope to where it intersects a similar paving extending from the top of the abutment on a 1 on 1¼ slope.

It is believed that this type of abutment, tying the dam into the high bank encountered here, will effectively prevent any possibility of floods flanking the structure.

The Construction of the Dam

Work commenced with excavating in the wet by derrick-boats in the area of the first cofferdam. Efforts to remove by derrick-boats the slag fill in the area, which had to be excavated for the abutment, proved unsuccessful until a steam shovel was set up there. It loosened the material at a rapid rate so that, thereafter, the derrick-boats had no difficulty in picking it up for removal in scows or for use as fill for the cofferdam.

The type of cofferdam is of interest, inasmuch as it is the first of this type used in this area on river work. Steel interlocking sheet pile circles, 40 feet in diameter and 40 feet high, were driven to form the cofferdam. A wooden template was constructed for use as a guide for the driving of these circles. Four special T-connection piles were driven in each circle, spaced so as to furnish a pair of connections to tie to the adjoining circle at either side of the point of tangency. Thus, a double curtain wall could be driven to tie adjoining circles together. The circles and connections were then filled, and a berm thrown up on the outside of the entire cofferdam by the whirley type derrick-boats used on the job. A battery of two 15-inch, electric, centrifugal submerged-runner pumps was then set up and the cofferdam pumped out.

This type of cofferdam proved particularly effective where such a high coffer was required. A vertical face inside the coffer, which required no inner berm for strength and rigidity, gave the maximum working area with a minimum size cofferdam. The cofferdam was very tight and had a minimum of leakage. After floods, it was possible to unwater the cofferdam in ten hours with the two 15-inch pumps.

Work commenced on the abutment in cofferdam A and will continue in successive cofferdams across the river to connect with the lock. Sufficient 20-foot spillway openings will be left in the dam to pass high water so that it will not be necessary to flood the cofferdam at every little rise passing down the river.

Floating plant is being used for the construction of this job. All material and equipment are brought in by water. Cement is shipped in on sealed barges and sand and gravel are obtained locally. A mixer boat of 2 cubic yards capacity is used for the mixing of the concrete. Whirley type derrick-boats, supplemented by whirley derricks running on tracks on the upper and lower coffer arms, handle forms, excavation, materials, and concrete.

The construction of the abutment was interesting in that caissons were used. This is also an innovation on lock and dam construction in this district. Due to the danger of cave-ins from the huge fill rising 66 feet on three sides of the site of the abutment, the contractor felt it would be cheaper to construct the abutment by sinking reinforced concrete caissons rather than carry the excavation back as far as safety would require, or resort to heavy shoring. These plans were approved by the District Engineer under the condition that no increased payment would be made for additional material or operations required over that necessary under the original contract plans.

Two caissons were used with a 1-foot interval between them. The downstream caisson was a rectangular structure, 27 by 75 feet, and 30 feet high. The upstream caisson was also 27 feet wide and 30 feet high, but it was L-shaped so that it incorporated the base of the abutment within itself.

Each caisson had a steel chisel-shaped cutting edge and was strongly reinforced throughout. As the concrete was poured into it in successive horizontal pours, it sank into the sand and gravel bottom of its own weight. The sinking of both caissons was remarkably even throughout. Four circular openings, 7 feet in diameter, were left in the downstream caisson, and five in the upstream one. These were large enough for buckets to pass through to remove excavation from the chamber within the caisson. They were also adaptable for the application of bonnets to transform the caissons into pneumatic caissons, in the event it became necessary to work under air. Such a necessity did not occur however, as the caissons proved exceptionally tight. It was a comparatively easy matter to keep the chamber dry, by the occasional use of steam-siphon pumps. Working gangs within the chamber loosened material, where necessary, and moved it toward the center under the bucket openings, where the buckets removed it.

When the caissons had sunk 30 feet to bedrock elevation 654, the chamber was cleaned, a 3- by 5-foot key was channeled, and the chamber and cylindrical openings filled with concrete. Similarly the 1-foot gap between the caissons was also cleaned to rock and filled with concrete. The remainder of the abutment was then constructed upon the caisson base.

Progress in construction of the dam has been most satisfactory, considering the fact that work has been interrupted by nine floods, which have delayed the contract about a month and a half. Concrete is being poured on the dam in 42-foot monoliths. Three sets of forms, complete for each monolith, are being used for the entire job.

The complete installation at Deadman Island Lock and Dam will be representative of the most modern and efficient lock and dam development. It has been designed and constructed to take care of present and prospective Ohio River traffic. It will furnish a stable pool, with rapid and efficient lockages of tows through it, with minimum operation and maintenance difficulties and expense. It will give dependable navigation at minimum cost.

The Cofferdam under Construction

This view shows the first section of the cofferdam under construction. The circles are 40 feet in diameter and about 40 feet high. The connections between circles should be noted. The template used in driving is shown floating in the water near the pile driver.