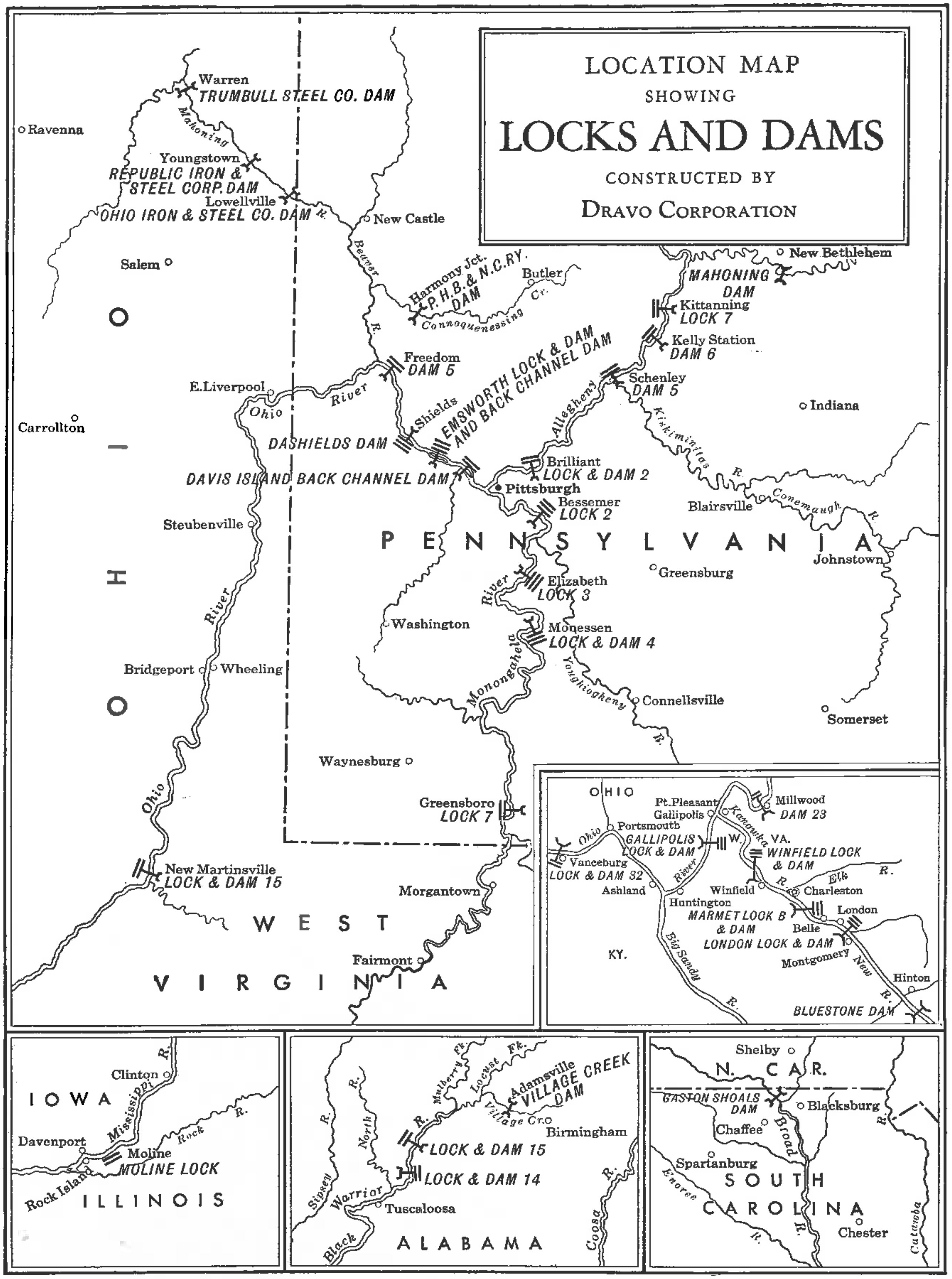
LOCKS AND DAMS

Bulletin No. 402-C
(Revised September, 1947)

DRAVO CORPORATION
THE CONTRACTING DIVISION
GENERAL OFFICES AND WORKS
PITTSBURGH, PA., U. S. A.


LOCATION MAP
SHOWING
LOCKS AND DAMS
CONSTRUCTED BY
DRAVO CORPORATION
Warren
TRUMBULL STEEL CO. DAM
Ravenna
Mahoning
Youngstown
REPUBLIC IRON & STEEL CORP. DAM
Lowellville
OHIO IRON & STEEL CO. DAM
New Castle
Salem
Beaver R.
Harmony Jct.
P.H.B. & N.C.RY. DAM
Butler
Connoquenessing Cr.
New Bethlehem
MAHONING DAM
Kittanning
LOCK 7
Kelly Station
DAM 6
Schenley
DAM 5
Freedom
DAM 5
EMSWORTH LOCK & DAM AND BACK CHANNEL DAM
Shields
E. Liverpool
Ohio River
Carrollton
DASHIELDS DAM
DAVIS ISLAND BACK CHANNEL DAM
Allegheny
Kiskiminitas R.
Indiana
Brilliant
LOCK & DAM 2
Pittsburgh
Bessemer
LOCK 2
Blairsville
Conemaugh R.
Steubenville
PENNSYLVANIA
Johnstown
Greensburg
Elizabeth
LOCK 3
River
Washington
Monessen
LOCK & DAM 4
Monongahela
Youghiogheny R.
Connellsville
Somerset
OHIO
River
Bridgeport
Wheeling
Waynesburg
Greensboro
LOCK 7
Ohio
New Martinsville
LOCK & DAM 15
Morgantown
WEST VIRGINIA
Fairmont
OHIO
Pt. Pleasant
Gallipolis
Millwood
DAM 23
Portsmouth
Kanawha
GALLIPOLIS LOCK & DAM
W. VA.
WINFIELD LOCK & DAM
Vanceburg
LOCK & DAM 32
Ashland
River
Winfield
Elk R.
Charleston
Huntington
London
MARMET LOCK & DAM
Belle
LONDON LOCK & DAM
KY.
Big Sandy R.
Montgomery
New R.
Hinton
BLUESTONE DAM
IOWA
Clinton
Mississippi R.
Davenport
Moline
Rock R.
MOLINE LOCK
Rock Island
ILLINOIS
Mulberry Fk.
Locust Fk.
Adamsville
VILLAGE CREEK DAM
Village Cr.
Birmingham
North R.
Sipsey R.
LOCK & DAM 15
LOCK & DAM 14
Warrior
Tuscaloosa
Black
Coosa R.
ALABAMA
Shelby
N. CAR.
GASTON SHOALS DAM
Blacksburg
Chaffee
Broad R.
Spartanburg
Enoree R.
SOUTH CAROLINA
Chester
Catawba R.

GENERAL OFFICES, WAREHOUSES AND NEVILLE ISLAND WORKS AT PITTSBURGH, PA.

Foreword...

DRAVO CORPORATION is the outgrowth of a company founded in 1891 and conducts its operations through four major divisions: The Contracting Division; Engineering Works Division; Machinery Division; and Keystone Division.

Through *The Contracting Division*, which carries out the heavy construction work of the corporation, the name Dravo has become closely associated with inland waterways development in the United States. After ten years of early experience in general construction, the Dravo Contracting Company, forerunner of the present Contracting Division, determined in 1901 to engage particularly in waterway construction. Since 1891 they have successfully completed under contract more than 2500 projects in the field of engineering construction. The Contracting Division specializes in the building of Locks and Dams, Bridges, Bridge Sub-structures, Shipways, Subways, Retaining Walls, Sea Walls, Pump Houses, Intakes, Wharves, Docks, heavy and difficult foundations, and similar projects. The character of the operations to be performed and the uncertainty of conditions encountered in this field of construction requires engineering skill of the highest order, adequate shop manufacturing facilities, large investments in land and floating equipment and an organization capable of anticipating and effectively meeting the exigencies that arise incident to such work.

The Contracting Division's *Shaft and Tunnel Department*, whose operations include pretreatment and consolidation of foundation strata through high pressure grouting, has completed over 375 separate projects. They played a major roll in the building of the Delaware Aqueduct project supplying fresh water to New York City; built important sections of the Valverde Aqueduct project in California; and have completed numerous shafts for the mining industry.

Engineering Works Division of Dravo Corporation designs, builds and maintains inland river and coastwise steel floating equipment, material handling installations, special service and heavy duty cranes, roller gates and lift gates for dams, lock gates, caissons and similar type structures. The main construction tools, equipment and standard and special purpose land and floating units required by The Contracting Division are supplied by Engineering Works Division. This division is also responsible for the design and fabrication of the steel floating caissons in which The Contracting Division specializes.

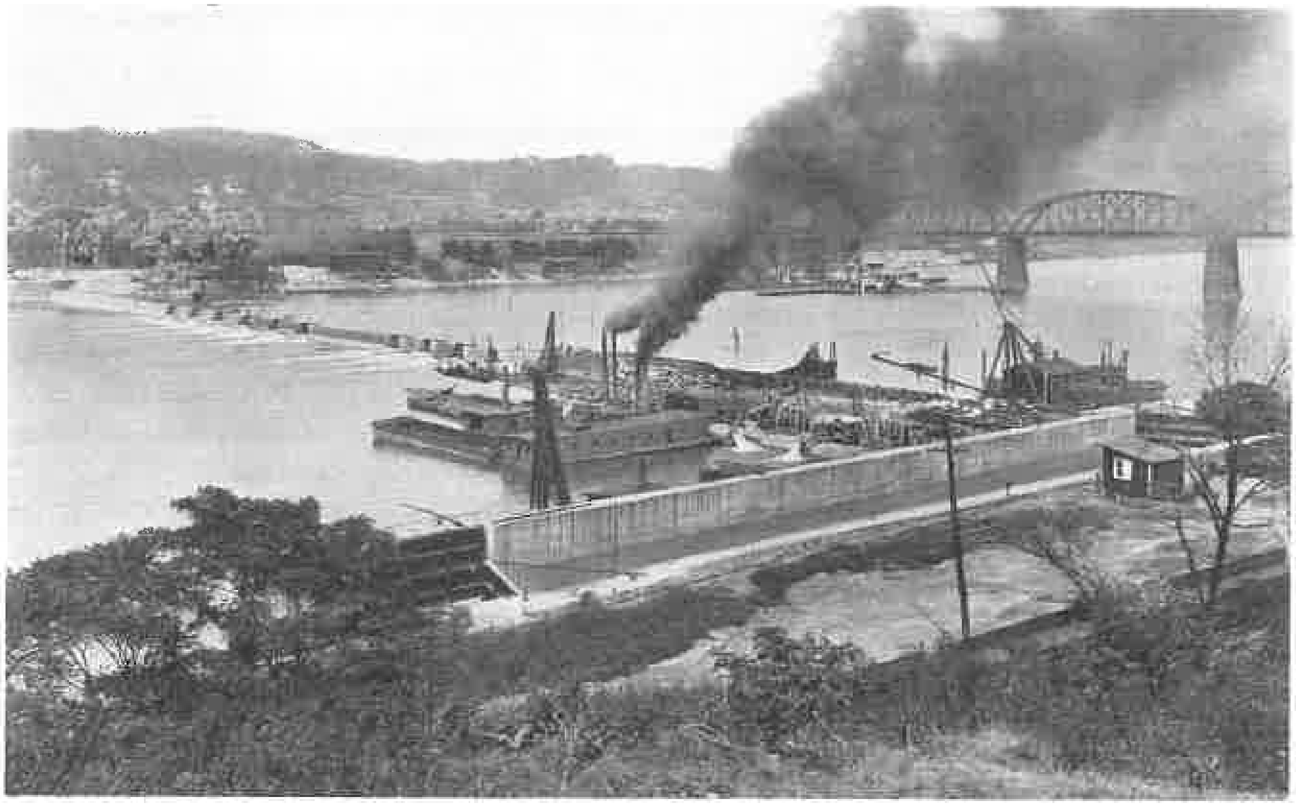
Machinery Division is concerned primarily with power, heating and pumping. They furnish and install heavy machinery and complete plants and represent many national manufacturers in those fields. Machinery Division also markets the Dravo Counterflo Direct Fired heater and the Dravo Crane Cab Cooler. They have built complete power plants, filtration plants, pump houses, sewage disposal plants, etc. for government bodies, for numerous municipalities and for many of the country's large industrial plants.

Keystone Division of Dravo Corporation is the largest producer and distributor of sand and gravel in the Pittsburgh area. Two modern dredges, which dig the sand and gravel from the river beds, also wash, sort and grade the aggregates. With a fleet of modern diesel towboats; centrally located land distributing plants; and a large fleet of batch trucks and mixer trucks Keystone Division is fully equipped to serve the Greater Pittsburgh area. This division also engages in contract towing and transportation in this same area.

Section of STORAGE YARD AT NEVILLE ISLAND.

Derrick Boats, Power and Shop Boat, Barges of Equipment and Materials and small Towboats enroute to start new construction operations.

DRAVO



First Dravo-built project for the Corps of Engineers, U. S. Army, was LOCK NO. 2, Allegheny River in 1902. Adjoining dam was a later contract completed by Dravo in 1908.

LOCKS AND DAMS

THE Locks and Dams constructed by our company have usually been units in the extensive program of the Corps of Engineers, U. S. Army, War Department, for canalization of the Inland Waterways; and are located principally in the Allegheny, Monongahela, Ohio Rivers and in the Great Kanawha River, a tributary of the Ohio. We have, however, constructed locks and dams for the Corps in the Black Warrior River, the Mississippi River and at other points at a considerable distance from our base. In addition to the projects built under Government contracts, our activities in this field include similar construction for private industry where dams were required in connection with power or water supply for steel, coal and railroad development, such as the

ELECTRIC MANUFACTURING & POWER COMPANY, SPARTANSBURG, S. C.—Hydro-Electric Plant—Main Gravity Type Dam 721′ long, 40′ high; and Power House Gravity Type Dam 479′ long, 60′ high, in Broad River.

OHIO IRON & STEEL COMPANY, YOUNGSTOWN, OHIO—Stop Log Dam, 198′ long, 10′ high, in Mahoning River.

PITTSBURGH, HARMONY, BUTLER & NEW CASTLE RAILWAY COMPANY, HARMONY JUNCTION, PA. Fixed Gravity Type Dam 153′ long, 11′ 3″ high, in Connoquenessing Creek.

REPUBLIC IRON & STEEL COMPANY, YOUNGSTOWN, OHIO—Fixed Dam 212′ long, 8′ high, in Mahoning River.

TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM, ALABAMA—Water Supply Dam, Gravity Type, 480′ long, 100′ high, in Village Creek, Adamsville, Alabama.

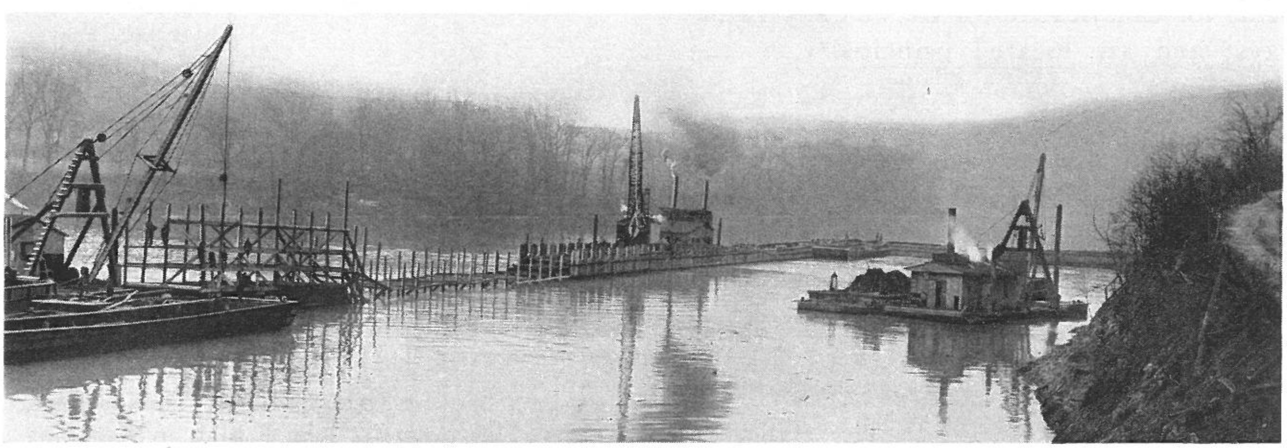
TRUMBULL STEEL COMPANY, WARREN, OHIO—Spillway Dam 120′ long, 12′ high, in Mahoning River.

Our record of approximately a half-century of building locks and dams for the Corps of Engineers challenges comparison. Our long experience in waterway construction is marked by the development of steel floating equipment and land plant for this class of work which is second to none in the United States. We have also initiated entirely new methods of constructing locks and dams, principally through the design and construction of various types of cofferdams and the use of steel floating caissons.

Cofferdams

THE type of cofferdam generally used in the early days of canalization of the Ohio River and its tributaries is known as the Ohio River Type box cofferdam. This cofferdam consisted of two rows of wood sheeting spaced 16′ to 20′ apart, with timber wales on the outside and held together with steel rods passing through the wales and sheeting.

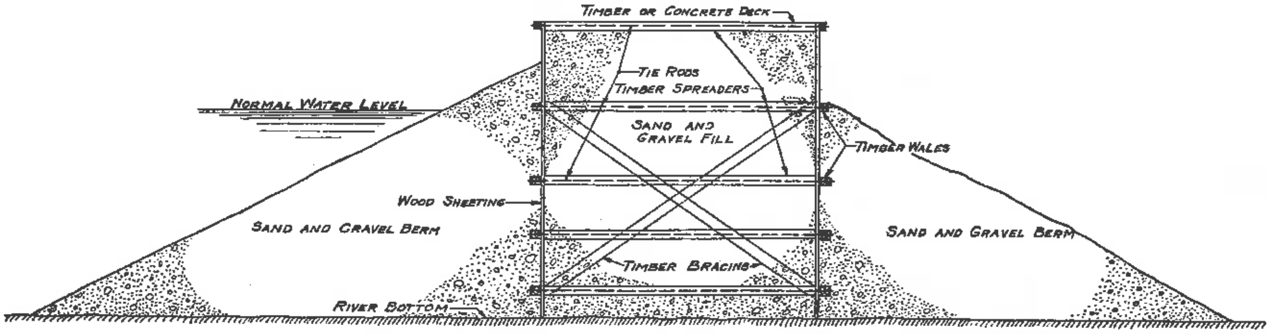
The first operation was to assemble on a barge a framework consisting of the wales, rods, spreaders and bracing, with one vertical sheet of planking at each tier of rods. As the barge was moved forward this structure was allowed to settle into place on the river bottom. The remaining space between the rods was then sheeted on each side with 2″ or 3″ planks resting on the river bottom—the size depending upon the depth of cofferdam. The cofferdam was filled immediately and as closely as possible to the top. A berm was then placed on both the inner and outer sides. Sand and gravel as dug from the river makes the best kind of fill and was ordinarily used. In most cases a decking was placed over the top composed of either 2″ plank or a layer



Building OHIO RIVER TYPE BOX COFFERDAM for Lock No. 7, Monongahela River.

of concrete 4″ to 6″ thick, to prevent washing out the coffer fill during high water periods, and it was often necessary to place riprap around the corners to prevent scour; inasmuch as stages of water up to 50′ can be expected to overtop a cofferdam in the Ohio River.

periods of 4 to 8 months during the high water season. The inconvenience and expense resulting from the maintenance of the land plant under such conditions led our company to experiment with improved types of cofferdams and special plant. These different types of cofferdams will be discussed in the following descriptions covering some of our lock and dam projects and will confirm our present practice of the almost universal use of steel sheet pile cofferdams for lock and dam construction.

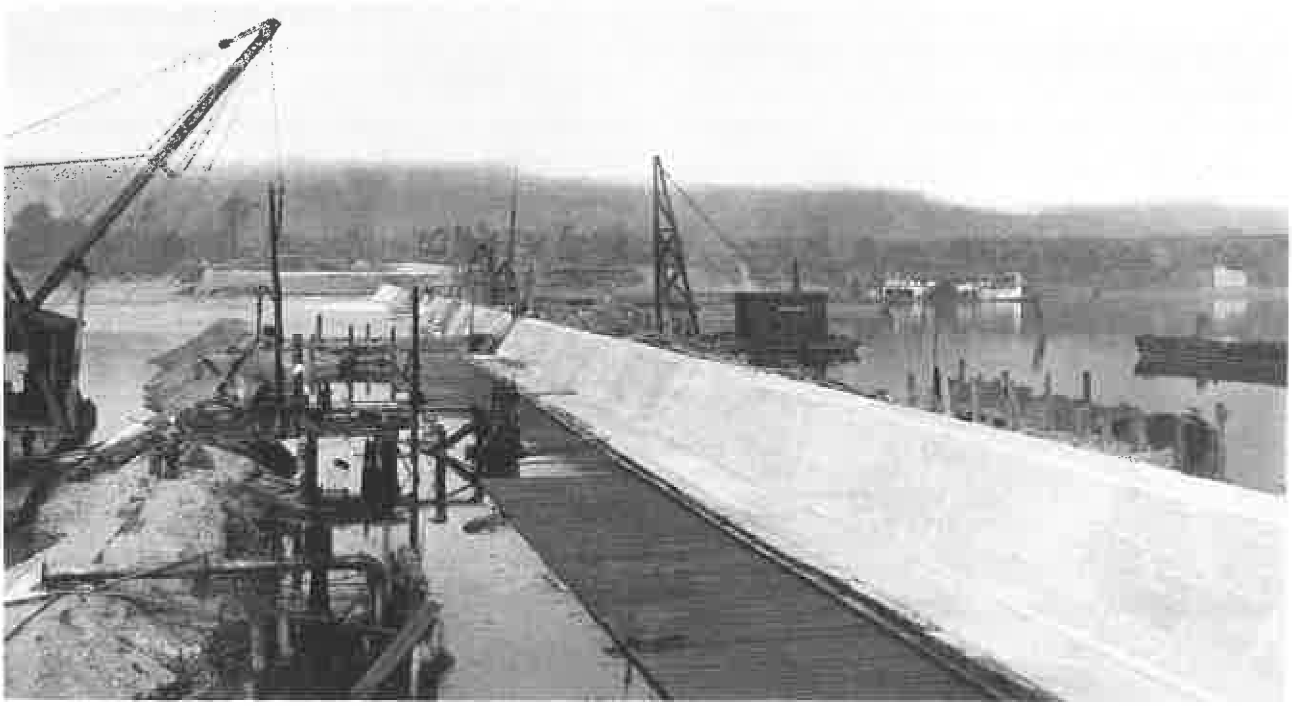


Typical Section through OHIO RIVER TYPE BOX COFFERDAM.

The Ohio River Type box cofferdam must of necessity be located a considerable distance from the enclosed work, and this distance between the inside of the cofferdam and the permanent structure varies with the character of the materials encountered. The material for the berm available in the vicinity of Pittsburgh will stand on a slope of 1 on 2 or 1 on 3, while in the lower reaches of the Ohio River a slope of 1 on 5 or 1 on 6 must be allowed, as the river bed contains less gravel and more sand further downstream. A cofferdam in the Pittsburgh District can therefore be located considerably closer to the permanent work than it could be in the region between Cairo, Ill., and Louisville, Ky.

The use of this type of cofferdam necessitates two kinds of plant on each job—floating plant for use on the outside and for the building of the cofferdam itself, and land plant for the work within the cofferdam. The land plant was very frequently submerged and in many instances was under water for

The year is 1920, the then modern MIXER BOAT NO. 4—Dravo designed and built.



Aspinwall (Pa.) Lock and Dam No. 2, Allegheny River

In December, 1902, we entered into our first lock and dam contract with the Corps of Engineers for the construction of Lock No. 2, Allegheny River—one of the first locks to be built of standard width for barge transportation with a chamber 56′ wide and 291′ long and with guide walls extending a distance of 645′. The lock walls were founded on rock and were constructed within an Ohio River Type box cofferdam.

It is interesting to recall the limitations of the available equipment in those early days, which proved the need for the development of specialized tools and an intensive study of cofferdam methods. The output from a small concrete mixer was handled on cars and pushed by hand, and at the end of the working season our plant was dismantled and stored. The lock was satisfactorily completed in January, 1905.

While in the interval between 1903 and 1907 we were awarded six other lock and dam projects, we returned in the latter year to our first location for the completion of Dam No. 2, Allegheny River—a project which had been started by another contractor.

The dam, 1,271′ 6″ long, was founded on wood piling, and was protected on the lower side by a wooden crib filled with riprap stone. The cofferdam was the Ohio River box type on the upper side and ends, and an earth berm on the lower side. As many as twelve pumps ranging from 8″ to 12″ were simultaneously required to unwater the closing section of cofferdam, although the depth of water did not exceed six or eight feet. This condition of excessive leakage may be expected in the Allegheny River inasmuch as the river bed consists mostly of coarse gravel with insufficient sand to fill the voids.

Repairs to Aspinwall (Pa.) Dam No. 2, Allegheny River

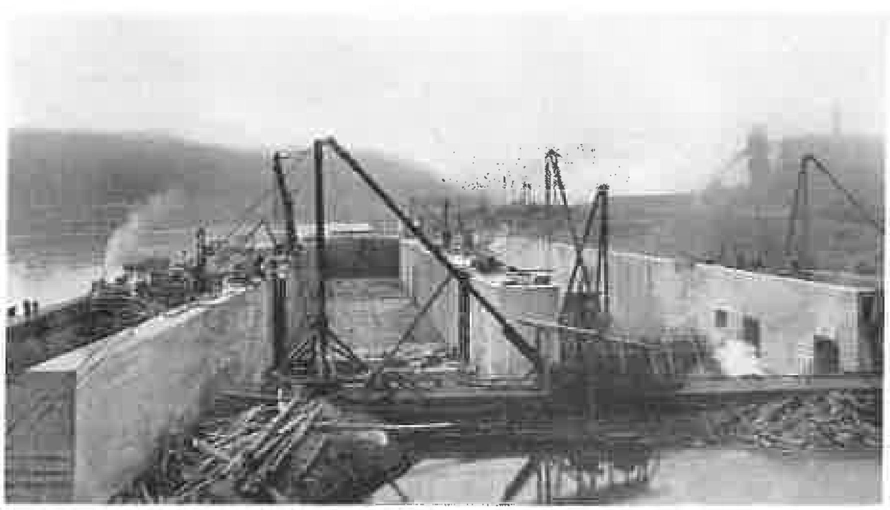
Ice pouring over the dam during the extreme winter of 1917-18 destroyed the crib protection below the dam and allowed the current to undercut and cause the failure of a 300′ section. The scouring extended to a depth of approximately 40′ below the lower pool. The Corps of Engineers filled the cut with heavy rock and we constructed a wooden crib on top of this rock fill and rebuilt the sections of dam during the Fall of 1918 and Spring of 1919.

The Back Channel Dam at Davis Island, Pittsburgh, Pa.

A view of the completed dam which was constructed in 1903 for the Corps of Engineers.

DAM No. 5, Ohio River, 24 miles below Pittsburgh, constructed for the Corps of Engineers, during 1905-1906-1907.

LOCK No. 3, Monongahela River. Twin locks each 56′ wide x 360′ long. Founded on rock and built in 1905-1906.



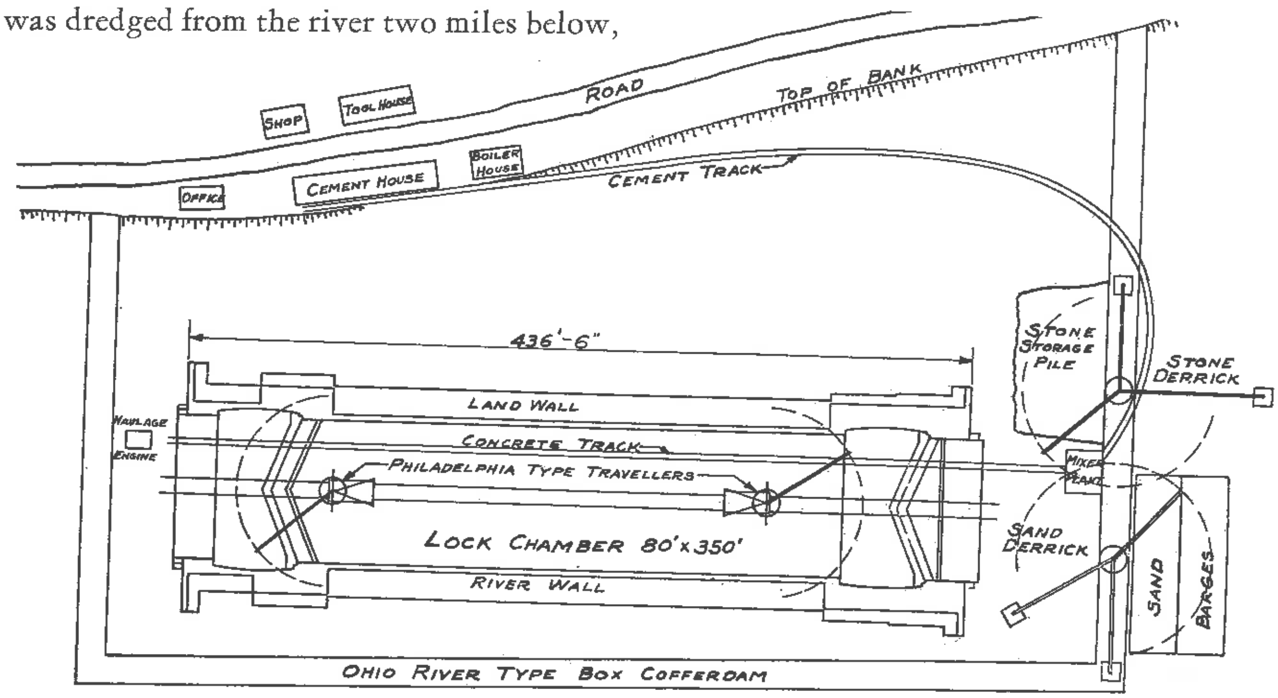
LOCK No. 2, Monongahela River. Twin locks each 56′ wide x 360′ long. Founded on wood piles and built in 1904-1905.

The Moline (Ill.) Lock, Mississippi River

THIS single chambered lock was built for the Corps of Engineers in 1906. It is 80′ x 350′ inside and has an over-all length of 448′ 6″, with foundations on bedrock, and provides an 8′ lift. Its construction enabled river transportation to take advantage of the slack water back of the existing wing dam, avoid two miles of rapids, and gave entrance to Moline Harbor.

The construction of a box type cofferdam was accomplished under difficulties. The outer wall of the cofferdam cut diagonally across the direction of flow in water ranging from 8′ to 12′ in depth with a 5 mile per hour current. Attempts to hold the cofferdam in position with anchors and with an anchored spud boat were unsuccessful. The problem was solved by drilling holes in the rock bottom and driving eyebolts into them. Wire lines were then clamped to these bolts and to the cofferdam. The fill for the cofferdam was dredged from the river two miles below, and was towed to the site on decked flat boats. In the absence of efficient derrick boats which were soon to be built, a traveling derrick was set up on an 18′ x 90′ hull and a clamshell bucket used to place the filling. Our contract included furnishing and erecting the miter gates which were of wood construction.

General View of operations.



PLANT LAYOUT for MOLINE LOCK, Mississippi River.

Locks and Dams Nos. 14 and 15, Black Warrior River, Alabama

LOCK AND DAM No. 14, Black Warrior River.

The contract for the construction of these locks and dams above Tuscaloosa, Alabama was awarded our company by the Corps of Engineers in 1907. The locks are identical in design, each 840′ in length, including guide walls, with foundations on rock. They are single chamber type, size 52′ x 283′ with two cut off walls 120′ and 90′ in length. The dams are of fixed type each having bases 24′ wide and abutment walls 125′ long. Dam No. 14 is 930′ long; Dam No. 15, 870′ long. Our contract included a lock tender house at each location.

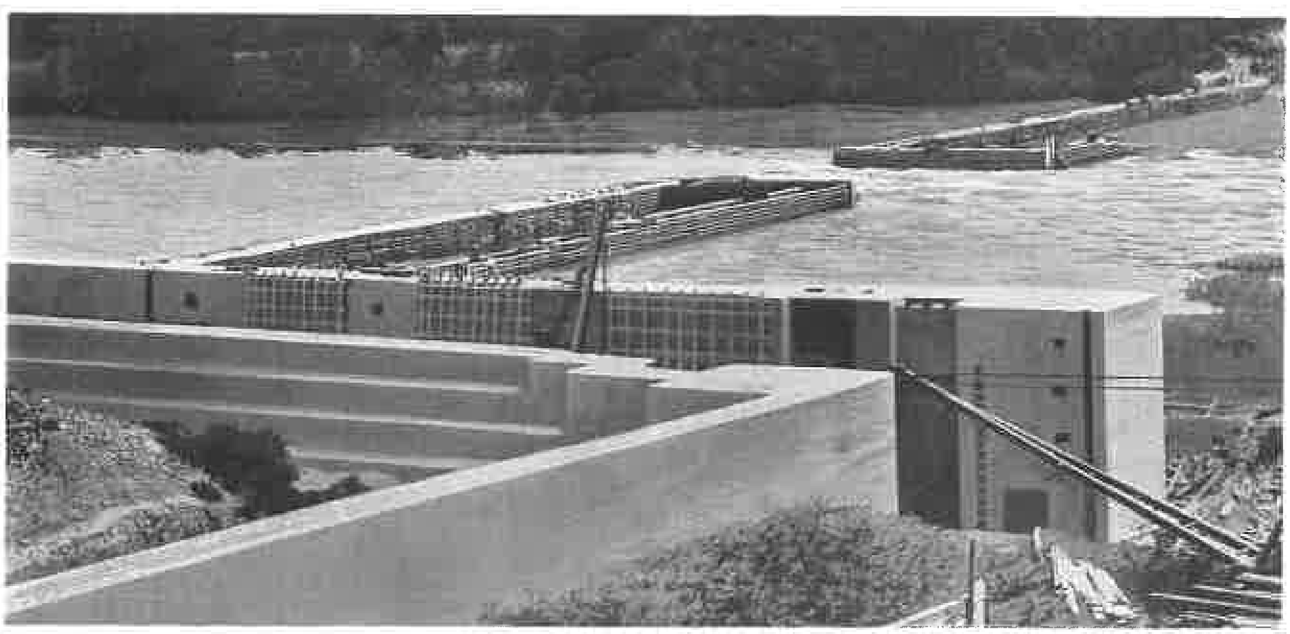
The cofferdams for these projects were designed by the Corps of Engineers and were a quite different type from those ordinarily used on the Ohio, Monongahela and Allegheny Rivers. They consisted of box cribs, made up of 6″ x 8″ timbers with the spaces between the timbers covered with 1″ x 12″ boards, placed longitudinally. The cribs were floated during their construction and built up, one section upon the other, until the bottom rested on rock. The cofferdam was then filled with earth and rock, and decked with 2″ plank.

In our later operations the cribs were filled mostly with rock and we depended on 1″ and 2″ vertical sheeting on the outside of the crib to cut off the water, thus permitting more accurate fitting of the sheeting to the irregular rock surface and affording a more stable and water-tight cofferdam than the design previously used.

These two dams were the first to be built in the Black Warrior River without constructing the closing section of the cofferdam higher than the crest of the dam. The dams have lifts of 14′ and each was constructed in three cofferdams—the first two in each case occupying slightly more than one-third of the distance from either shore toward the center of the river.

Gaps were provided in the completed portions to carry the flow of the river while work progressed on the closing sections. These gaps were 16′ wide and 12′ high and seven gaps were used at Dam No. 14 and six at Dam No. 15, and were closed by means of stop logs, it being necessary of course, to close those at Dam 14 last to avoid flooding the work at 15. A moderate river stage during the month of March, 1910, permitted the early closing of the gaps, and according to the record of Black Warrior River stages, not once in the previous twenty years had this river been sufficiently low to permit such work during March.

Equipment and materials were shipped by rail to Lock 14, but the absence of a railroad between this point and Lock 15 necessitated the adoption of water transportation to reach the latter job. A temporary low head dam was placed across the river at Lock 14. This dam was also utilized later as the upper arm of the cofferdam in the construction of Dam 14. A gasoline towboat and several wooden barges were constructed and launched above the temporary dam, and a narrow gauge track about one mile long was built down from the site of Lock 15 and past the rapids, and a temporary water to rail terminal was constructed for transporting cement, plant, lumber, coal and other supplies to Lock 15. On both jobs it was necessary to open quarries and install crusher plants to provide concrete aggregate and the larger stone embedded in the work. Sand dug from the river and crusher screenings were used as small aggregate for the 65,388 cu. yds. of concrete which were placed in the two projects.



LOCK AND DAM No. 15, Black Warrior River.

Village Creek Water Supply Dam
Adamsville, Alabama

THE Tennessee Coal, Iron & Railroad Company, Birmingham, Ala., awarded us the contract for the construction of this dam in 1910 as part of a reservoir project to insure adequate water supply for their steel mills. It is of gravity type having an over-all length of 480′ at the top, is 100′ high, and is keyed into bedrock. Our work covered 65,000 yards of concrete and masonry, including the facing of both sides with precast concrete blocks, and the placing of two revetments and two abutments for a bridge over the spillway.

A branch railroad was constructed to the site for delivery of materials, but plant and equipment were hauled by teams a distance of four miles over mud roads and erected to permit work being started prior to completion of the railroad. A very economical plant was constructed for the mixing of concrete. It was located at the bottom of a ravine with its two 2-cu. yd. mixers, sand and gravel bins and the cement house underneath the railroad trestle above, so that all materials travelled by gravity from the cars to the mixers. The concrete was transported over a narrow gauge track skirting the side of the hill from the mixers to a point under two cableways which rehandled it to the dam site and also handled the excavation and the concrete blocks which were cast in a yard nearby.

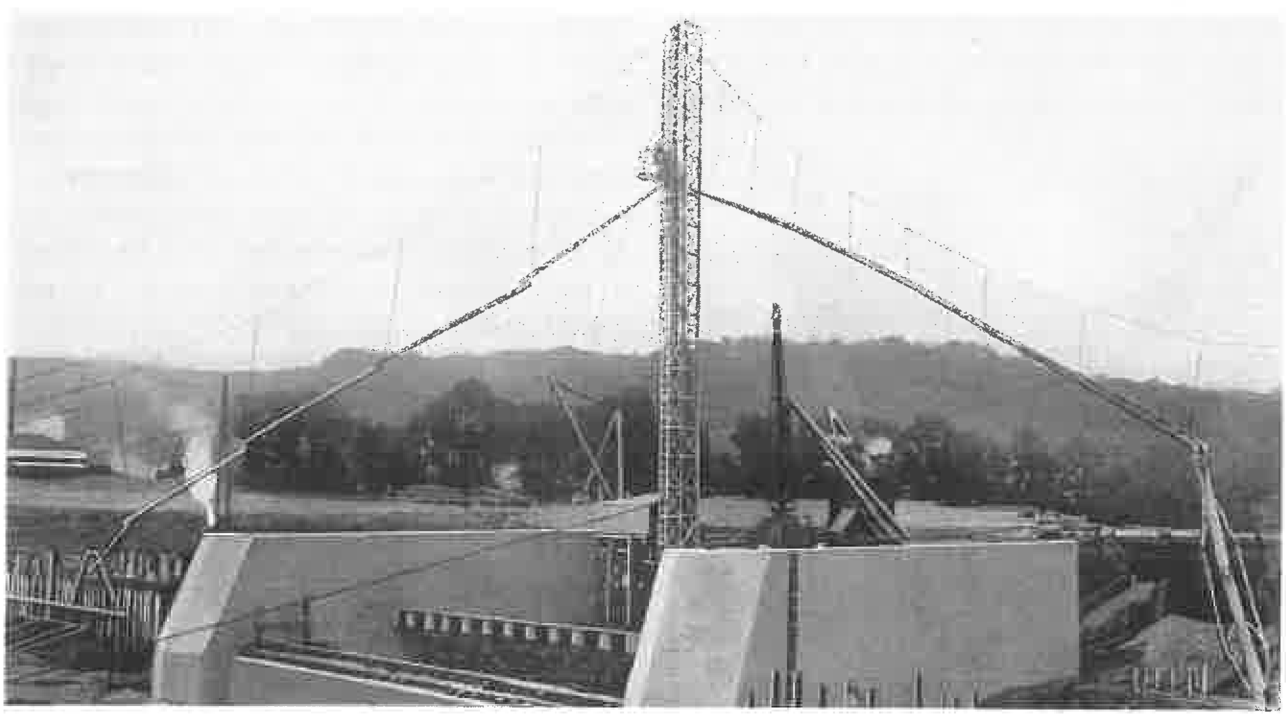
Four derricks were used for the placement of the materials. They were first set up in the bottom of the valley and later elevated on the sloping downstream face of the dam as the work progressed. A Dravo built whirler crane was also used in the block yard for the handling of forms and concrete. Other equipment consisted of a main boiler plant, compressor plant, and electric light plant. Due to the inaccessibility of the site, a complete camp was required for this project. Frequent runs of 1,200 cu. yds. of concrete were made in the two 10-hour shifts, and the dam was constructed in record time.

New Martinsville (W. Va.) Lock and Dam No. 15 Ohio River

We started work in 1911 on this typical Ohio River lock—size 110′ x 600′—and dam 1,028′ long, all founded on rock, using Ohio River Type box cofferdams as specified. The cofferdams for the lock and part of the dam were constructed the first season, but progress was slow, as we were flooded out eleven times during 1912. In March, 1913, the biggest flood ever known in the Ohio River at that point was experienced, and early autumnal rises further reduced our effective working season.

The job presented plant layout difficulties which would have been surmountable only at great expense if undertaken without the use of effective floating equipment. The railroad lies back upon the West Virginia side of the river while the lock is located on the Ohio side. A narrow gauge track was constructed from the railroad to the river, and all cement deliveries and part of the supplies were handled via this track to barges. We had our first experience here with high towers and chutes for the transportation and placing of concrete. Although since used to some extent, it is not our practice to employ high towers or long systems of chutes.

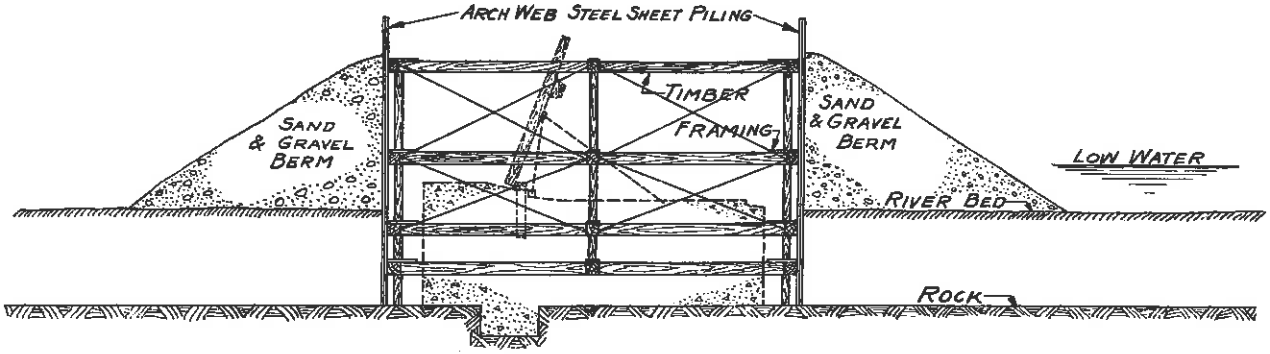
This work involved 193,913 cu. yds. of common excavation, 36,150 cu. yds. of back filling, 3,116 cu. yds. of riprap, 6,421 lin. ft. of round piling, 78,350 cu. yds. of concrete and 974,488 lbs. of structural and reinforcing steel, and was completed in October, 1914.



BEARTRAP PIERS at DAM No. 15, Ohio River.

Millwood (W. Va.) Dam No. 23, Ohio River

Revival of lock and dam construction after an interruption of the program of canalization during the World War, occurred in 1919 with the construction of Dam No. 23—a movable dam 1,012′ long, with foundations on rock at a maximum depth of 24′ below pool level.



TYPICAL SECTION through timber braced arch webbed STEEL SHEET PILE COFFERDAM.

The outstanding feature of this job was the use of steel sheet pile cofferdams, which method was adopted with full cognizance of the fact that two previous attempts had been made by contractors to construct river dams in steel sheet pile cofferdams, and in both instances the scheme was abandoned either during, or after construction of the first unit. We decided, however, that the successful use of this method lay in the effectiveness of the bracing of the cofferdam. Accordingly we designed a cofferdam using arch web steel piling, with an arrangement of timber sets, at sufficient frequency so that no difficulty was experienced in making this construction of adequate strength. The cofferdams were built in lengths of 160′ with an additional transition section of 16′, the first cofferdam being 176′ long and 42′ wide and the remaining units 160′ long. An interesting article on the stresses in this cofferdam will be found in the "Engineering News-Record" dated June 15, 1922.

Typical WHIRLER BOAT—of Dravo design and construction.

While good progress was made during the Summer of 1919, our Fall and Winter operations were not without the usual difficulties, being flooded out nine times. However, by taking advantage of the short periods of available working days, and by having our complete fleet of floating equipment continuously on hand, the beginning of 1920 found us on our third cofferdam in about the middle of the river.

To illustrate the effectiveness of the steel pile cofferdam, it may be mentioned that one of the river raises completely filled the cofferdam with chunks of ice of such size as to test the capacity of a ten-ton Dravo whirler boat, and twice the coffer was half filled with river deposit which had to be excavated. Yet the steel pile cofferdams held through all of this buffeting.

The paramount advantage of the steel pile cofferdam, apart from its stability, is the absence of working plant within its area, and in this instance floating equipment was used almost exclusively. When a flood was forecast, derrick boats, mixer boat and all other floating plant were taken to shore and tied up safely at the bank. When the flood subsided, the plant was quickly moved to the coffer where the pumps soon had the water down to a level which would permit work being resumed.

The advantage of our floating equipment on this job was notable. Three Dravo derrick boats handled the excavation, piles, timbers and forms. The concrete was mixed and placed with a Dravo built mixer boat. Another barge carried a power plant consisting

ICE JAM during construction period.

of four 70 horsepower locomotive boilers and a repair shop. All units were easily and quickly available for any part of the work. In the yard a five-ton Dravo whirler crane handled supplies, and near the river a 10-ton whirler crane transferred materials and supplies from railroad to barge.

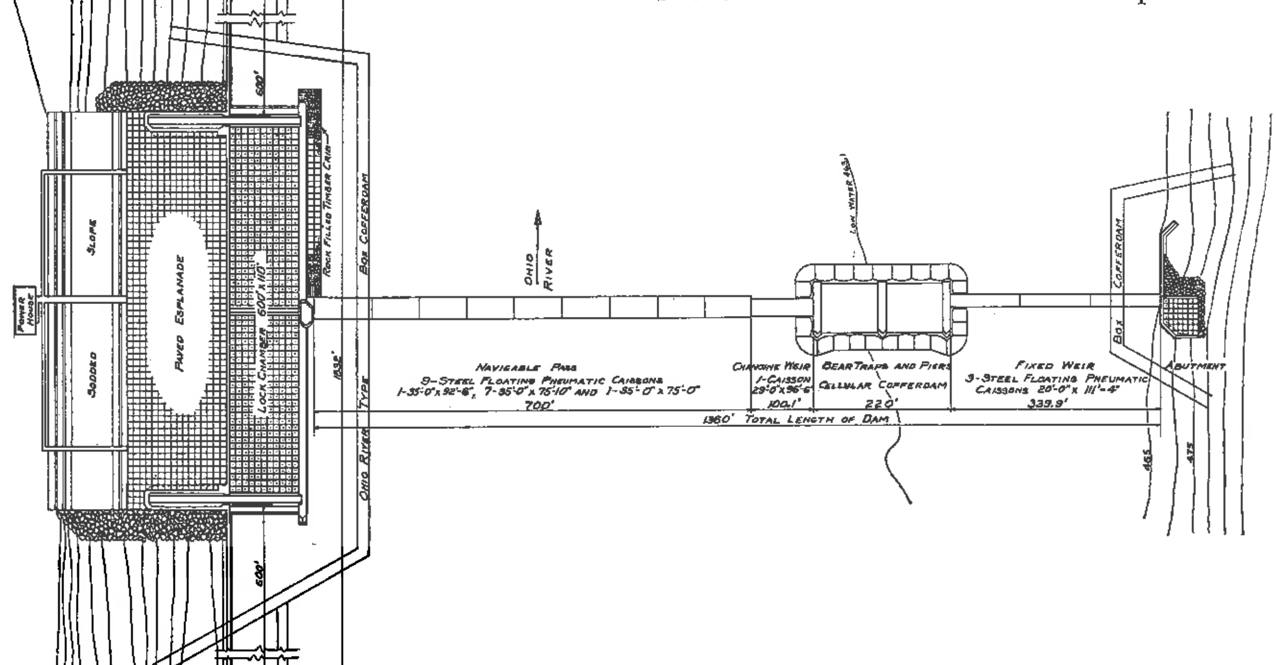
Thus the steel pile cofferdam, together with the availability of adequate floating equipment, for the first time proved conclusively its superiority over Ohio River type box cofferdams for dam construction.

BUILDING COFFERDAM and Excavating for DAM No. 23, Ohio River.

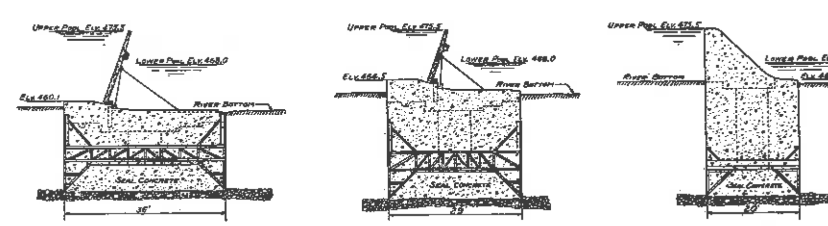
Vanceburg (Ky.) Lock and Dam No. 32 Ohio River

Although the work was awarded to us in 1919 and 1922 as two separate contracts, it was carried out as one continuous job for the Corps of Engineers. The lock is located on the Kentucky side of the river and the lock chamber is 110′ by 600′ with the total length 1,857′ including guide walls. The length of the dam is 1,360′ from river wall to face of the abutment. The lock was constructed in a typical Ohio River Type box cofferdam and was founded on wood piles driven to refusal. A total of 39,060 lin. ft. of wood piling were driven. The floor of the lock was paved with an 18″ concrete slab divided in 10′ square sections.

For locks and dams built in the lower section of the Ohio River, scarcely more than a four months working season can be expected. Our work was started in July, 1919 but continuous rains and floods prevented



GENERAL LAYOUT OF CAISSONS AND COFFERDAMS

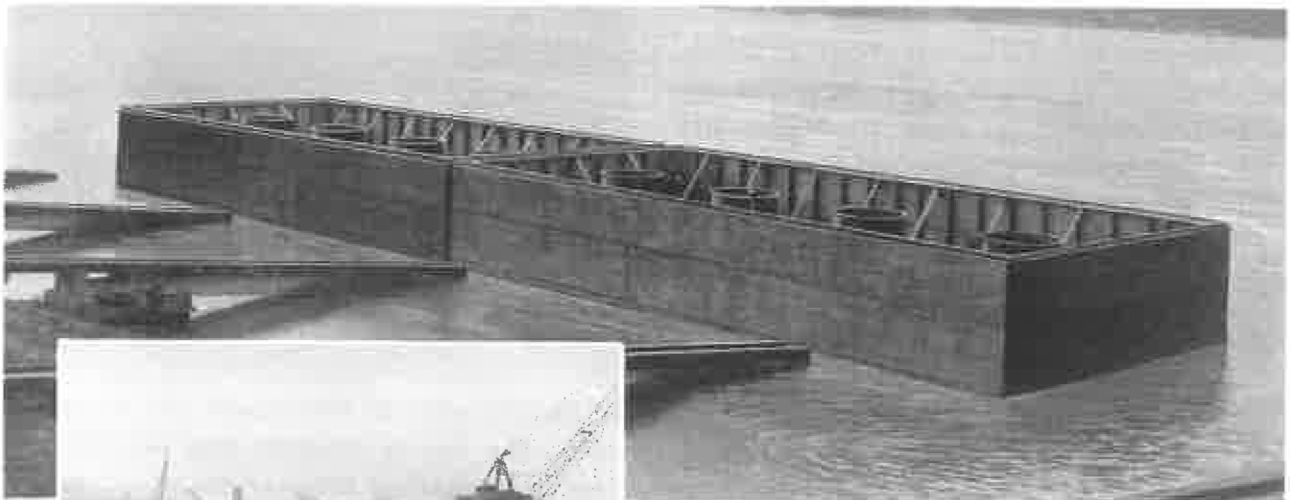


Navigable Pass — Chanoine Weir — Fixed Weir

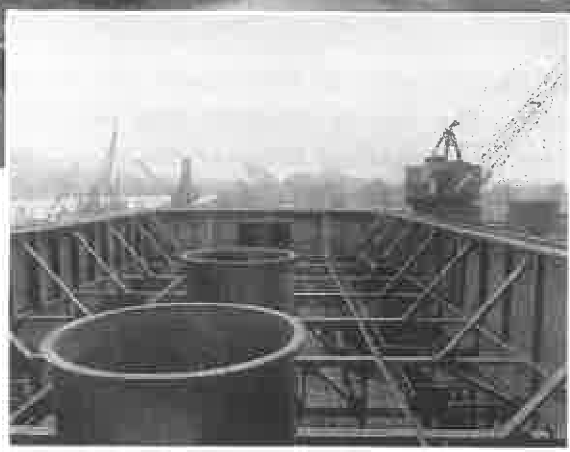
TYPICAL SECTIONS OF DAM

any progress except the building of the cofferdam that year, and not until August, 1920, were we able to start the actual placing of concrete. The job was again tied up by high water in November, the lock being only about

means of pneumatic caissons. The Corps of Engineers reviewed our caisson methods, which had been well tested on previous work and thereafter awarded the contract to us on this basis.



STEEL FLOATING CAISSONS launched at our Neville Island Yards for DAM No. 32, Ohio River.



Interior View of STEEL FLOATING CAISSON.

half completed. The cofferdams were pumped out twice in May, 1921, only to be flooded immediately; but in June they were dewatered for the season and concrete operations started. Despite several floods during the Fall and Winter, the lock and the abutment for the dam were completed by February, 1922.

Before the removal of cofferdams and final cleanup of the lock operations, we were able to proceed with work on the dam, which is of the movable type. For this construction alternate bids were asked, one for the dam to be constructed on pile foundations and the other for foundations carried to rock by

Steel Floating Caissons

THIRTEEN pneumatic caissons of the steel floating type were designed, fabricated and assembled by our Engineering Works Division at Pittsburgh, and were towed to the dam site a distance of 372 miles. The following table gives the length of several sections of the dam, and the corresponding sizes of the caissons used in constructing its foundation:

Length of Dam Section	Size of Caissons Used	
Navigable Pass, 700′	35′ 0″ x 75′ 0″	1 caisson
	35′ 0″ x 75′ 10″	7 caissons
	35′ 0″ x 92′ 6″	1 caisson
Chanoine Weir, 100′	29′ 0″ x 96′ 6″	1 caisson
Fixed Weir, 340′	20′ 0″ x 111′ 4″	3 caissons

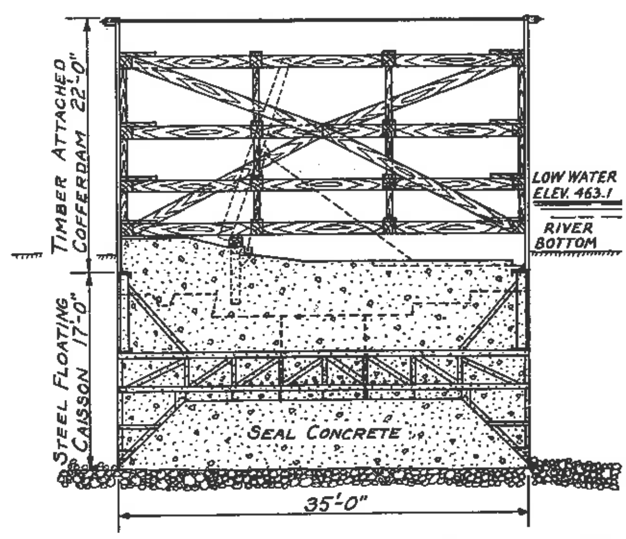
The first caisson sunk was adjacent to the river wall of the lock. Excavation within the caissons was done by open dredging with orange peel buckets until the caisson had been sunk to an elevation supposedly near rock. Air locks were then attached to the dredging tubes, compressed air was applied and the sinking continued through compact gravel and boulders until the cutting edge of the caisson reached a depth about 4′ below the elevation at which solid rock was expected to be found. At about 10′ below this grade, fire clay was encountered and borings indicated that it extended an additional depth of approximately 35′. In the absence of rock, the first two caissons were carried

SINKING CAISSONS at DAM No. 32, Ohio River.

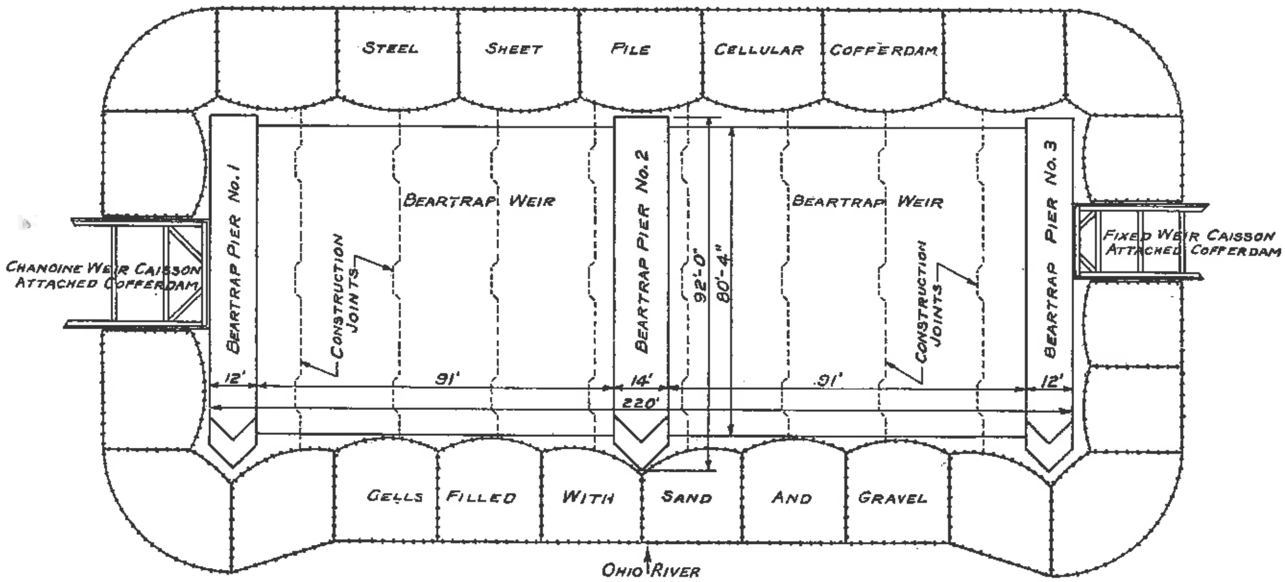
EXCAVATING CAISSON through Air Locks, DAM No. 32, Ohio River.

down to the fire clay strata and sealed. The Engineers then decided to stop the remaining caissons in the compact gravel, the elevation at which, according to the original borings, rock should have been found. Satisfactory protection of the dam foundations was secured by the deposit of riprap against the downstream side.

The two outside beartrap piers are 12′ wide, the middle pier 14′ and the distances between the piers is 91′. In the construction of foundations of the piers and beartrap weirs, the use of caissons was not practicable. The shallow foundations of the beartrap piers and the absence of rock upon which to found the caissons did not permit the addition of sufficient weight to the caissons to hold them in place while the beartraps were being constructed. We therefore, proposed the use of a cellular type steel pile



Section through Navigable Pass showing STEEL FLOATING CAISSON WITH ATTACHED COFFERDAM.

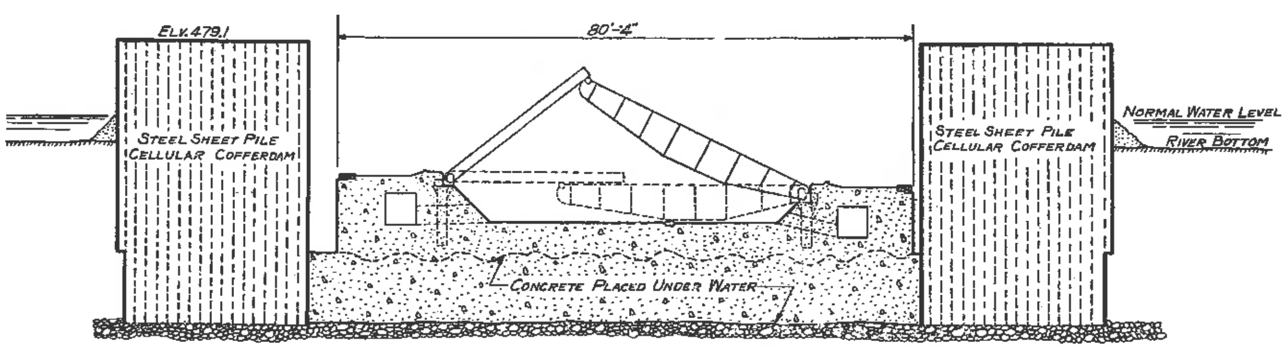


Plan of CELLULAR STEEL SHEET PILE COFFERDAM used for construction of Beartraps and Beartrap Piers at Dam No. 32, Ohio River.

cofferdam in which the bases of the beartrap piers and weirs were poured under water. By providing weep holes the floating of this base, or pad, was prevented when the cofferdam was later unwatered. This method proved eminently successful and the entire construction was completed in 1924.

The complete service of Dravo built equipment was the vital factor in the placement and concreting of the caisson units. A suction dredge produced the sand and gravel locally. Dravo whirler boats were used to handle forms and for general utility, while concrete was mixed and placed with a Dravo built mixer boat. The complete project involved the placement of 78,085 cu. yds. of concrete.

All the steelwork in connection with the beartraps was fabricated by our Engineering Works Division and expeditiously erected by their forces, exemplifying our complete facilities from a single source.



Section through Beartrap and CELLULAR TYPE COFFERDAM.

Emsworth Lock and Dam and Back Channel Dam, Ohio River

THE first fixed dam on the Ohio River was located at Emsworth, Pa. and provided a permanently navigable harbor for the Pittsburgh district. The river is divided at this point by Neville Island, and our contract with the Corps of Engineers comprised twin locks, a dam and abutment in the main channel and a dam and two abutments in the back channel. The two dams have since been reconstructed and operate as movable gate structures.

One lock chamber was 110′ x 600′ and the other 56′ x 360′. The river wall was 1,155′ long, the middle wall 862′, and the land wall 1,943′. These walls were, on the average, 24′ wide at the base and 51′ high, and were founded on bedrock. Three sections of Ohio River Type box cofferdam were employed in the construction of the lock. The dewatering of the cofferdam was facilitated by a Dravo built motor-driven pump boat—capacity 16,400 g.p.m. and first used on this job.

The large amount of rock excavation for the locks was handled with steam shovel, drag line excavator, and Dravo whirler cranes. A movable mixer was used for the placing of concrete in the land wall and middle wall, while for the river wall we used an all-steel floating mixer plant. This floating plant consisted of a steel whirler crane for handling materials, a 1½ cu. yd. mixer with bins and a 100′ tower in conjunction with a 150′ bridge carrying concrete chutes, thereby permitting concrete to be mixed *outside* of the cofferdam and chuted to the wall.

The main river dam at Emsworth was 1,000′ long and floating equipment was used almost entirely for this part of the work. A small portion of the dam was founded on rock, the remainder on wood piles within a rock-filled crib. For that section of the dam which was founded on piling, the method of procedure was by progressive sections. After

WINTER WORK at EMSWORTH LOCK.

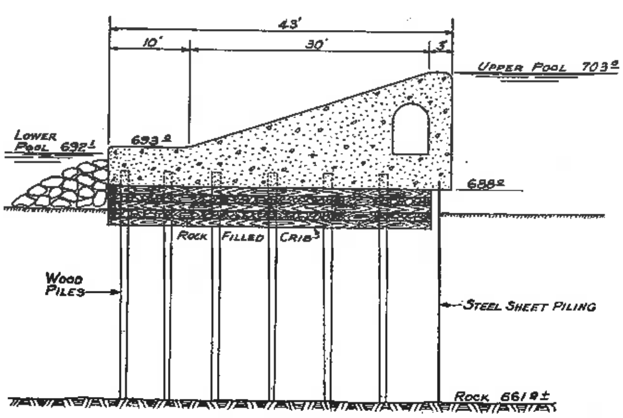
UNWATERING COFFERDAM after flood—EMSWORTH LOCK.

each section was excavated to grade, a crib base was floated to place and sunk, and wood piling was driven inside the crib to bedrock. A berm cofferdam was then thrown up around the crib base, the water pumped out, and concrete poured in the dry.

The back channel dam was 750′ long and involved the use of land plant consisting principally of Dravo whirlers.

The major work involved in the project—consisting of 90,760 cu. yds. of rock excavation, 139,572 cu. yds. of earth excavation, 126,265 cu. yds. of concrete and 5,243 lin. ft. of cofferdams, (lin. ft. of permanent work) was executed in the period 1919-1922.

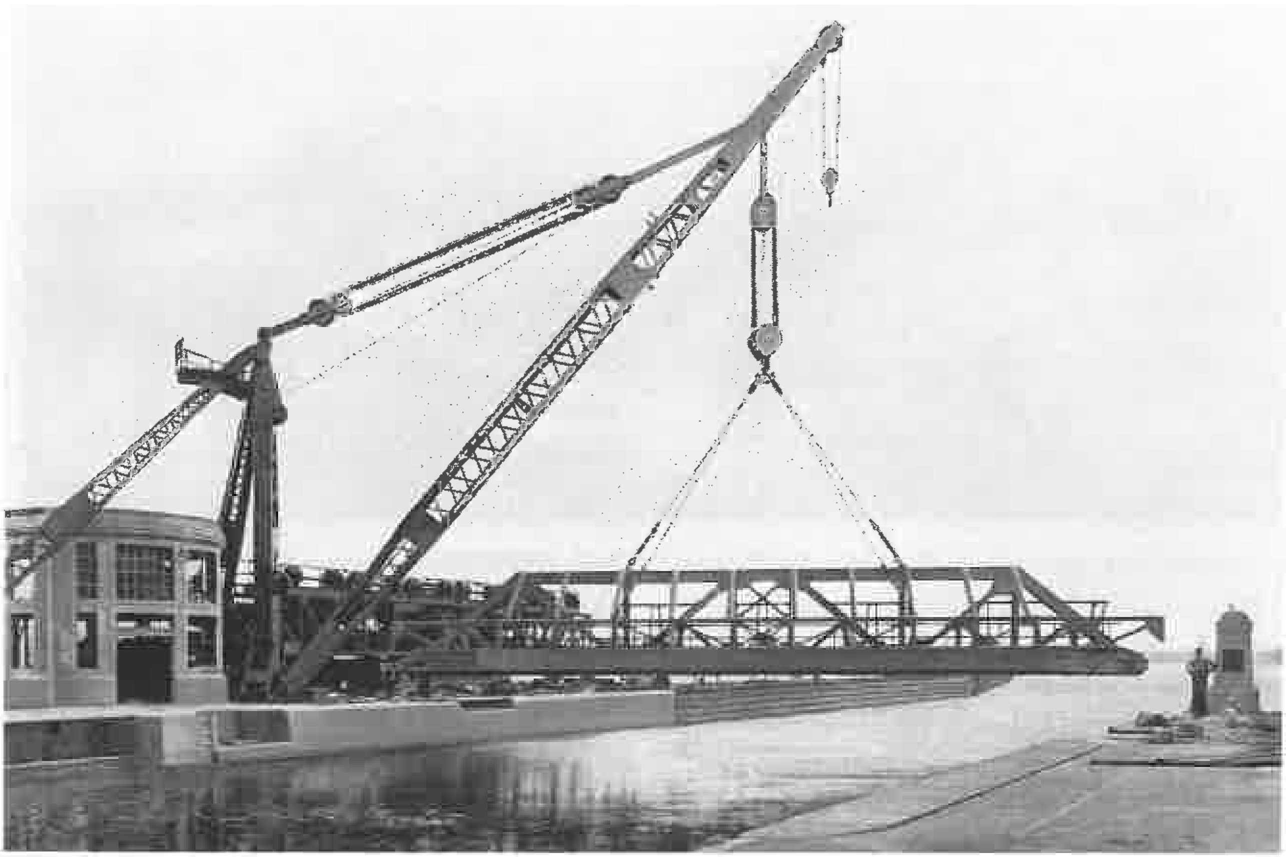
The gates for both the 56′ and 110′ locks, as well as the emergency dam, were built and erected by our Engineering Works Division under a separate contract. The gates which were of all-steel construction, except the timber protection fenders, were of the mitered type with the largest 58′ long and 37′ high, located on the lower end of the 110′ lock.



Section through EMSWORTH main channel dam.

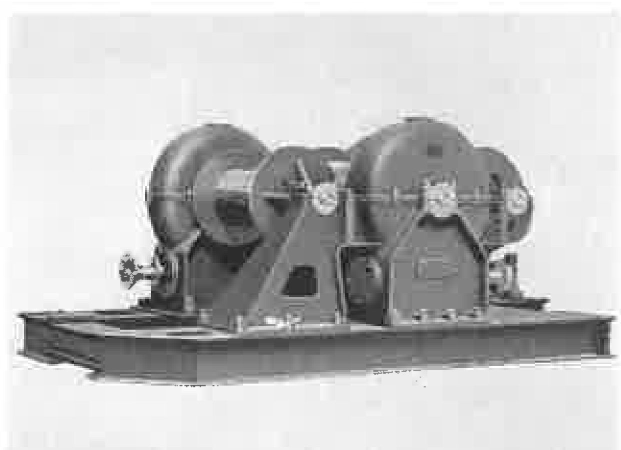
View from upper end of EMSWORTH LOCK.

Lake Washington Ship Canal, Seattle, Washington



THE LAKE WASHINGTON EMERGENCY DAM, including a 75-TON DERRICK for handling the complete structure, evidences the completeness of our service in the field of hydraulic engineering in its relation to lock and dam construction and the incidental works. The fabrication and installation was accomplished by our Engineering Works Division. The main derrick is equipped with a 90′ boom and has a capacity of 75 tons at a radius of 60′.

THE MAIN TRUSS—88′8″ long, 13′9″ high, weighing 45 tons.



100 H. P. HOISTING ENGINE—Dravo designed and built.

Monongahela River Lock No. 7

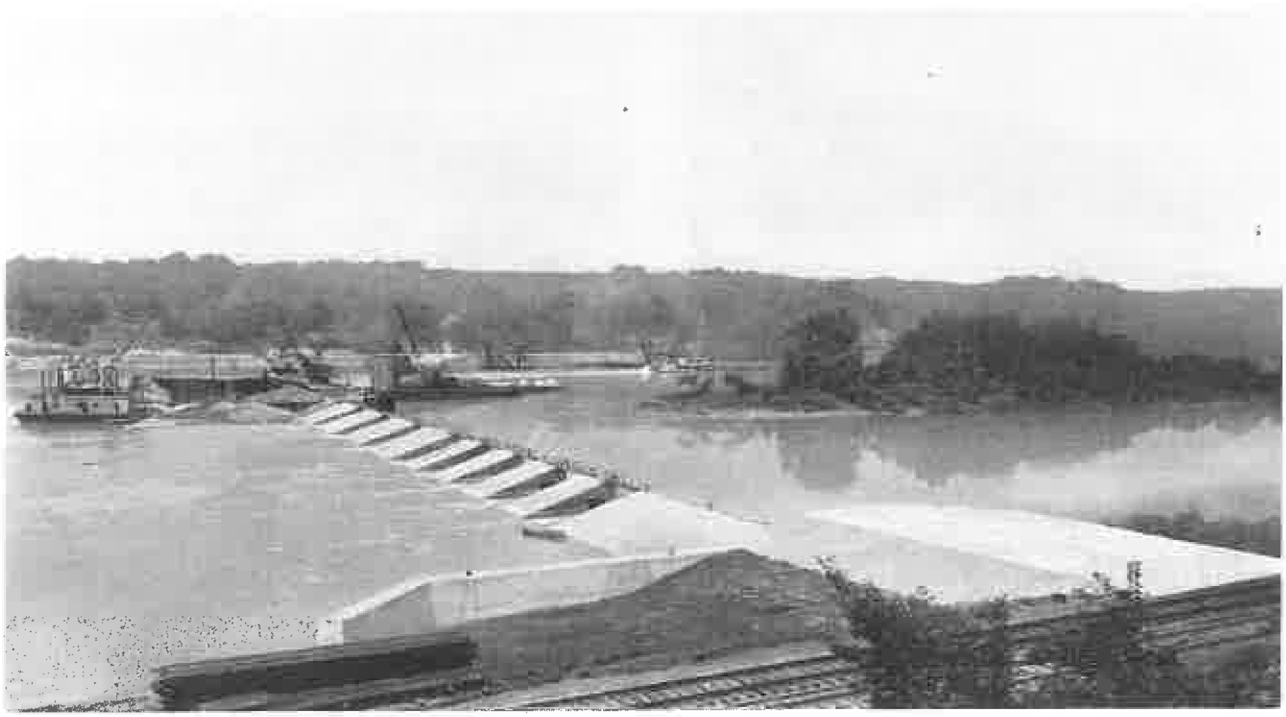
UNWATERING COFFERDAM AND EXCAVATION IN PROGRESS. Pump boat in foreground.

WALLS BEING BUILT IN ALTERNATE MONOLITHS. Floating mixer plant in background.

THE contract for the construction of Lock No. 7, Monongahela River was awarded to us by the Corps of Engineers in 1923 and consisted of a single chamber lock 56′ wide x 360′ long. With its foundations on rock, an Ohio River Type box cofferdam was used. The work inside of the lock was handled by means of Dravo whirlers and an all-steel floating mixer plant was used for mixing and placing the concrete.

GATES FOR LOCK No. 7, Monongahela River being assembled on Barges at our Neville Island plant. These gates of the mitering type, as well as the fixed metal work and the butterfly valves in connection with the project, were furnished by our Engineering Works Division.

Allegheny River Dams Nos. 5 and 6



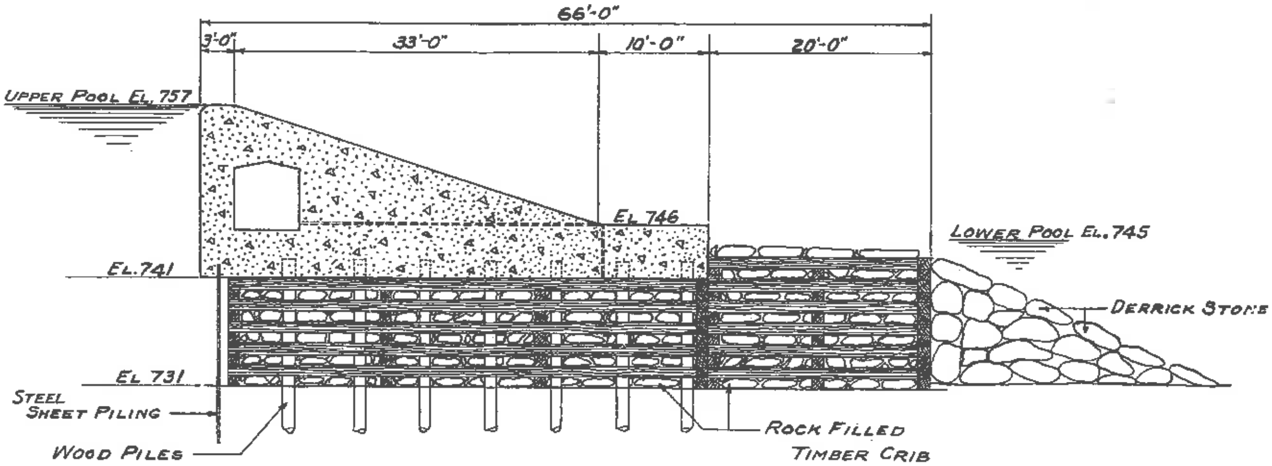
CONCRETING in second cofferdam, DAM No. 6, Allegheny River.

These dams were constructed under separate contracts—Dam No. 6 being started immediately after the completion of Dam No. 5. The latter is 740′ long and the former is 1,140′ long, and both have 12′ lifts. They are similar in construction, each resting on a stone-filled wooden crib and pile foundation with a steel pile cut-off wall on the upper side of dam and a 20′ wide stone-filled crib on the lower side.

STEEL PILE COFFERDAM at DAM No. 6.

The cofferdams for these jobs were of unusual construction as we used steel piles for the first time in a box type cofferdam. While similar to the Ohio River Type box cofferdams, they consisted simply of two rows of steel piling held together by means of tie rods. These tie rods were spaced 10′ apart longitudinally and about 3′ vertically. The filling was of sand and gravel. This type proved especially sturdy and satisfactory. The usual procedure of three separate cofferdams was employed at both jobs and sufficient gaps were left in the first two sections to pass the river during the construction of the closing section.

An interesting feature in connection with



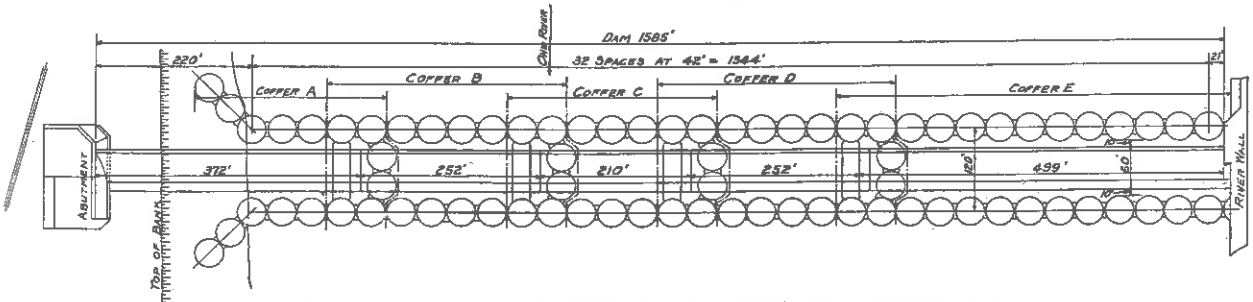
Section through typical ALLEGHENY RIVER DAM.

building the closing section of the cofferdam at Dam No. 5 was the necessity of backing up the water to a height of 10′ due to the fact that Dam No. 4, next below, had not been completed. This also necessitated the building of the greater portion of Dam No. 5 with land equipment as we were not able to avail ourselves of the proper use of our floating equipment until the dam was almost completed.

Floating equipment consisting of all-steel Dravo whirler boats, mixer boats, etc., was used almost exclusively for the construction of Dam No. 6 except that two Dravo whirlers were carried on the upstream cofferdam.

General View of operations at DAM No. 6, Allegheny River.

Dashields (Pa.) Dam, Ohio River



PLAN showing arrangement of CIRCULAR CELL STEEL PILE COFFERDAMS.

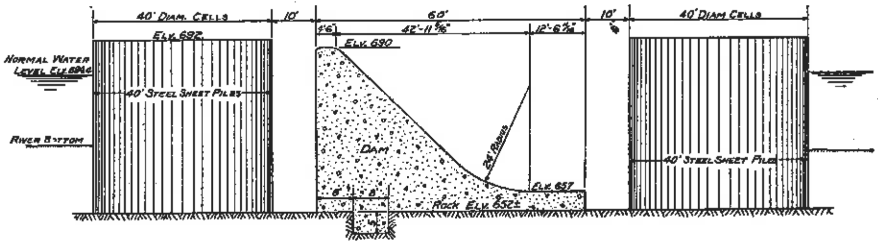
ELEVATION OF DAM.

DASHIELDS Dam, commonly known as Deadman Island Dam, located at Shields Station, 14 miles below Pittsburgh, was constructed by us in 1928 and 1929. It is the second in the Government's supplemental program of fixed replacement dams for the 9-ft. waterway development of the Ohio River, and greatly facilitates heavy traffic in the upper river by elimination of pool interruptions at old Dam No. 3 two miles above.

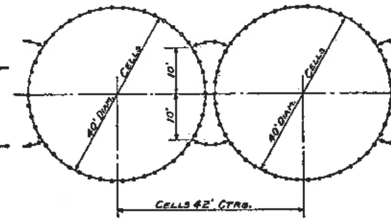
The dam is 1,585′ long with a base 60′ wide resting on solid rock 32′ below lower pool level and has a crest width of 4½′. The noteworthy feature of this work was the use of the circular cell type of cofferdam. In spite of advice to the contrary, we decided, after thorough investigation, to employ a circular cell cofferdam somewhat similar in construction to that used in raising the Battleship "Maine" in Havana harbor.

The abutment, located 100′ landward from the top of the river bank, entailed excavation to rock at a depth of 67′. To economize on the excavation the abutment was supported on two reinforced concrete caissons which were sunk by open dredging during the construction of the first section of the dam. The steel lock gates and emergency dams for the lock chambers were fabricated and erected by our Engineering Works Division under a separate contract.

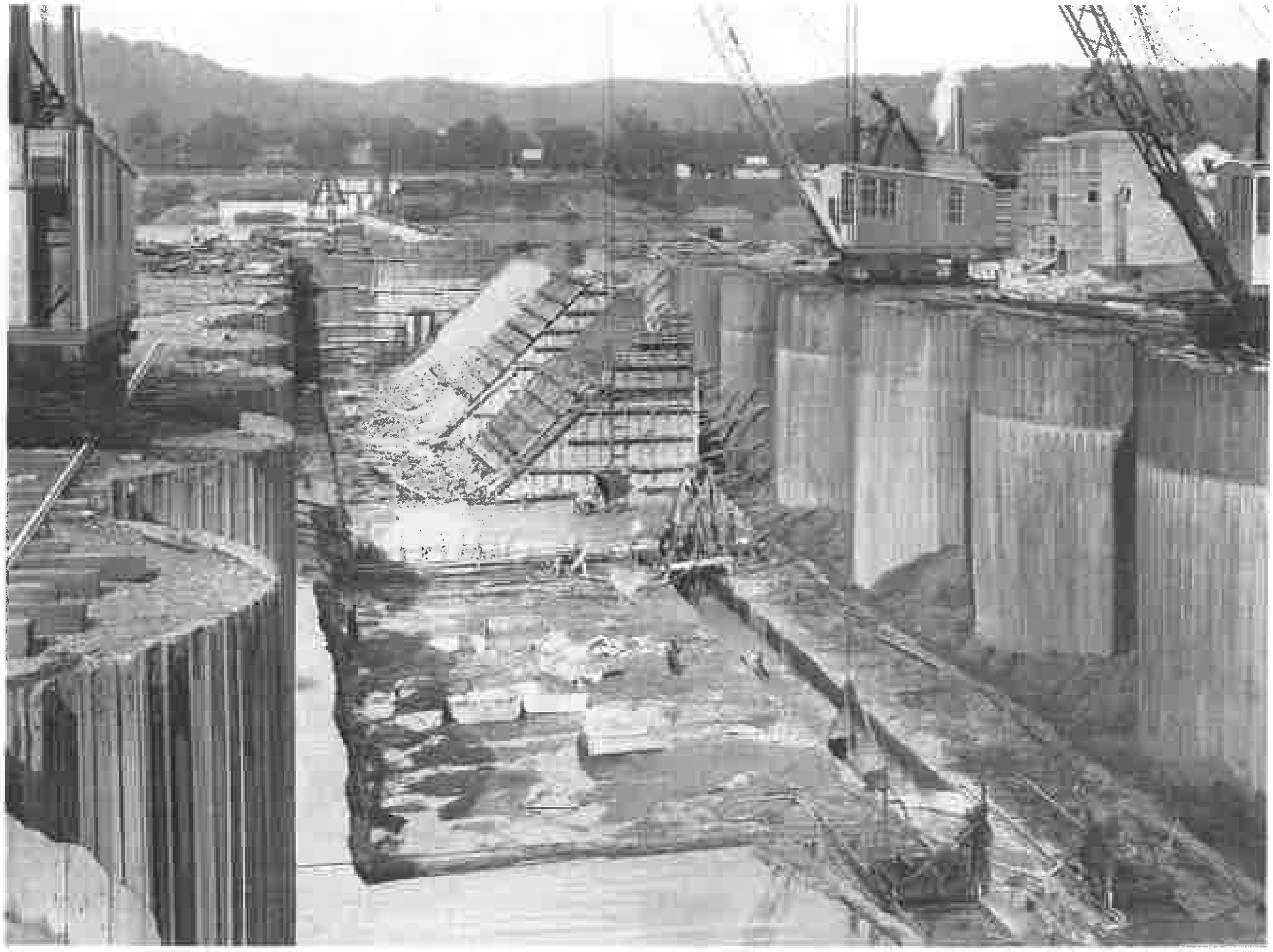
The dam was built in five sections of cofferdam, each enclosing an area 80′ wide and



Typical Section showing Dam Masonry and location of CIRCULAR CELL COFFERDAM.



Details of CONSTRUCTION BETWEEN CELLS.



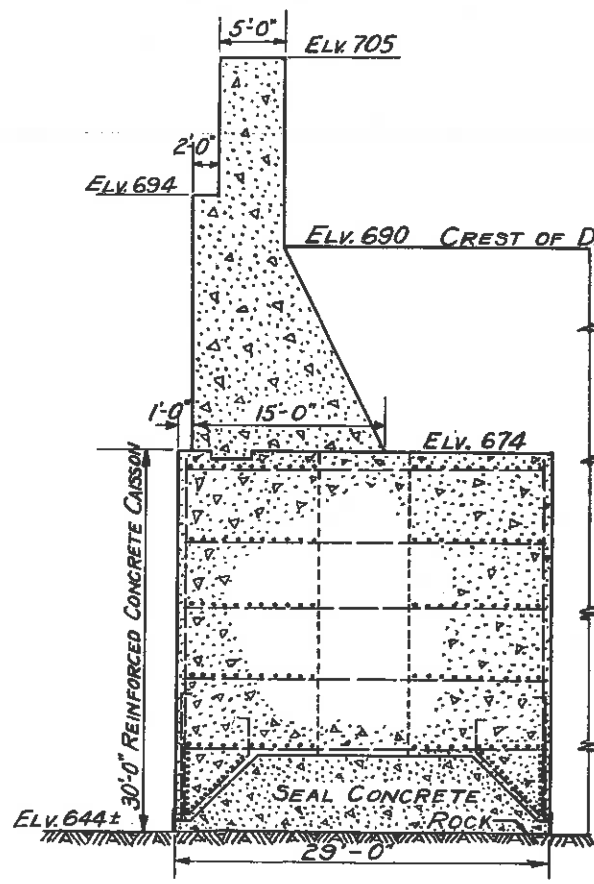
CONCRETING AND EXCAVATING for DASHIELDS DAM. Note verticality of steel piling.

Ohio River in flood at DASHIELDS DAM with WATER OVERTOPPING COFFERDAM.

PLANT AND EQUIPMENT working at DASHIELDS DAM.

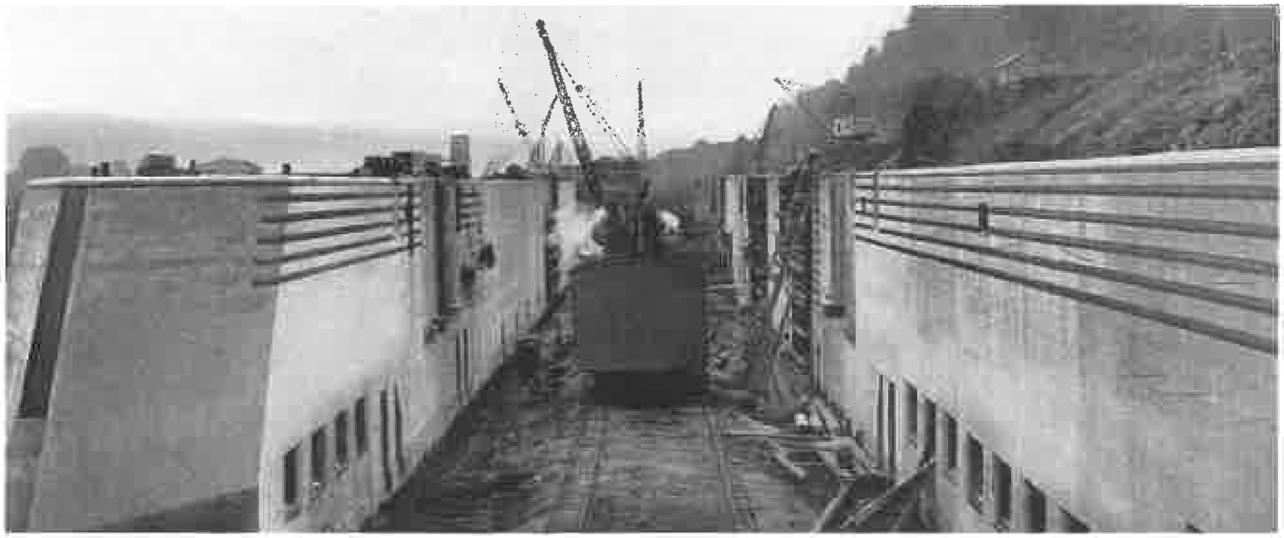
varying from 210′ to 498′ in length. The cells, 40′ in diameter, were placed 42′ center to center and each contained 100 steel piles 40′ long. The 2′ spaces between the cells were closed by two short arcs of sheeting connected to T-piles in the walls of the cells. The cofferdam used in raising the "Maine" differs from the one we used at Dashields in that the former employed a single arc to connect adjoining cells. The piling was driven to solid rock and the cells filled with sand and gravel. A distance of only 10′ was allowed between the inner walls of the cells and the permanent structure. Further details of this cofferdam as well as the method employed for final closure of the dam are described in "Engineering News-Record" dated January 9, 1930.

While this cofferdam was looked upon by capable engineers as an experiment and of uncertain success in the Ohio River, nevertheless our actual experience proved the practicability of its plan and use beyond doubt. The cofferdam was exceptionally water-tight—after unwatering the 80′ x 489′ section under a 32′ head, one 15″ centrifugal pump kept it dry. All plant was carried above the river except channeling machines, drills and pumps; and the mounting of the whirler cranes on top of the cofferdam permitted easy access to the work for excavating and form handling, unobstructed by timber bracing. Although flooded out eleven times during the job, the work was completed in the time allowed. Minimum interference to navigation was occasioned due to the use of short sections of cofferdam. The use of the improved type of cellular cofferdam proved beyond question its superiority over the old Ohio River Type box.



Section through Abutment showing REINFORCED CONCRETE CAISSON BASE.

Kittanning, (Pa.) Lock No. 7, Allegheny River



General View of LOCK No. 7, Allegheny River.

Many of the difficulties of winter construction in river work and the damages resulting from the ravages of ice can be avoided by selection of the type of cofferdam best suited to the conditions, as was exemplified in our construction of Lock No. 7, in 1928.

The work was started late in the Fall and it was decided to use a double wall steel pile type box cofferdam which consisted of two rows of piling 20′ apart, held together by steel rods, and sand and gravel filled. Before the cofferdam was finished, early zero weather was encountered and increasing quantities of ice necessitated the building of a temporary steel pile ice breaker at the end of the cofferdam to protect our floating equipment. A number of severe ice gorges occurred during the winter, but the portion of the cofferdam constructed remained undamaged, even though conditions were so severe that the cofferdam could not be completed and pumped out until April.

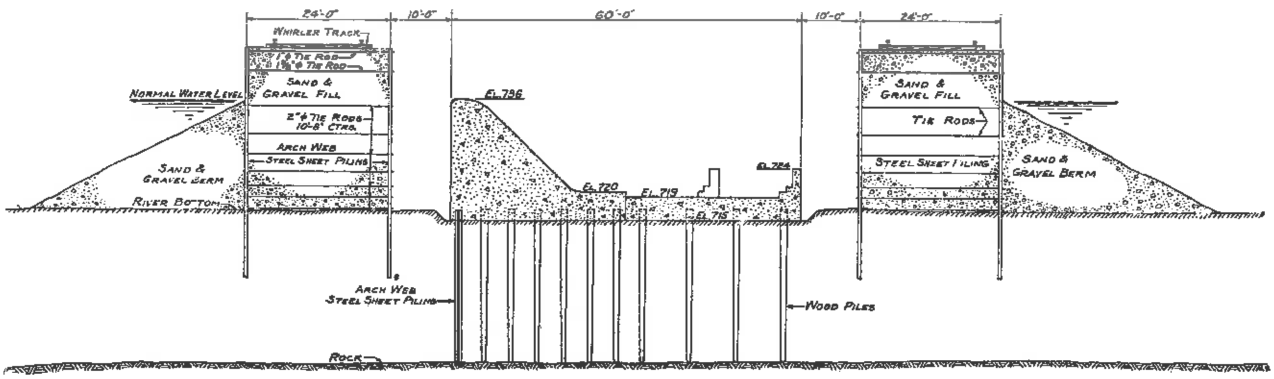
The job proceeded with regularity thereafter—the entire project being completed including the power house, the cofferdam removed, and plant towed to our Neville Island base before the recurrence of ice. Our plant included a 2-yd. Dravo land mixer to which cement was fed by a belt conveyor system. We also fabricated and erected all the butterfly valves and miscellaneous imbedded steel work.

ICE at Upper End of Cofferdam, LOCK No. 7, Allegheny River.

Monessen, (Pa.) Lock and Dam No. 4, Monongahela River

General View of Operations at LOCK No. 4, Monongahela River. Note Steel Pile Cofferdam at left.

THE construction of the new twin locks, 56′ x 720′ and 56′ x 360′ located above old Dam No. 4, Monongahela River, was awarded to us early in 1931. A double sheet steel pile box cofferdam with walls spaced 24′ apart was used. 9,600 wood piles were driven for the foundation and 92,000 cu. yds. of concrete were placed in the work, with the miscellaneous steel and butterfly valves being fabricated at our Neville Island Shops. The completion of the lock in six months less than the allotted time resulted



Typical Section showing DAM CONSTRUCTION AND COFFERDAM. Note—Only 10′ clearance needed between cofferdam and permanent structure.

DRAVO

BUILDING STEEL PILE COFFERDAM for LOCK No. 4, Monongahela River with Dravo built Whirler Boats.

in the Government's call for bids on the dam nearly a year earlier than their original schedule.

The usual practice of using three cofferdams was followed for the 551′ dam, these being of the double wall sheet steel type box. The total area of cofferdam required for both the lock and dam was 453,000 sq. ft. Six whirler boats along with a dipper dredge, necessary scows and a towboat were used in excavation and the constructing of cofferdams. The mixing plant for the lock operation consisted of 2 yd. mixers fed from one set of hoppers and served by a Dravo whirler with a 2-yd. clamshell bucket. Nine whirlers in all were used on the lock, while three whirlers and a 2-yd. floating mixing plant were used on the dam operation along with three whirler boats for cofferdam construction and general utility.

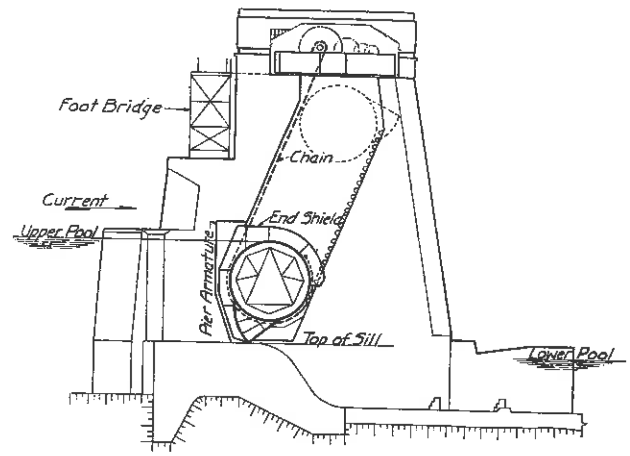
UNWATERING COFFERDAM for LOCK No. 4.

General Description of Roller Gates

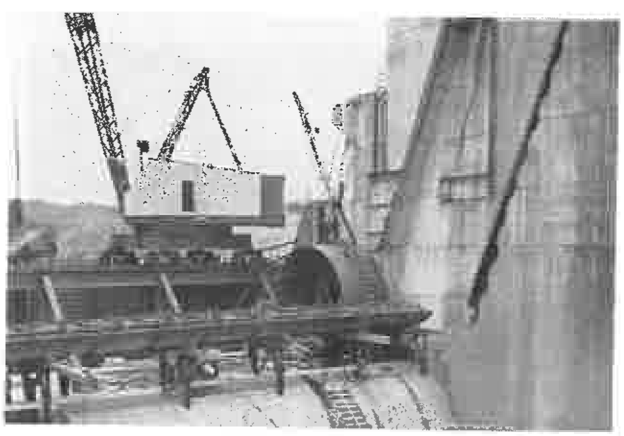
THE first roller gate dam was built in 1902, on a branch of the river Main, near Schweinfurt, Germany. This installation consisted of a single roller approximately 13′ in diameter at the ends with a pear-shaped middle body and a width of opening of 59′. The roller was raised and lowered by rolling it up and down masonry inclines by means of wire ropes wound around each end of the roller and fastened thereto at one point. The gate was hand operated by two winches requiring twelve men four hours to raise the gate to its highest position.

Roller gates are particularly adaptable for damming heights of 25′ to 30′ where flood waters require maximum discharge openings and gates must be kept operative during drift and ice conditions.

The Marmet Dam on the Kanawha River in West Virginia is the first roller gate installation constructed for and placed in operation by the Corps of Engineers, U. S. Army. Five gates with a damming height of 24′ and a clear width of opening between piers of 100′ are used at Marmet. Four of these gates are the so-called Standard Roller Gate while the fifth is a special type of roller equipped with a movable flap for pool regulation.



STANDARD ROLLER GATE at Winfield Dam.

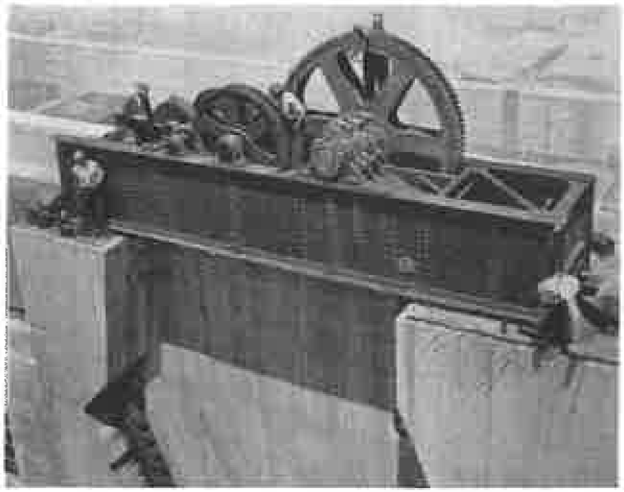


ROLLER GATE ERECTION, Winfield Dam.
Note DRAVO C-20 WHIRLER.

The standard roller gate consists of a cylindrical steel shell heavily reinforced with internal bracing and having an apron attached to the bottom of the cylinder to give increased damming height.

Flexible steel diaphragms extending out from the upstream side of the cylinder and the apron at each end of the gate are held against the faces of the pier by the water pressure and make water-tight seals at these points. The main body of the gate with its attached apron rests directly on the sill of the opening. The apron and the end seal diaphragms are faced with timber seals.

Recesses are provided in the piers at each end of the gate with the gate ends extending into these recesses. Each end of the gate is provided with a circular combined track and rim gear which run on and mesh with a similar track and rack section which is anchored to the concrete on the downstream

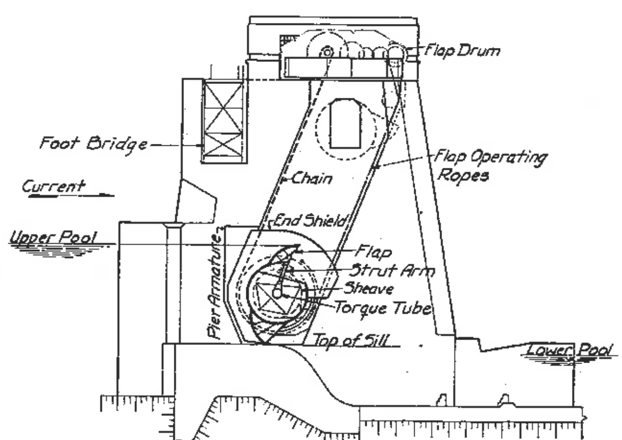


Erecting ROLLER GATE HOIST at Gallipolis Dam.

side of the recess. For the raising and lowering of the gate a hoisting unit is provided at one end only of the gate structure with a lifting chain attached to a fixed point near the upper part of the cylinder and carried completely around the cylinder and thence up to and over the sprocket of the hoisting unit.

The hoisting unit, located on top of a pier, consists of a series of reduction gears, and is motor driven. By rotation of the chain sprocket the chain is pulled up causing a rotation of the gate body upward along the inclined track. The speed of movement on various installations is usually from 6″ to 9″ vertical lift per minute.

The roller gate with flap is a special adaptation of the standard gate and is used to pass small fluctuations in discharge or to clear ice and surface debris over the top of the gate. There are various methods of flap operation and various types of flap. One of the most satisfactory and simplest forms used is that which was developed for the Marmet installation. The flap is a hinged section of the main body of the roller, which is somewhat smaller in diameter than that used for the standard rollers. The hinged flap is operated by means of thrust arms working through a bell crank system from a center torque tube extending the full length of the roller. At one end of the torque tube a large sheave is provided around which wire rope lines are wound and extend up to the hoisting unit where a drum is provided for the operation of the flap. The rotation of the wire rope drum in either direction causes a raising or lowering of the flap quite independently of the operation of the main hoisting chain. When the gate is to be raised from its normal damming position the flap is first lowered by rotation of the wire rope drum using the regular driving motor of the hoist unit and then by a clutching arrangement the flap drum is disengaged and the main hoist gears are actuated to lift the entire gate in the same manner as the standard roller gate is lifted. To provide for emergency operation it is possible to lift the flap gate to a height of 5′ without lowering the flap. At this elevation limit switches are installed to stop the movement until the flap is lowered in order to provide for proper clearance when the gate approaches the top of the recess.



ROLLER GATE WITH FLAP at Winfield Dam.

Marmet (W. Va.) Lock "B" and Dam, Kanawha River

A GENERAL VIEW OF THE LOCKS AND DAM showing flap gate with flap raised.

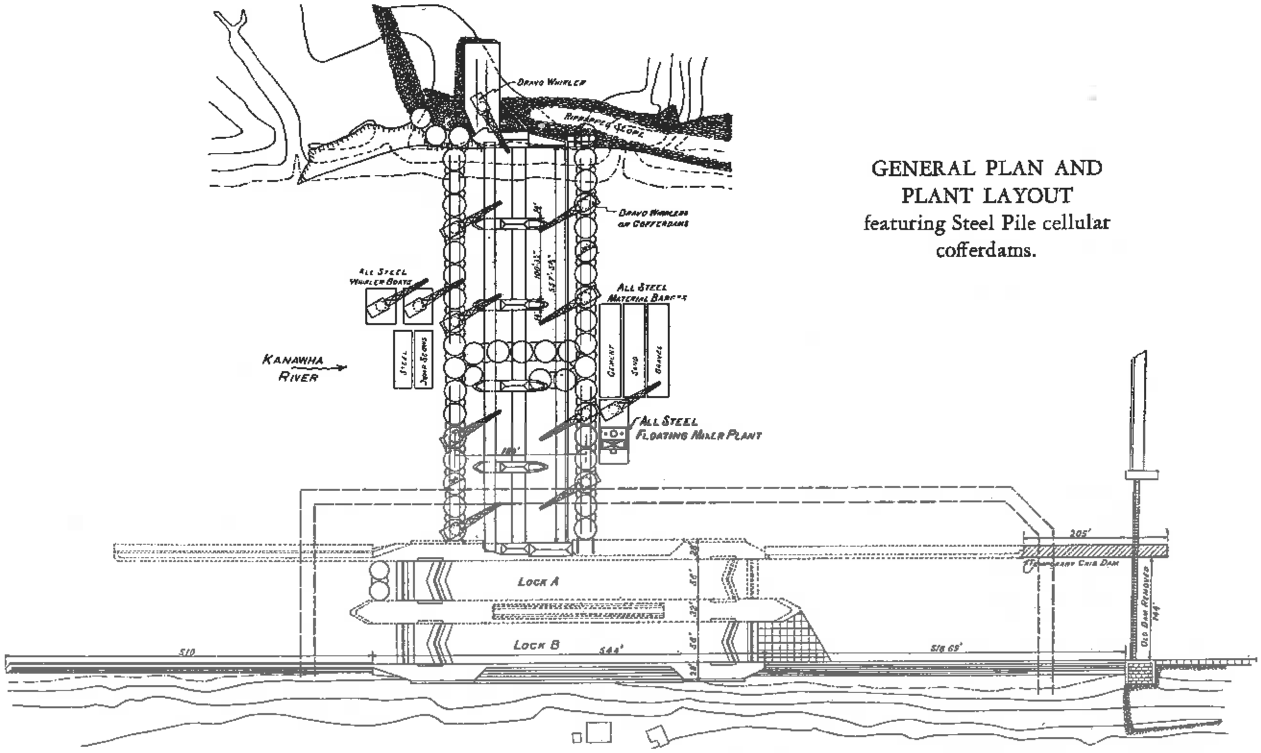
THE Marmet Twin Locks and Dam comprises one of the four major units in the modernization of navigation facilities in the Kanawha River, in which program our company had a principal part.

The contract for Lock "B" was awarded to us in November, 1931. This part of the project consisted of a land wall and adjacent guide walls with a total length of 1,555′, together with power house and temporary crib dam 165′ long. This work also included furnishing and placing two stoney gate valves and the mitering gates with operating machinery.

In August, 1932, with Lock "B" nearing completion, the construction of the dam was awarded to us. This dam is of the roller gate type and consists of six piers and five cylindrical roller gates 100′ long and 26′ high, closing on concrete sills. These gates are operated by individual hoists mounted on the tops of the piers, well above high water. Access to the hoists is provided by a service bridge, which also supports a traveling crane used in drift removal and repair.

Gates, machinery and structural steel were fabricated and erected by our Engineering Works Division. The materials were moved via river from our Neville Island shops to the job site.

The steel pile cofferdams for the dam were constructed in two consecutive units and were of the cellular type, consisting of a series of circular cells connected on both sides by short arcs, all filled with sand and gravel and paved with concrete for flood protection. The Kanawha River is subject to frequent and sudden rises, and it was necessary to cease operations to flood the

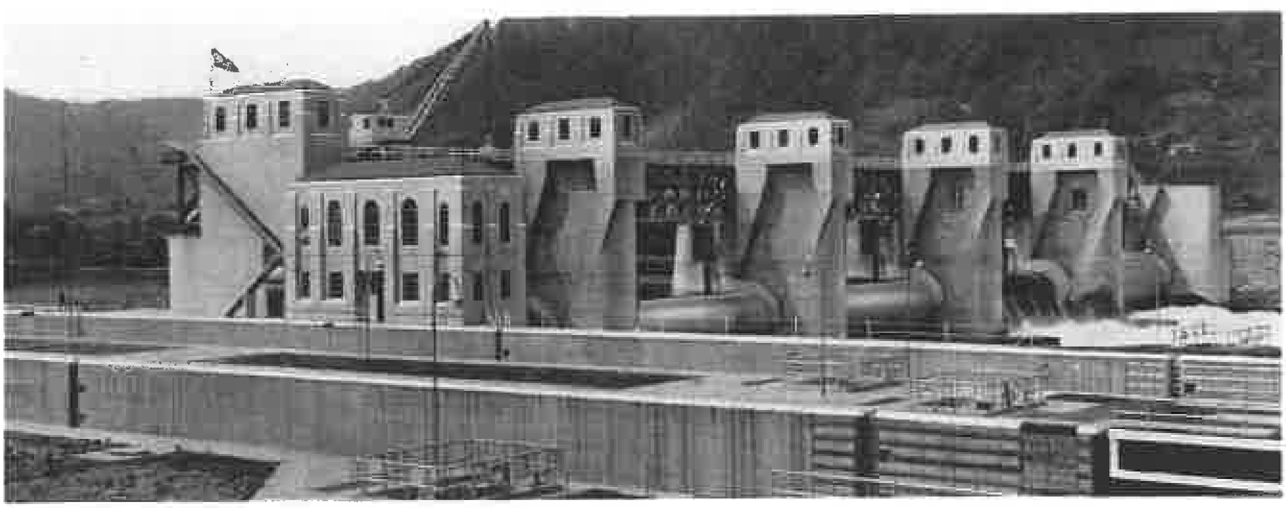


GENERAL PLAN AND PLANT LAYOUT featuring Steel Pile cellular cofferdams.

lock cofferdam nine times in seven months.

Dravo whirlers were used for excavation and for handling forms, concrete and steel. The floating plant consisted of Dravo built mixer boat, derrick boats and barges. All work was completed on April 6, 1934.

This work constitutes another example of the variety of engineering construction and equipment furnished by our company as a single source. This makes possible a coordination and single responsibility that could not otherwise obtain on a project.



The ROLLER GATE RECESSES AND OPERATORS HOUSES here reveal the scheme of hoisting gates from one end only and the seals at the faces of the piers.

London (W. Va.) Lock "B" and Dam, Kanawha River

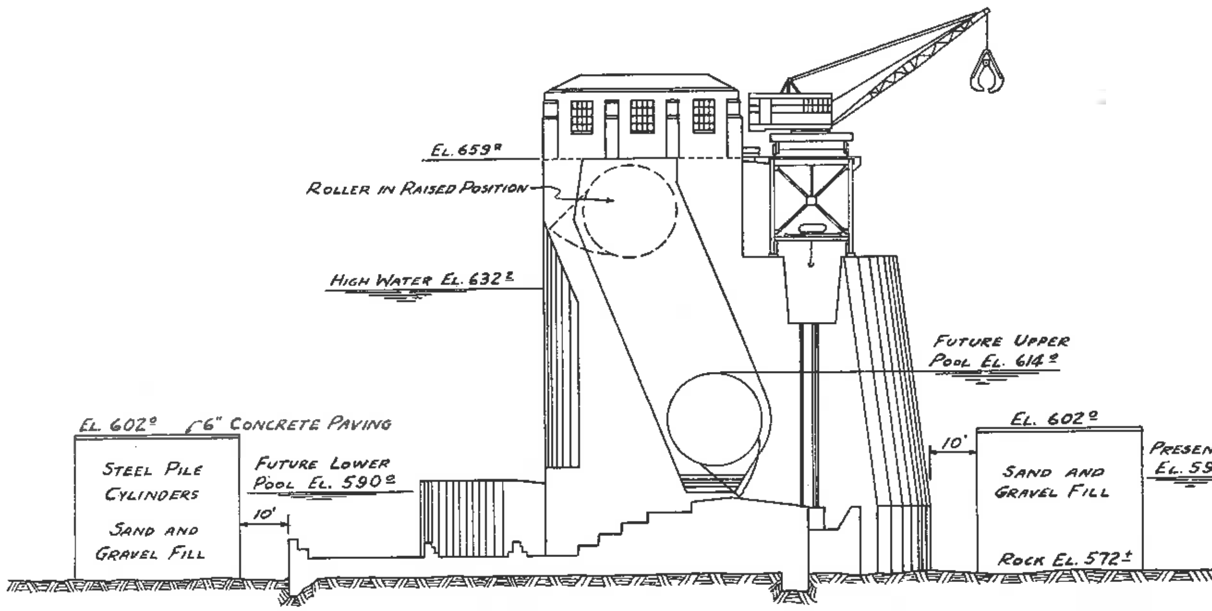
LONDON LOCK AND DAM performs a vital function in the Industrial Development of Kanawha Valley.

THE London Twin Locks and Dam is the second built in the plan of four new control points for the Kanawha River. It is located near the head of the Kanawha River, which is formed by the junction of the New and Gauley Rivers, from whose watersheds frequent extreme rises are experienced and for which hazard our organization and plant are especially suited.

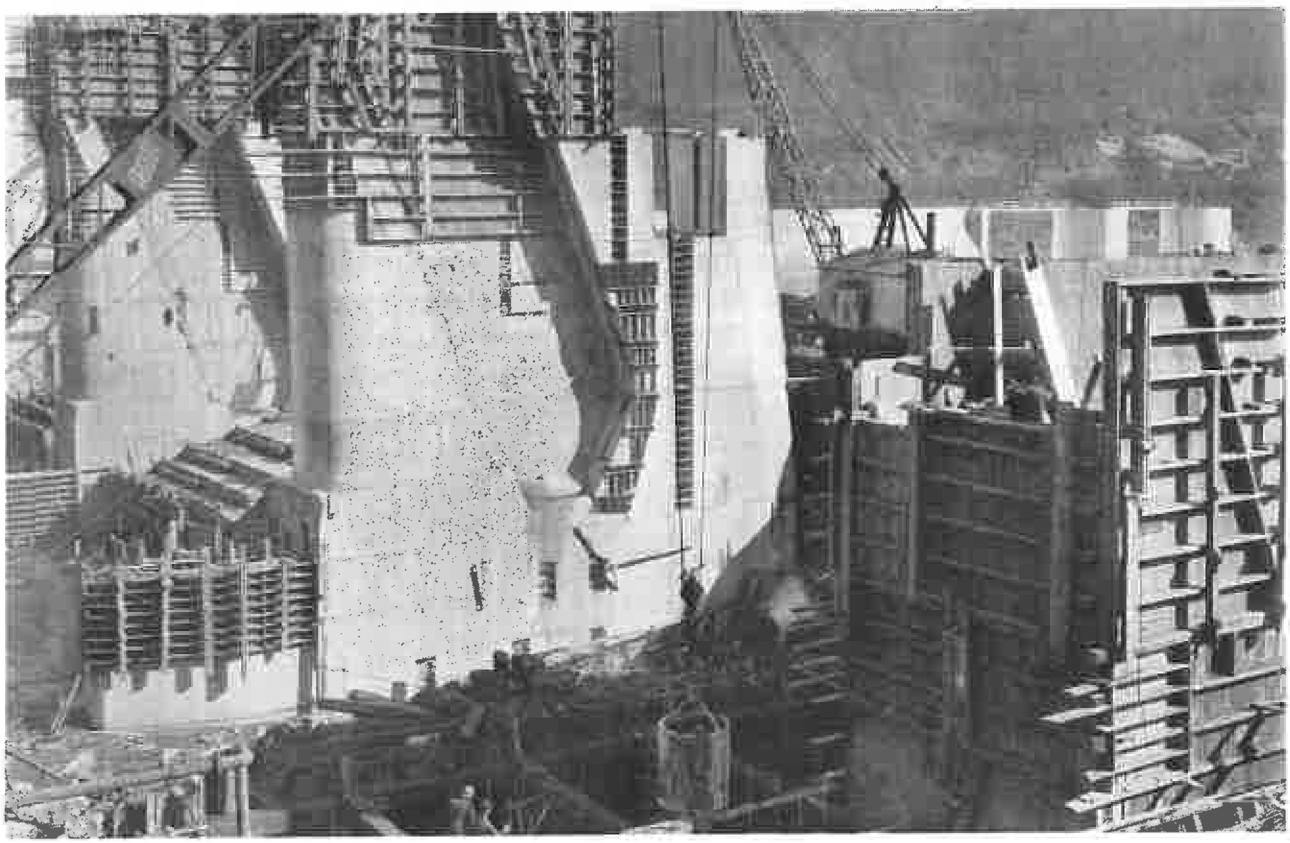
The contract for Lock "B" and the Dam was awarded to us in December, 1932. Lock "B" is 56′ x 360′, and the dam consists of six piers and five rollers, the latter 100′ long and 26′ high, providing a lift of 24′. The dam is 568′ long, of similar design to Marmet Dam, which is 15 miles downstream. The cofferdams were similar to the cellular steel sheet pile construction at Marmet Dam.

For plant, Dravo whirlers were used for excavation and handling materials on both the lock and the dam. A double 2-yd. mixing plant served the lock and a 2-yd. mixer boat furnished concrete for the dam. Derrick boats were used for cofferdam construction and removal and other miscellaneous work.

The major items in this contract consisted of the excavation of 156,000 cu. yds. of earth and rock, the placing of 74,000 cu. yds. of concrete, and fabrication and erection of all lock gate and roller gate structural steel and operating machinery. The project was completed on June 25, 1934.



TYPICAL SECTION THROUGH DAM AND COFFERDAM.



FORM WORK AND CONCRETE operations proceeding with fine coordination within the LARGE CELLULAR COFFERDAM.

Winfield (W. Va.) Lock and Dam, Kanawha River

The INDEPENDENT OPERATION OF EACH ROLLER GATE is revealed in this view of the completed Winfield Lock and Dam.

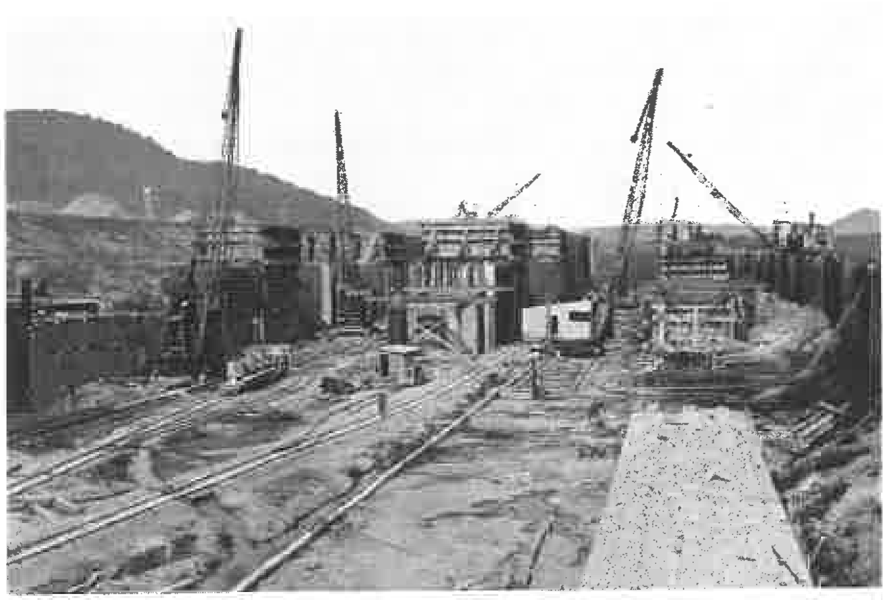
THE Winfield Twin Locks and Dam constitute the third link in the navigation chain on the Kanawha River, and control a pool 36.6 miles long.

The contract for the locks was awarded to us in October, 1933, and the work was completed in February, 1935. After an intermission of six months, the dam was advertised and was awarded to us in August, 1935, and was completed in August, 1937.

The Twin Locks are each 56′ x 360′. The total length of the structure including guide walls is 1,564′. Major items of work were 191,335 cu. yds. of earth and 50,791 cu. yds. of rock excavation, and 132,941 cu. yds. of concrete.

The locks were constructed within a box cofferdam, consisting of two rows of arch web steel sheet piling, tied with cross rods, and filled with sand and gravel. Well points midway of the high bank back of the land wall served to keep in place the very unstable stratum which was disclosed in the early stages of excavation.

All work on these locks was carried out under a P.W.A. contract, through the Corps of Engineers, U. S. Army, the object being to put as many men to work as possible in the shortest time. Preliminary excavation was performed by derrick boats and disposed of by means of scows. The construction of the cofferdam was carried on simultaneously with the excavation of overburden which, as noted above, amounted to approximately



A general view of LOCK CONSTRUCTION featuring the extensive HEAVY EQUIPMENT required.

191,000 cu. yds. Inside the cofferdam, heavy rock excavation required channeling. This was done by the drilling and broaching method, with machines of our own design and construction. The form work was principally of slab construction, and in certain instances these slabs were carried on and moved by means of a special form carriage designed, patented and constructed by our own organization. Concrete mixing and handling were performed in the main by equipment of our own construction and design. Aggregate was produced by our own ladder dredge in the Ohio River about 60 miles from the dam and was transported by our towboats and barges. A whirler unloaded this material and served a double 2-cu. yd. mixing plant. Concrete was transported in 2-yd. cylindrical buckets on flat cars to the forms where whirlers handled it to place.

Similar methods were used later on the dam construction. The dam is 692′ long and consists of 6 roller gates 100′ long and 26′ high, including one flap gate. This dam is similar to the Marmet and London Dams except that it has one more roller gate, the only other difference being in the service

A battery of DRAVO WHIRLER DERRICK BOATS busily engaged on cellular cofferdam construction.

ROLLER GATE erection showing clearly the Pier Recess and the supporting Sill.

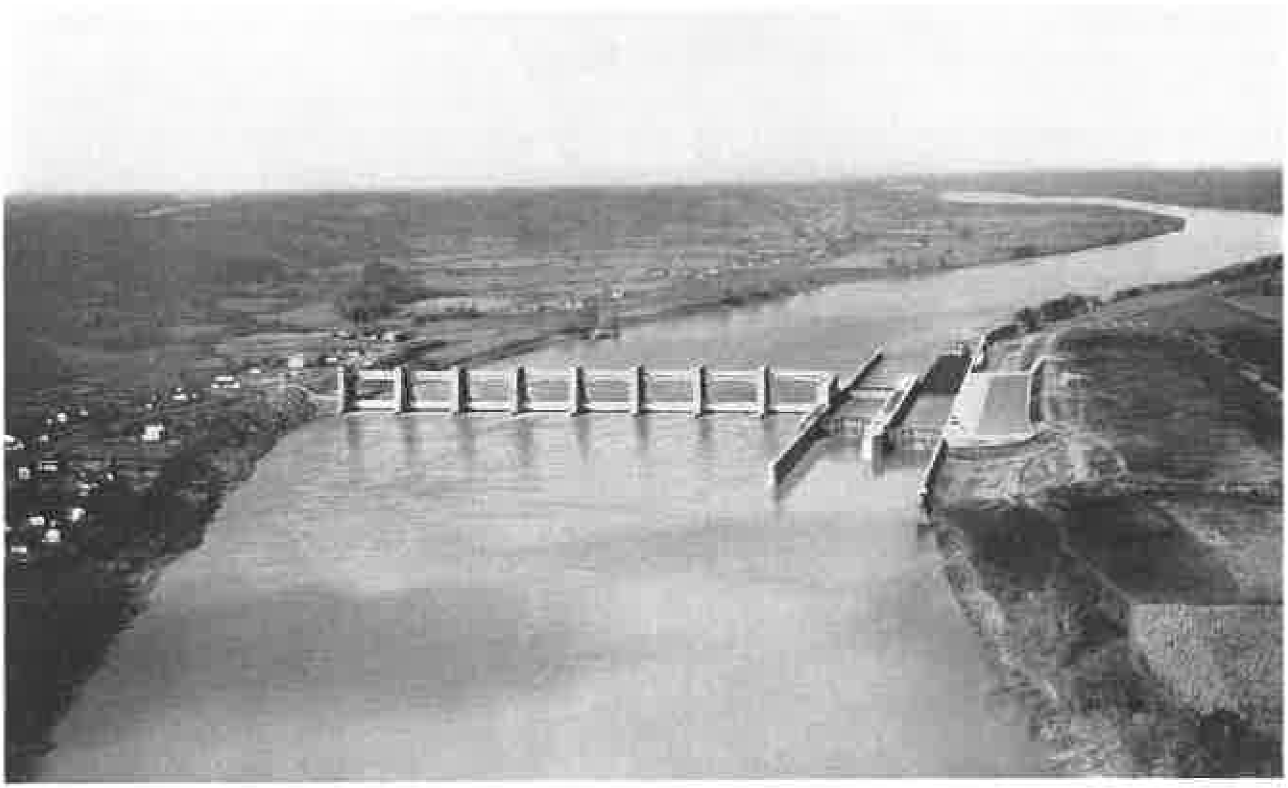
bridge, which is of lighter type, as the traveling crane is eliminated and a derrick boat is substituted therefor.

The cofferdam was of the usual cellular steel sheet pile construction, similar to that used at Marmet and London Dams. All of the lock and roller gate steel and machinery was fabricated and pre-assembled at Neville Island, and was then knocked down into units of the largest size adapted to our handling equipment. These sections were then loaded on our barges for shipment down the Ohio River and up the Kanawha River where they were assembled in final position. Major quantities in the dam consisted of 191,965 cu. yds. of earth excavation, 23,506 cu. yds. of rock excavation, and 53,241 cu. yds. of concrete. Handling of forms and concrete followed closely the lock methods, except that one of our double 2-yd. marine mixing plants was used.

The Winfield Dam awarded to us in August, 1935, was carried out as a Works Progress Administration contract. Consequently nearly all of the labor used on this job had to be trained for the work, and while this required a great deal of attention from the standpoint of supervision, we believe the results were in harmony with the spirit of the contract, the intent of which was to place as many individuals as possible on a self-supporting basis.

The PIER AND SILL CONSTRUCTION was greatly facilitated on this project by the use of DRAVO GANTRY WHIRLERS.

Gallipolis (Ohio) Lock and Dam, Ohio River



The magnitude of the GALLIPOLIS LOCK AND DAM is suggested by comparison with the fleet of twenty 175′ Coal Barges locking through.

Gallipolis Lock and Dam is the only roller gate structure on the Ohio River, and embodies the largest roller gates installed anywhere in the world.

Award for the lock construction was made to us in October, 1933. This contract included the construction of two locks 110′ x 600′ and 110′ x 360′ respectively, measuring 2,158′ between extremities of upper and lower guide walls, later increased 500′ as an extension to the upper guide wall.

The work involved the excavation of 601,537 cu. yds. of earth, 48,740 cu. yds. of rock, and the furnishing and placing of 265,604 cu. yds. of concrete, together with the furnishing and erection of the tainter gates, lock gates and operating machinery.

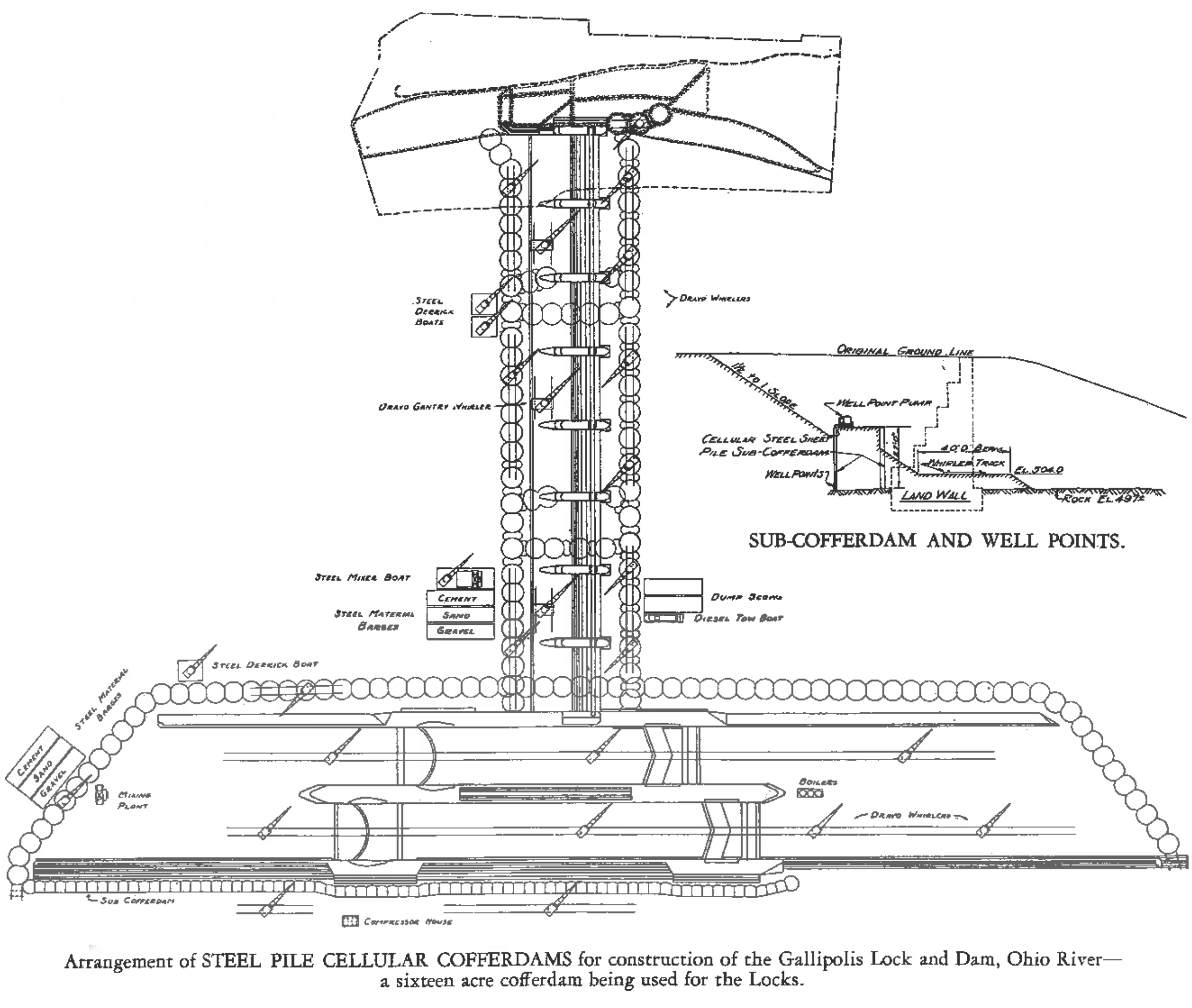
A cellular steel sheet pile cofferdam was constructed to enclose the entire 2,158′ of lock, using two lines of sheeting, connected with cross walls at 35′ intervals, filling the whole with sand and gravel and capping with concrete to prevent loss of the fill. Three 15″ and two 12″ electric pumps were used for dewatering, with one 15″ pump taking care of leakage after dewatering was completed.

The contract required the disposition of all excavated material on the high ground adjacent to the esplanade. The high bank back of the land wall was supported by means of two rows of steel piling connected by steel pile cross walls, and filled with sand and gravel. Well points were used to eliminate hydrostatic pressure and to secure stability.

Concrete mixing and placing followed closely the method used at Winfield Locks.

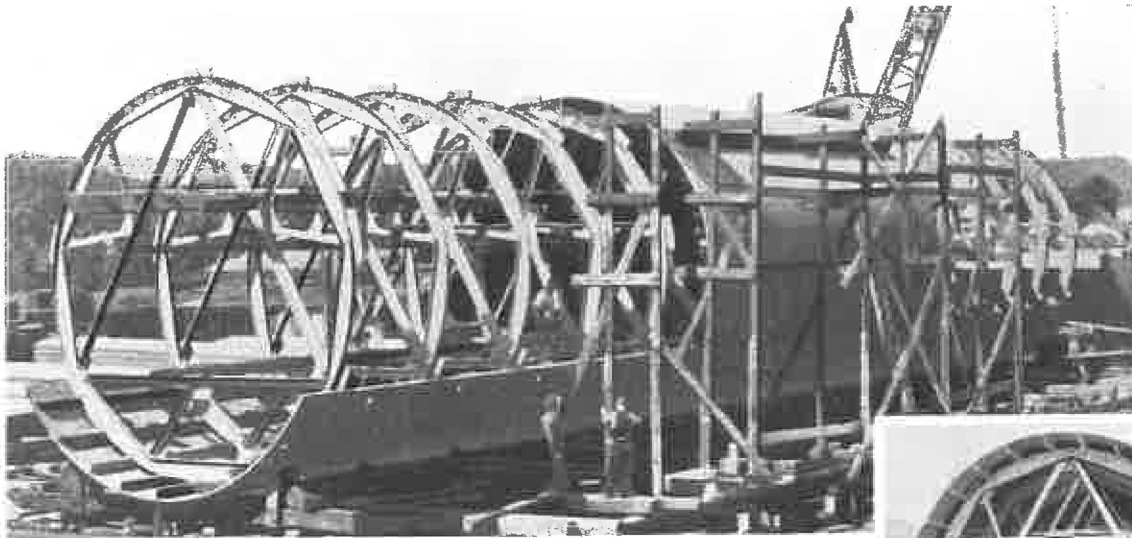
The lock contract was completed in May, 1936. We were awarded the contract for the dam in January, 1935. This structure is 1,149′ long and consists of nine piers with eight roller gates 125′ long and 29.5′ high. Major items included 157,053 cu. yds. of earth excavation, 19,236 cu. yds. of rock excavation and 102,245 cu. yds. of concrete together with the fabrication and erection of machinery and roller gates.

The cofferdams for this job were especially designed to fit the existing conditions. The upper arm was composed of 40′ diameter cylinders spaced on 50′ centers and connected by means of short arcs, these short arcs being used to shut off the river when closing the upper arm of the cofferdam. The lower arm of the cofferdam was also of cellular construction, but using cross walls located 35′

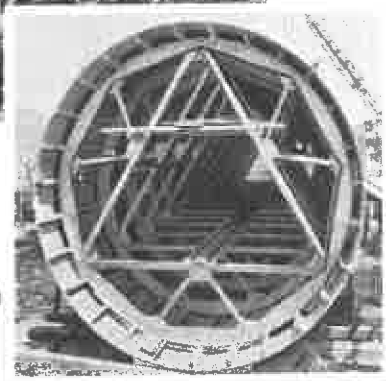


Arrangement of STEEL PILE CELLULAR COFFERDAMS for construction of the Gallipolis Lock and Dam, Ohio River—a sixteen acre cofferdam being used for the Locks.

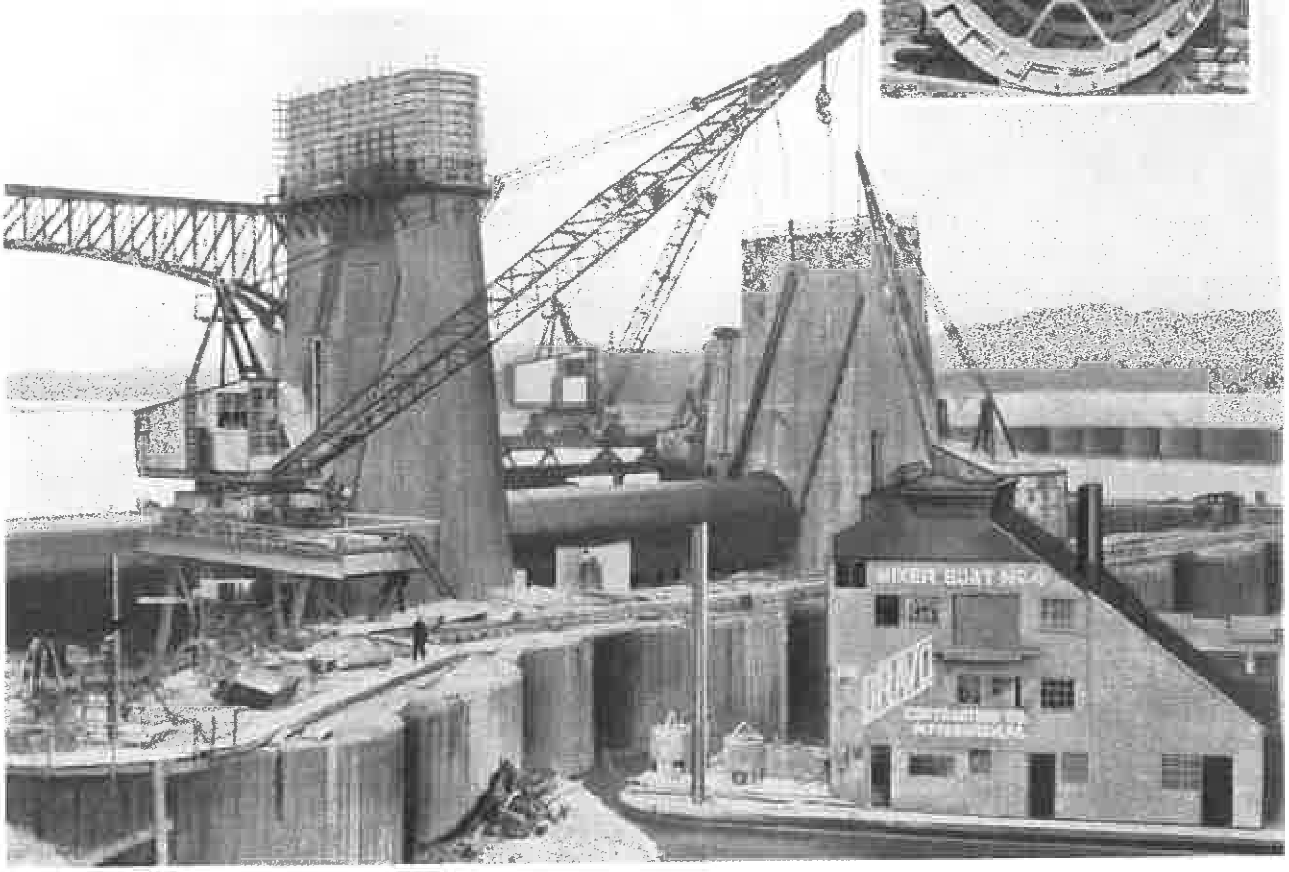
DRAVO



Pre-assembly at Neville Island of STANDARD ROLLER GATE for Gallipolis Dam.



End view of ROLLER GATE Pre-assembly.



ROLLER GATE erection, Gallipolis Dam, showing GANTRY WHIRLERS and the MARINE CONCRETE MIXING PLANT.

With sixteen acre COFFERDAM COMPLETE AND WORK in progress.

centers with connecting arcs. The entire cofferdam was decked with concrete.

Excavated material was disposed of in the river by dump scows. Heavily braced forms were provided to hold accurate lines against the relatively rapid pouring of concrete mixed by a floating plant. Steel was erected by C-17 Dravo whirlers on special gantries. Electric power was used wherever feasible.

Work proceeded rapidly in spite of heavy ice and repeated floods, including the all-time record flood of January 28, 1937, and the project was completed and accepted on October 23, 1937.

Both the Gallipolis Locks and the Dam were awarded as P.W.A. contracts, the object being to furnish the maximum amount of man days employment in a minimum of time. Owing to insufficiency of P.W.A. funds, approximately 38% of this work was done under supplemental agreement with W. P. A. funds. This necessitated the training of labor inexperienced in this type of work, thus adding very considerably to the problems of job supervision.

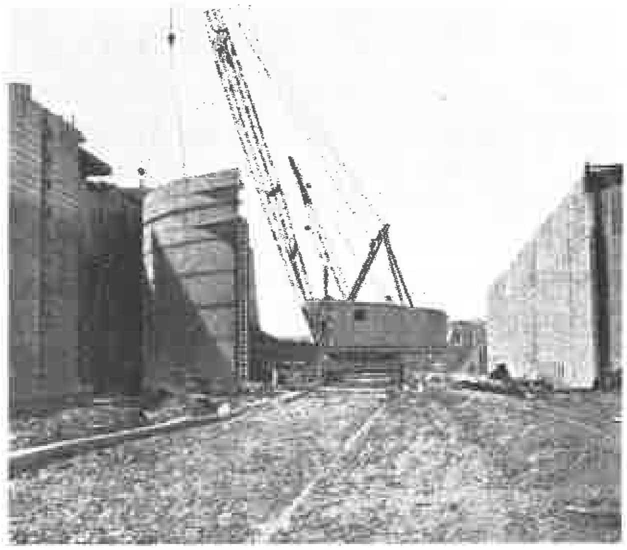
We were engaged on the construction of the Marmet, London, Winfield and Gallipolis Locks and Dams during the period beginning in December, 1931, and ending in October, 1937—a total of nearly six years of continuous application on this program, interrupted only by cessation of work in times of flood and ice.

General view of LOCK CONSTRUCTION featuring the application of WELL POINTS in foreground.

Three of these major contracts were under way concurrently, each with independent supervision and plant. This required a large and diverse organization of trained personnel, together with an immense amount of specialized equipment.

The total combined value of the work done by us on these four locks and dams under contracts awarded to Dravo Corporation was approximately $13,800,000.00. The volume of work done is reflected in part by the following schedules of quantities:

Common excavation	1,452,428 cu. yds.
Rock excavation	169,479 cu. yds.
Concrete	693,833 cu. yds.
Structural Steel . . .	19,000 tons



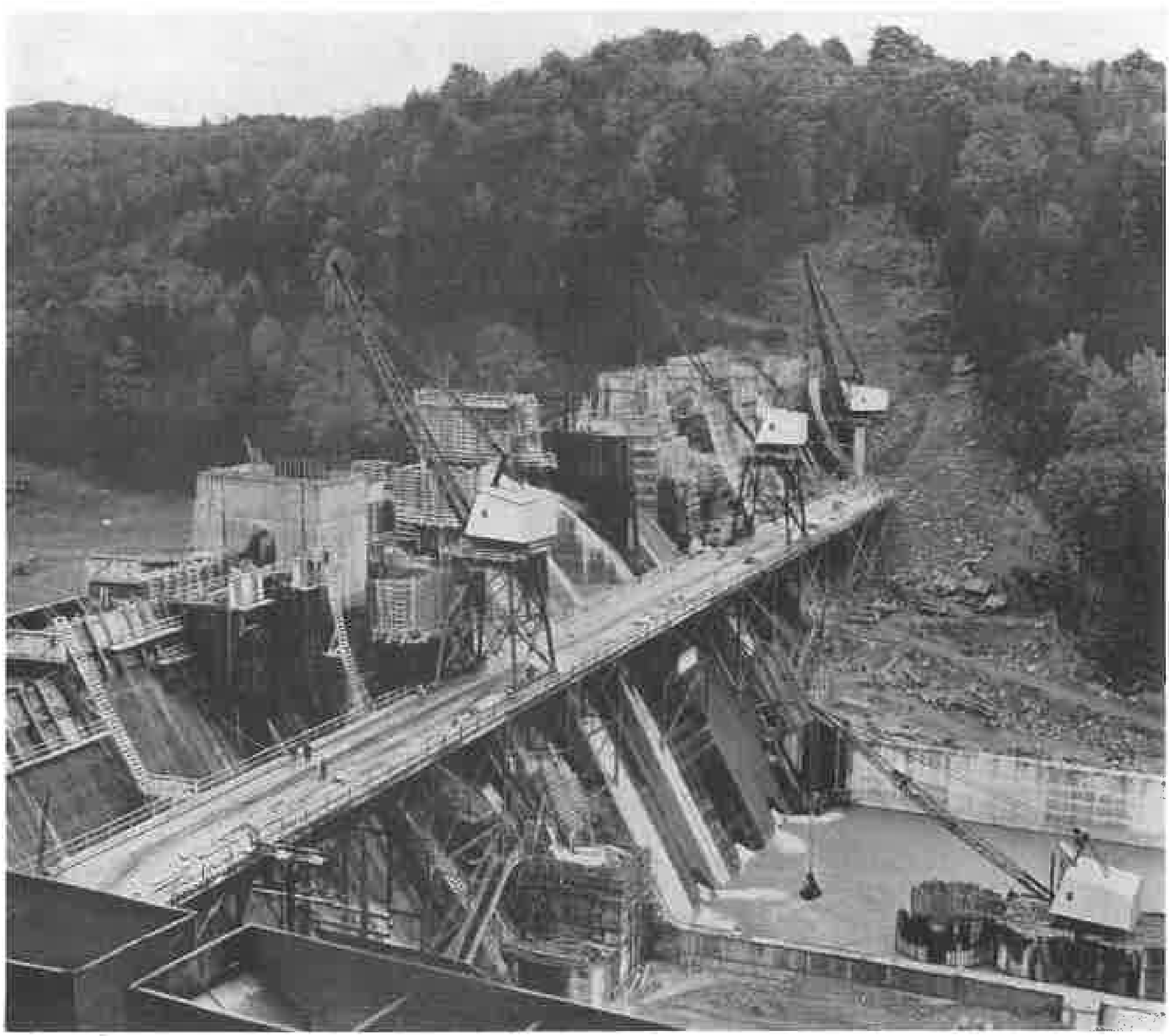
Erection of LOCK GATES.

FLOOD AND DRIFT, at Gallipolis Locks constituted a construction handicap.

The RECORD BREAKING FLOOD at Gallipolis Dam, January 28, 1937.

Mahoning Dam (Pa.), Allegheny River

THROUGH the foothills of the Allegheny Mountains winds Mahoning Creek, a tributary of the Allegheny River. A slender peaceful trickle of water in summer, it frequently assumes torrential stature and madly rages in the spring when it is fed by thawing snow from the mountains. To hold its annual flood waters in check, the U. S. Engineers selected a suitable site for one of the Pennsylvania Flood Control Dams—60 miles north of Pittsburgh, near New Bethlehem, Pa. At this point, the gorge narrows



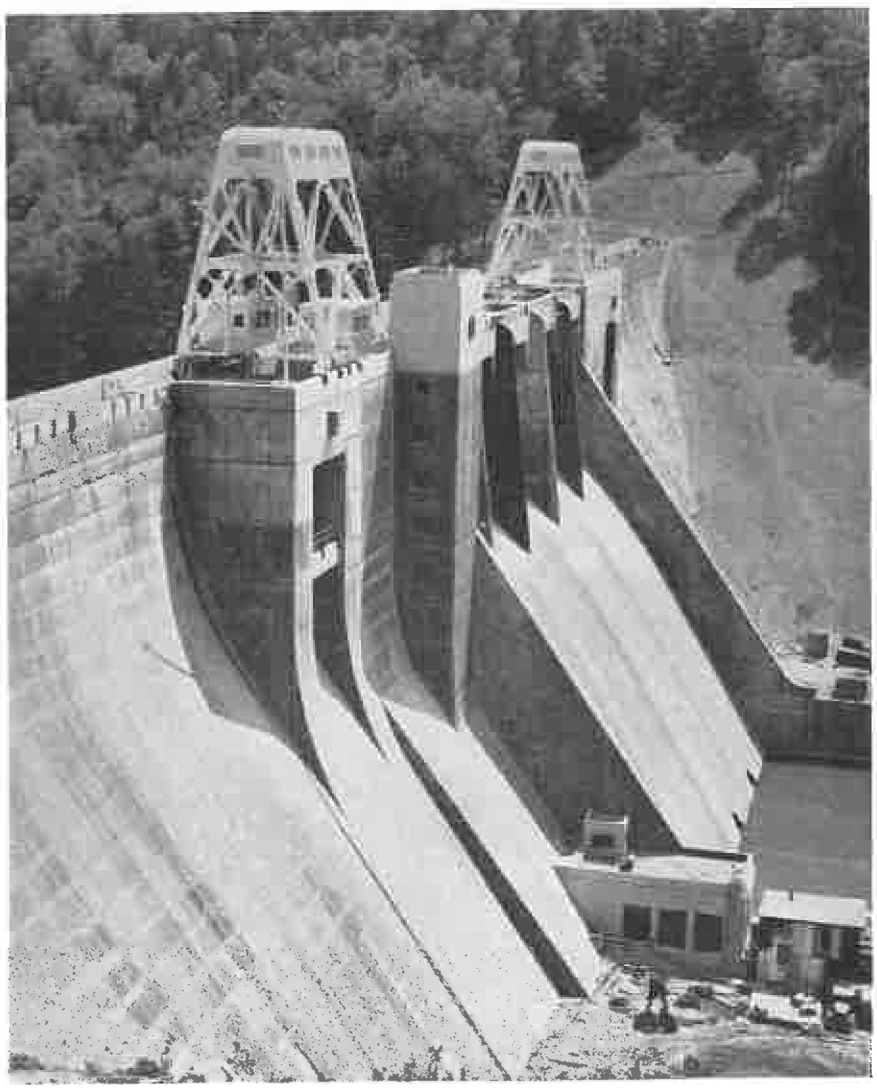
DRAVO WHIRLERS, mounted on GANTRIES on the concrete dinkey track bridge, dominate the scene as Mahoning Dam rises.

and an economical dam that would develop the necessary storage facilities was feasible. The dam approved for this site was 175′ high, 993′ across the top and consisted of some 346,000 cu. yds. of concrete, and in addition, required about 250,000 cu. yds. of earth and rock excavation. Mahoning Dam, by comparison in size to some of the great dams previously constructed, would be given no great rank. Yet Mahoning Dam is not the mere model of the larger structures; it is as individual and substantial as the rugged Pennsylvania hills that embrace it.

Notice to proceed with the construction of Mahoning Dam was given to Dravo Corporation on February 2, 1939.

From the beginning, accessibility to the dam site was the nagging problem; moving the thousands of tons of sand, gravel, cement and other materials over the rugged and heavily forested mountain terrain was a colossal task. Nearly every phase of the estimate for Mahoning considered access to the site. Consideration was given to many possible means of transportation. It was finally decided to construct a 3.8 mile spur track through the forests and across the intervening gorges to connect with the Pittsburgh & Shawmut railroad near McWilliams, Pennsylvania.

During access construction while heavy clearing of the site and railroad spur were carried on, mobile equipment was advanced to the location and all was in readiness to start construction of the cellular steel pile cofferdam upon arrival of the first car of steel sheet piling. During May and June of 1939 the first cofferdam was constructed, earth and rock excavation, drilling 2″ and grouting and drilling 30″ inspection holes, etc., were carried on, and from early July to early



Part of the Pennsylvania Flood Control Project, MAHONING DAM is situated sixty miles north of Pittsburgh, Pennsylvania on Mahoning Creek, a tributary of the Allegheny River.

View of plant erected for MIXING CONCRETE at the dam site.

December of that year concrete was placed along with all other sundry operations. During the late winter months, the first cofferdam was removed and the second cofferdam placed. Earth and rock excavation and some grouting were continued whenever extreme

DREDGING OPERATION IN THE ALLEGHENY RIVER. Concrete aggregate for Mahoning Dam was prepared from this dredged material.

To move aggregates to the dam site, a 3.8 MILE SPUR TRACK was constructed. Here a section of track crosses a ravine over a DRAVO DESIGNED AND CONSTRUCTED TRESTLE.

winter weather permitted.

The sand and gravel for concrete came from the Allegheny River. By obtaining a contract from the U. S. Engineer Department for dredging the Allegheny River channel just below Lock No. 9 shortly after Mahoning Dam was started, it was possible to utilize a portion of this dredged material as aggregate for the dam and effect a considerable saving for the U. S. Government in the cost of the two projects. At Reesdale a modern washing and screening plant was erected. Material was dredged by Dravo C-20 whirler, mounted on a sectional steel hull and operated as a floating, spud anchored dragline. The dredged material was loaded into Dravo 225 cu. yd., 3 pocket dump scows, and we may as well add that the scows were towed to the screening plant by Dravo designed and constructed towboats. The boats, "Pioneer," Dravo 43, and 44 were all used in this portion of the work. Material from the scows was dumped in the river within reach of a Dravo C-14 whirler mounted on a steel pile cell. This whirler, operating a dragline bucket, fed this material through a grizzly to a belt conveyor for transporting to the washing and screening plant. Material moved by gravity to hopper cars for transportation to the dam. This plant was designed and fabricated by the Dravo's Engineering Works Division and erected by Dravo forces.

The accompanying pictures with their captions portray the story of Mahoning. This contract was completed early in 1941.

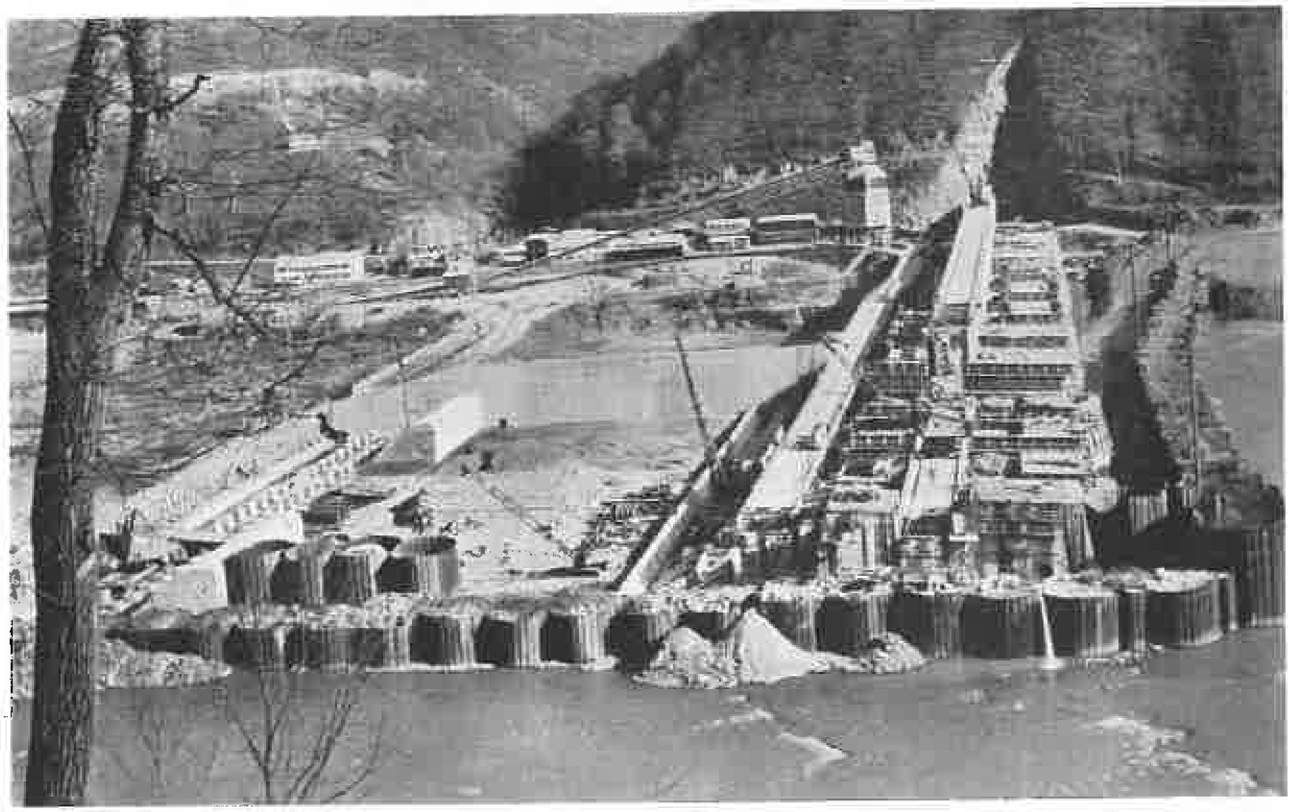
Bluestone Dam (W. Va.), New River

3-YARD BUCKETS OF CONCRETE move along the tracks in cars to the pouring site where they are dumped by DRAVO WHIRLERS. Approximately 1,000,000 yards of concrete will go into Bluestone Dam.

IN THE lonely mountains of North Carolina rises the New River, a twisting tortuous mountain stream whose waters ultimately empty into the Ohio River and eventually reach the Gulf of Mexico. True to the inherent characteristics of streams situated in the mountains with their excessive run-off rate, the beautiful New River can in a matter of minutes change to an ugly raging torrent. This stream is one of the major contributors to the raging Kanawha, that flows through Charleston, West Virginia. Charleston is an expanding industrial center where many of the large Chemical Industries of America have located important plants. All of these plants are in the Kanawha Valley and most of them along the banks of the

SEVEN CONCRETE-PLACING WHIRLERS operate on the platform supported by CONCRETE COLUMNS 8 feet in diameter. The columns are ultimately incorporated into the dam.

Kanawha River. Protection of this industrial concentration and the homes of the people who work in it by preventing flood damage is of utmost importance in peacetime and in wartime to assure the steady flow of chemical products which modern America requires. To control the frequent wild outburst of the New River and protect this inland rise 168′ above the bed of the stream. In addition to the quantities already mentioned, 262,000 cu. yds. of rock excavation and 66,000 cu. yds. of earth excavation are required to accomplish this task. The contract for construction of this dam was awarded to The Contracting Division of Dravo Corporation in January 1942. The accompanying



General construction view showing the CELLULAR-TYPE COFFERDAM of steel sheet piling in the foreground.

chemical center, the U. S. Engineers in the late thirties finally decided on a site for a major flood control dam to be located near Hinton, West Virginia just above the point where the Greenbriar River joins the New River.

The dam required, at this point, to control the river will contain 939,000 cu. yds. of concrete, will be 2100 feet long at its crest and pictures show the progress of the work as this dam was started prior to the war and its status upon resumption after the war.

The first obstacle which had to be overcome in the construction of Bluestone Dam was to provide railroad access to this site. This necessitated a spur 5900 feet long which involved crossing the Greenbriar River with an 1165 foot bridge and at the site involved

UPRIVER VIEW OF BLUESTONE DAM rising out of the New River just south of Hinton, W. Virginia. When completed the dam will impound 631,000 acre-feet of water, creating a reservoir approximately 35 miles long.

RAILROAD BRIDGE constructed by Dravo to facilitate movement of material to dam site.

Six sizes of AGGREGATES are delivered from storage bins by a 700-foot conveyor to the CONCRETING PLANT at left above.

construction of a yard consisting of 7200 feet of spur tracks. Primarily, this access railroad was for the purpose of bringing aggregate to the mixer plant for the concrete involved in the dam. However, in addition to the aggregate and cement required for concrete there are many thousands of tons of miscellaneous materials required in a dam of this sort.

The mixer plant on this job is worthy of note. It involves a series of bins constructed on timber bents supported by wood piling which will hold 5000 cu. yds. of aggregate of the six types required for the dam. These bins feed by gravity to a conveyor belt 1200 feet long which leads to the top of the mixer plant. The mixer plant itself was erected as a high steel tower supported on concrete foundations and is capable of turning out nine cu. yds. of concrete every three minutes with its three (3 cu. yd.) tilting mixers.

The cofferdams for this job are not unusual as they have been used many times before by Dravo on its various river jobs. The upstream cofferdam consists of full circular sheet pile cells with short connecting cells. The lower or downstream cofferdams are double walls of sheet pile connected by rods filled in between with rock and partially bermed on the outside.

Another feature worthy of note in construction of this dam, as well as in Mahoning dam previously built by Dravo Corporation, is the use of cylindrical concrete piers to support the whirler cranes which place the concrete. These piers are poured in advance of concreting in the main dam structure and then are incorporated in the dam itself as part of its mass concrete. This system eliminated the need for a complicated steel trestle or an overhead cableway to place concrete.

From the mixer plant to the whirler which finally places the concrete in the forms, the concrete is moved by dinkey railroad system running across the downstream face of the dam.

The accompanying photographs tell the rest of the story.

DRAVO CORPORATION

PITTSBURGH PHILADELPHIA CLEVELAND

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