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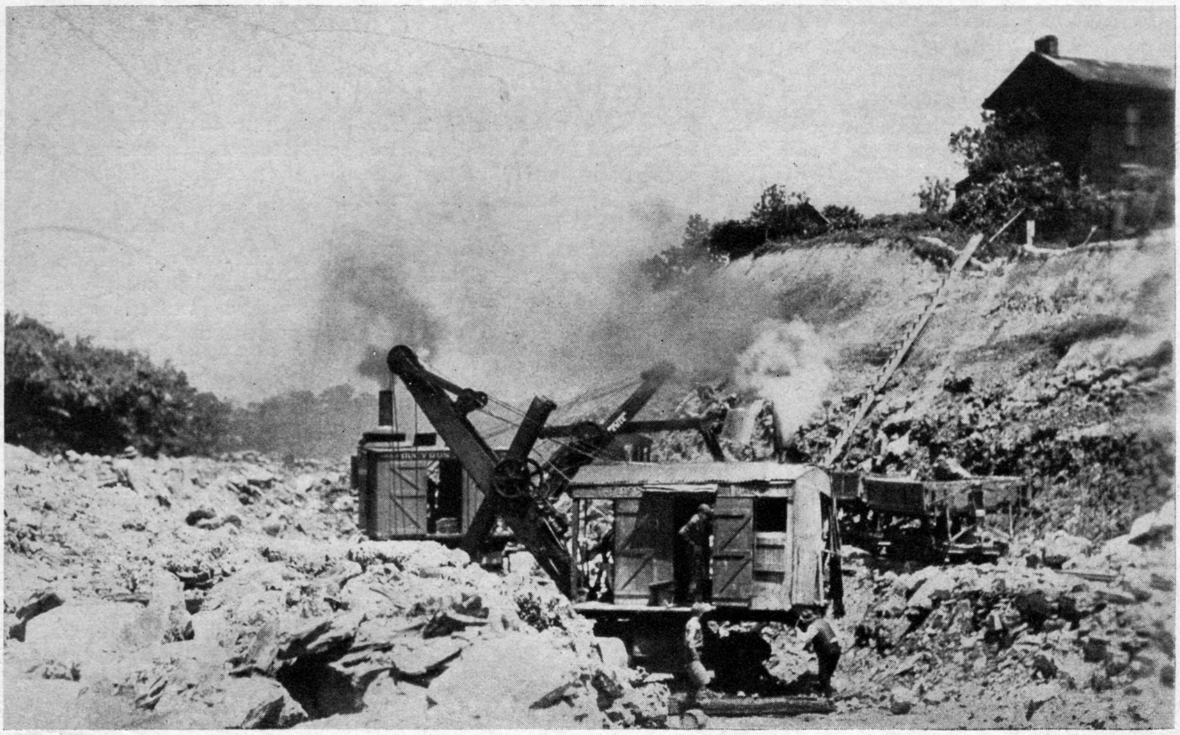


Courtesy L. W. Hoon

Modern Methods and Equipment on Connellsville Extension of Pittsburgh & West Virginia Ry.

First Section of Line, 17½ Miles in Length, Will Be Completed Early This Year—40 Power Shovels on Heavy Grading—Centrally-Mixed Concrete in Structures—2,600-Ft. Bridge to Span Monongahela River

By CHARLES M. NELSON

Associate Editor, Engineering and Contracting

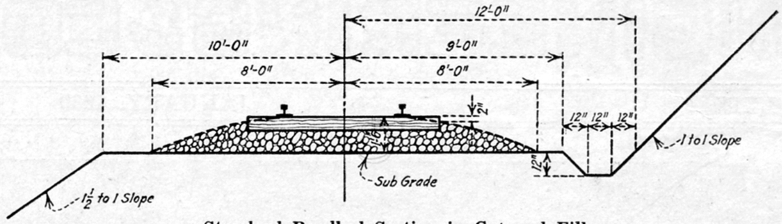
THE early part of the year 1930 will see the completion of the first 17½ miles of the Connellsville extension of the Pittsburgh & West Virginia Ry. Since March, 1929, a variety of earth-moving equipment, including 40 power shovels and numerous trucks, tractors, crawler-mounted wagons and narrow and standard-gauge locomotive and dump-car outfits, has been carrying the grade of the new line across the hills south and east of Pittsburgh. This work involved some of the heaviest grading that has ever been required in railroad construction, approximately 95 per cent of which had been completed by the end of 1929. The line has one 130-ft. fill and several fills close to 100 ft. in height. The deepest cut is 100 ft. deep and the heaviest cut contained 275,000 cu. yd. of excavation. Much of the excavation was in rock. The project also comprises one 735-ft. tunnel and 15 steel structures, including a 17-span bridge having a total length of 2,610 ft. over the Monongahela River at Belle Vernon.

The Vang Construction Co., of Pittsburgh, are the contractors for the grading and the masonry work. For some of the grading and construction of the tunnel the Vang forces were supplemented by the outfits of fourteen subcontractors. Contracts for the steel structures were let to the American Bridge Co., McClintic-Marshall Co. and Fort Pitt Bridge Co. The total estimated cost of the work performed by contract is $4,390,000.

Location

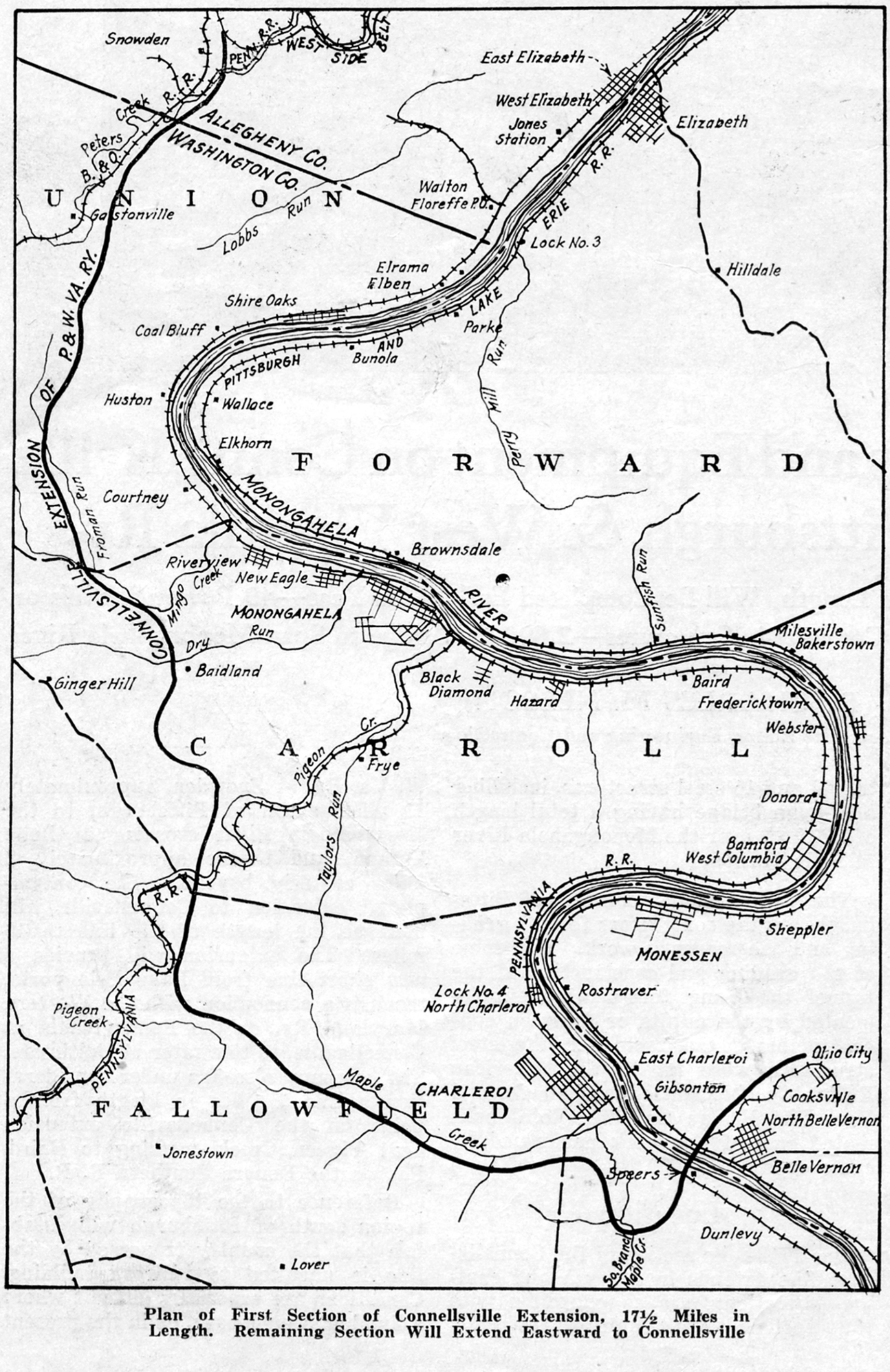
The 17½-mile section of the Connellsville line extends in a south and easterly direction from a connection with the West Side Belt Line of the P. & W. Va. Ry. at Snowden, approximately 11 miles south of Pittsburgh, to the Monongahela River crossing at Belle Vernon, and thence approximately 2 miles easterly beyond. The contemplated extension to Connellsville will increase the length of the line to 40 miles. The extension will provide a new short line from Lake Erie ports, through a connection with the Western Maryland Ry. or the Pennsylvania at Connellsville, to tidewater at Baltimore. The company also has under consideration a line 6 miles in length from a point on the Connellsville extension near Pigeon Creek crossing to Baird, Pa., on the Donora Southern R. R.

Reference to the topography of the region south of Pittsburgh will establish that the country traversed by the line is unsuited to railroad building. Conditions are especially difficult where a line has been chosen, as in the present case, for its directness and does not follow a longer, low-grade route adjacent to a water course. The Connellsville extension is a cross-country "high line": there are two steel-trestle crossings carrying the rails nearly 200 ft. above stream level below, and there are only three highway overpasses on the line. Construction consists of cutting off the tops of the hills, filling with the material removed where the haul is not excessive and spanning the deeper and wider valleys with steel viaducts.



Standard Roadbed Section in Cut and Fill

From the connection at Snowden (El. 885.00) the grade ascends at a nearly uniform rate to El. 1054.67 just beyond Sta. 184, descending to El. 958.85 at Sta. 285. The grade rises to El. 1047.36 at Sta. 395, descends to Pigeon Creek viaduct (El. 990.53) and ascends to El. 1089.46, the summit of the line, at Sta. 617, just beyond the tunnel. From the summit, the line is downhill all the way to Belle Vernon bridge. From the river, the grade ascends to Ohio City, where the present contracts terminate. The ruling grade is 1 per cent. The maximum curvature is 6 deg.; however, few of the curves are this sharp, 4-deg. and easier curves predominating.



Plan of First Section of Connellsville Extension, 17½ Miles in Length. Remaining Section Will Extend Eastward to Connellsville

Grading

Grading for the 17½ miles comprises 3,100,000 cu. yd. of unclassified excavation. Before commencing grading operations it was necessary to clear 120.8 acres of right-of-way. Of the total quantity of grading, close to 2,500,000 cu. yd. was required in the 10-mile section from Mingo Creek to Belle Vernon.

Material Encountered.—In general, the material consisted of from 5 to 15 ft. of earth overburden, covering layers of soft shale which crumbles easily upon exposure to the air, slate, limestone, sandstone and coal. The standard roadbed section, with 1½:1 slopes in fill and 1:1 slopes in cut, is shown in one of the accompanying illustrations. The 1:1 slopes were generally adhered to in the rock cuts, since it was found that the loose rock had a tendency to slide easily. In some cases, however, where a stratum of limestone or sandstone was encountered, the slope was altered to ¾:1 or even ½:1. Preliminary diamond-drill borings were made in the larger cuts to determine the nature of the underlying material and thus the allowable slope of the rock; possession of this information in advance of excavation allowed the setting of slope stakes in the proper position to give the desired completed slopes.

Division of Work and Equipment.—The general contractors reserved the heaviest and most difficult grading for themselves, letting out the remainder to thirteen grading subcontractors, who attacked the work from as many points. Subcontractors and their equipment, in order from the beginning of the stationing to the terminus of the line, were as follows:

Hardy Construction Co., Moorefield, W. Va., two Thew gasoline shovels loading trucks;

Sam Polino, Fairmont, W. Va., one Koehring gasoline shovel loading trucks;

S. T. Brotemarkle & Sons, Cumberland, Md., two Thew gasoline shovels loading trucks;

R. H. Cunningham & Sons, Turtle Creek, Pa., three Bucyrus steam shovels loading trucks and Linn tractors;

Freeland, McHale & Patten, Pittsburgh, Pa., one Bucyrus steam shovel

Courtesy L. W. Hoon

Upper Left—Building High Fill Over Arch at St. 420; Upper Right—Loading Standard-Gauge Equipment at Sta. 170; Center Left—Osgood Shovel Loading Caterpillar-Crawler-Wagon Outfit at Sta. 603; Center Right—A Busy Day in One of the Deep Cuts; Lower Left—3,450-Lb. Blast of Dynamite at Sta. 170; Lower Right—Marion 480 of the Vang Construction Co. Loading Standard-Gauge Equipment

loading Euclid crawler-mounted wagons drawn by Caterpillar 60 tractors;

Corrado & Galiardi, Connellsville, Pa., four Koehring, Osgood and Bucyrus-Erie shovels loading trucks and Western 4-yd. narrow-gauge dump cars;

Yost Construction Co., Pittsburgh, Pa., two Northwest gasoline shovels loading trucks;

James P. McCabe, Pittsburgh, Pa., one Marion 450 gas-electric and one Erie steam shovel loading trucks and Linn tractors;

Rankin Construction Co., Uniontown, Pa., two Erie shovels loading trucks and Western 4-yd. narrow-gauge dump cars;

Stein & Geisel, Niles, O., one Koehring and one Thew gasoline shovel loading trucks;

C. M. Hall, Delmont, Pa., one Erie steam shovel loading trucks;

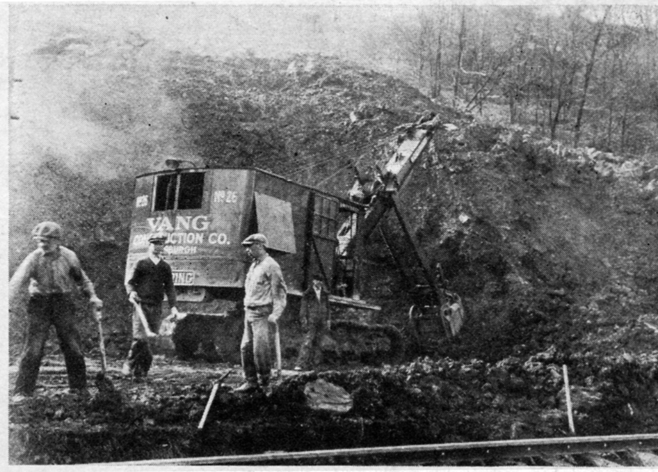
E. N. Jones, Pittsburgh, Pa., one Northwest gasoline shovel loading trucks;

Donora Construction Co., Donora, Pa., four Osgood shovels loading trucks.

In addition to these subcontractors, construction of the 735-ft. tunnel was assigned to the Faulconer Construction Co., Orange, Va.

In carrying out their own sections of the excavation the general contractors used Erie, Marion, Koehring, Osgood and Bucyrus shovels loading trucks, Linn tractors, Athey wagons and Western 4-yd. narrow-gauge and 20-yd. standard-gauge dump cars.

Gasoline-powered excavating equipment predominated, and it will be noted from the account of equipment given above that trucks were used exten-

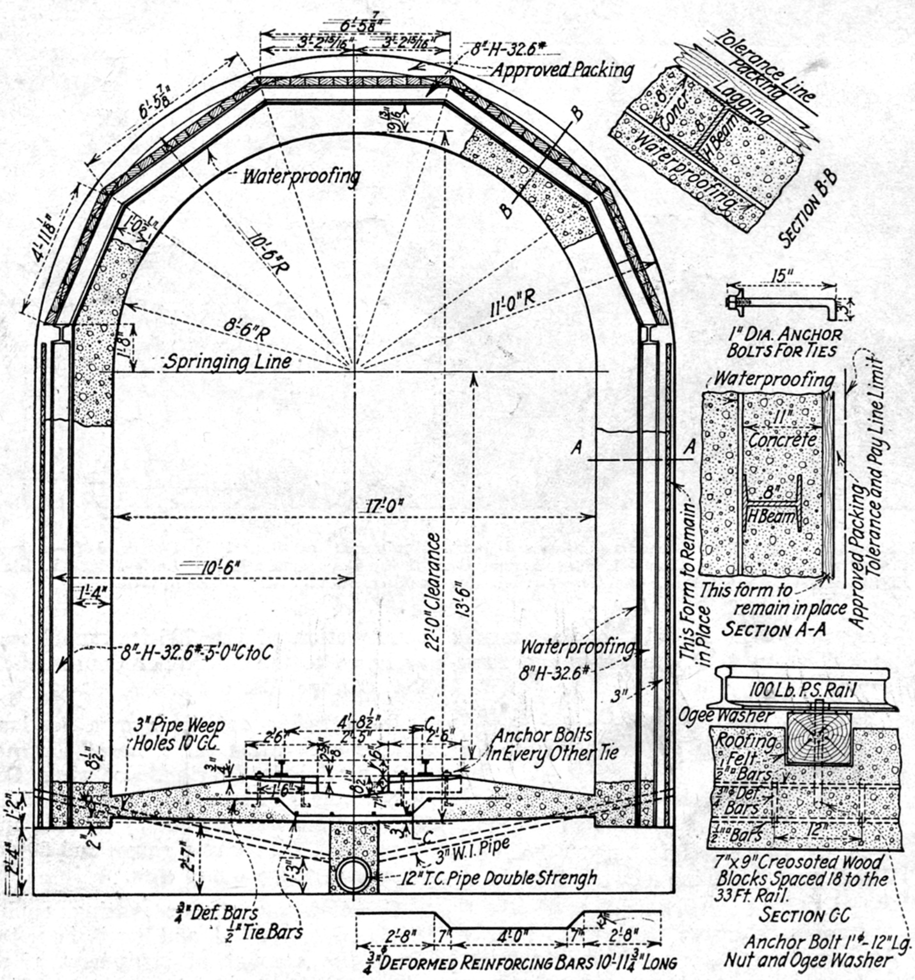


Left—Slide at Sta. 329 from Grade Above; Right—Koehring 1½-Yd. Gasoline Shovel at Work on State Highway at Foot of Slide

sively for hauling spoil. At some sections handled by steam power where water was not available at hand, it had to be piped for long distances; in one such case it was brought nearly 2 miles from the nearest town. Many of the trucks were equipped with dual pneumatic-tired wheels, and this equipment performed successfully in wet weather when hauling through the clay and mud was difficult. The Linn tractors also gave a good account of themselves under adverse conditions.

Contractors' Methods.—Following stripping of the overburden in the cut sections, holes were put down with Keystone drillers and shot with Atlas explosives. In the heavy rock cuts the blast holes went as deep as 20 ft. below the rock surface. The heaviest cuts were excavated in five or six lifts. Power shovels were mainly brought in by rail and trucked to the point of operations. In some cases the shovels moved short distances from sidings or highways under their own power.

Some of the heaviest rock excavation on the line occurred between Sta. 165 and the viaduct over Froman Run and the state highway at about Sta. 230. Here the top of the cut was removed by a Marion 480 and a smaller Erie steam shovel loading trucks. Later, standard-gauge track was brought up to this point and spoil was loaded into 20-yd. Western dump cars. At the south end of this cut material was wasted by pyramiding it above the surface of the ground at the sides of the cut, the haul being made by trucks. Excess of excavation over fill quantities was typical of the grading along the whole line, and material was deposited frequently in waste fills and in low places at the sides of highways. Narrow-gauge equipment was used in excavating the lower lifts of many of the cuts, the shovels loading Western 4-yd. cars propelled by Porter dinkeys. The cars dumped in embankment from temporary timber trestles.



Tunnel Section, Showing Timbering and Concrete Lining

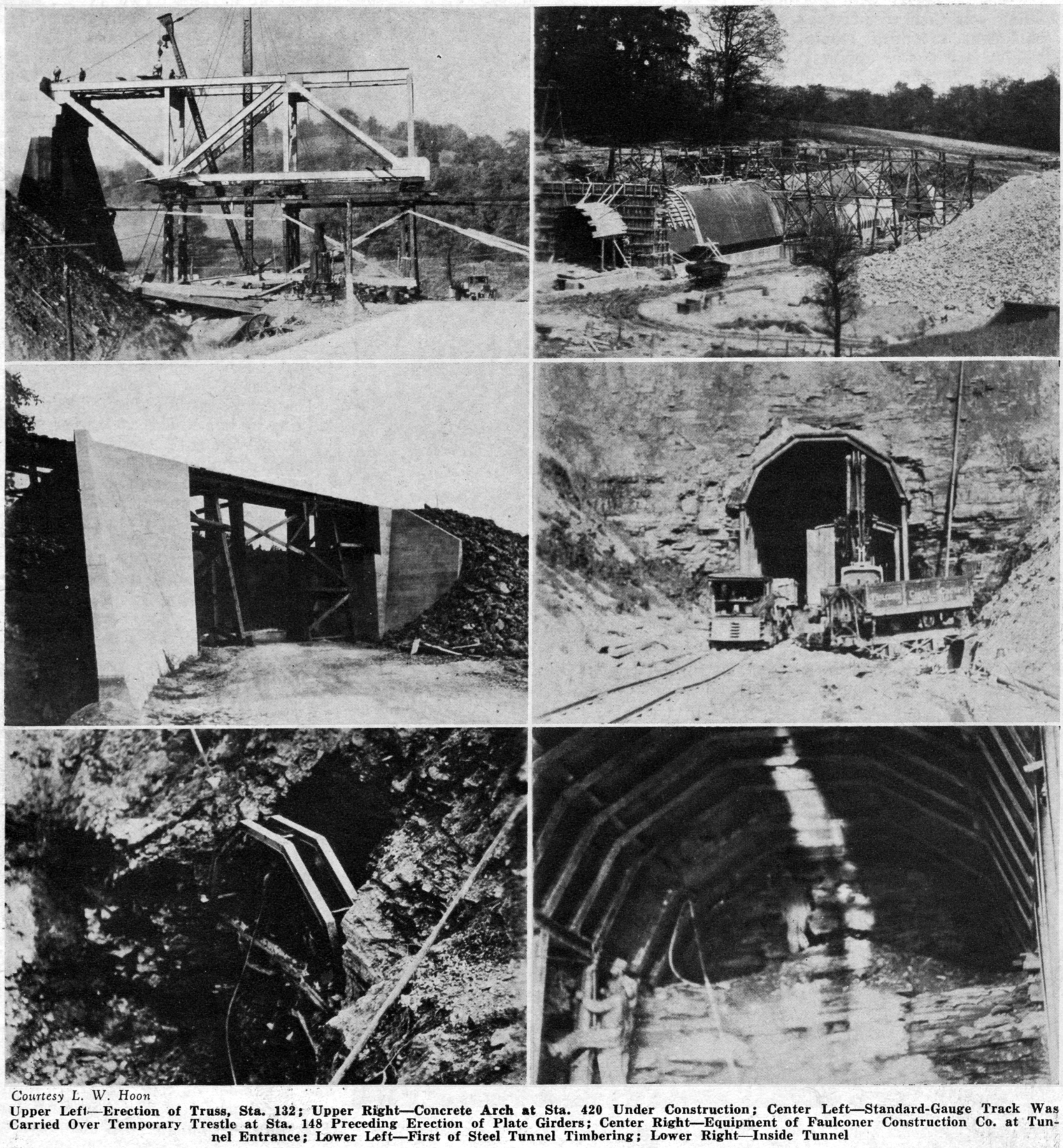
Fills were made by dumping from trestles, or by building out with dump trucks, crawler wagons or Linn tractors. The lower layers of earth fills built in the latter fashion were compacted by rolling. Where fills were built on the sides of hills and sliding of the embankment on underlying layers of clay or on sloping rock surfaces was anticipated, benches were blasted in the rock before depositing the embankment material.

The highest fill on the line is at Sta. 753. This fill has a maximum height of 130 ft. A 5x6-ft. box culvert under the fill is 450 ft. long. This fill was built out by dumping over the two ends and was rolled up to a height of 60 ft. Embankment above this height was simply piled on. The fill has moved slightly since its completion, but to no great extent.

Slides.—A certain amount of trouble was caused by sliding of the high fills built on sloping ground or over inclined rock surfaces. The highest fill on the line has shown evidence of instability; slides of minor consequence occurred on the section of R. H. Cunningham & Sons near Froman Run viaduct and at about Sta. 350, where the fill is chiefly rock of a slaty character. At a sidehill section near this fill, the earth overburden for a distance of about 150 ft. back along the hillside began to slip toward the grade. This movement was stopped by driving a row of steel-and-concrete piling down to a bedding in rock at the foot of the hill along the side of the grade.

The most serious slide occurred at Sta. 329, where the line parallels the state highway about 500 ft. away. Here the grade leaves a cut, passes over a concrete skew underpass and is carried to the next cut section on an earth and rock fill. The fill was built on sloping ground and contained approximately 40,000 cu. yd. of material. On Nov. 9 a slide carried almost the whole of the embankment down the hillside as far as the highway, blocking motor traffic and threatening to tie up traffic on an interurban line next to the road. A 1½-yd. Koehring gasoline shovel was brought in to clear the road and dispose of the oncoming material as it flowed down the hill, on to the highway. This shovel worked alone day and night loading trucks until the morning of Nov. 13, when a 1½-yd. Marion steam shovel was moved in to work alongside. The two shovels loaded a double line of trucks—one line moving in each direction. A truck received its load, hauled it to a waste fill a mile or two down the road and returned to join the line moving in the opposite direction. The attack on the slide continued until the highway was clear and the flow of mud, clay and rock had ceased. It is estimated that half of the yardage in the fill was lost in the slide.

Before the fill at this point was started, the underlying stratum of rock was properly benched. However, after con-



Courtesy L. W. Hoon

Upper Left—Erection of Truss, Sta. 132; Upper Right—Concrete Arch at Sta. 420 Under Construction; Center Left—Standard-Gauge Track Was Carried Over Temporary Trestle at Sta. 148 Preceding Erection of Plate Girders; Center Right—Equipment of Faulconer Construction Co. at Tunnel Entrance; Lower Left—First of Steel Tunnel Timbering; Lower Right—Inside Tunnel

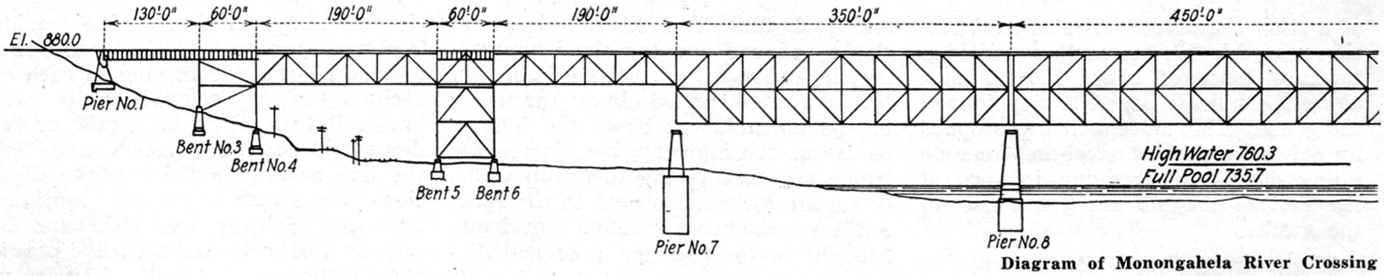


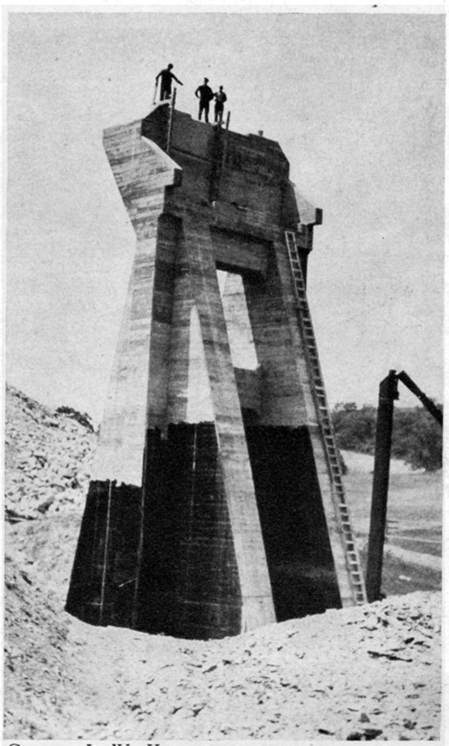
Diagram of Monongahela River Crossing

siderable filling had been done there were indications of a slide. A number of french drains were constructed, and the bottom slope of the fill was rolled in 3-ft. layers, in an effort to solidify the new material with the old. The filling was then resumed, and the embankment remained stable until the weight above was again sufficient to push the fill out at the bottom. The grade at this point will be restored by driving piling fitted with steel shoes into the underlying rock, to carry the track across the ravine on a temporary trestle. A fill will be made eventually with granulated slag. In the case of the high fill at Sta. 753, sliding probably results from the weight of the fill being more than the character of the material will stand with a 1½:1 slope. Motion of the fill will probably cease automatically when slopes have been assumed that will take care of the weight on top. Considering the character of the country through which the line passes, the railroad company has been fortunate as far as slides are concerned.

Tunnel

The single tunnel on the line is on a tangent nearly at the summit of the grade. It was built to avoid a 130-ft. cut and the resulting overpass that would have been required to carry a county road over the grade. The tunnel, 735 ft. long, was driven in soft rock—chiefly shale and soft slate. A seam of coal was also encountered.

Tunnel Section.—The tunnel section is shown in one of the accompanying illustrations. The tunnel is lined with concrete throughout its length. Steel timbering, consisting of 8-in. 32.6-lb. H-sections, was specified, as shown. Dry packing was used to fill the space between the timber lagging and the limit of the excavation. The tunnel has a concrete floor with center drain. Weepholes of 3-in. pipe spaced on 10-ft. centers lead to a 12-in. terra-cotta drain along the center-line of the tunnel below the pavement slab.



Courtesy L. W. Hoon

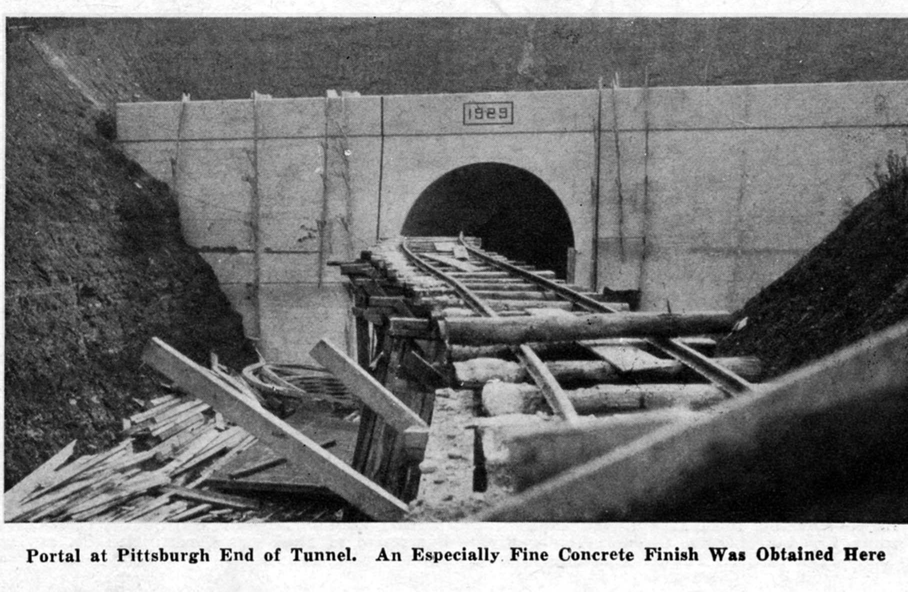
Abutment of Deck Truss at Sta. 132

Contractor's Methods.—The soft nature of the material encountered precluded opening more than 5 lin. ft. of tunnel at a time. Two 4x4-ft. drifts were advanced in 10-ft. lengths to permit setting the wall plates. The top heading was carried forward 5 ft. at a time and the arch timbers and lagging were placed immediately. The H-beam sections were placed 2 ft. 6 in. on centers for 250 ft. at the Pittsburgh end of the tunnel and on 5-ft. centers the rest of the way. Small charges of dynamite were sufficient to loosen the soft rock. Muck was handled by an Erie ¾-yd. air shovel with a special rock dipper, loading 5-yd. narrow-gauge dump cars pulled by a Plymouth gasoline locomotive. Compressed air was furnished by three Ingersoll-Rand diesel-driven compressors. Excavation was carried on from one end of the tunnel only. Very little water was encountered.

Dry packing was placed behind the lagging by hand. The contractor placed his tunnel lining in sections, moving a panel of forming up ahead as soon as a section was stripped. Concrete was delivered to a hopper at the west portal and chuted into 2-yd. cars running into the tunnel on a trestle. Workmen shoveled the concrete into the forms by hand. The tunnel portals are of concrete; the excellent finish obtained reflects credit upon the manufacture of the concrete and the care with which it was placed.

Excavation was begun on May 11 and the tunnel was holed through on Sept. 2. The lining is nearly complete at the present time. Tunnel quantities are as follows:

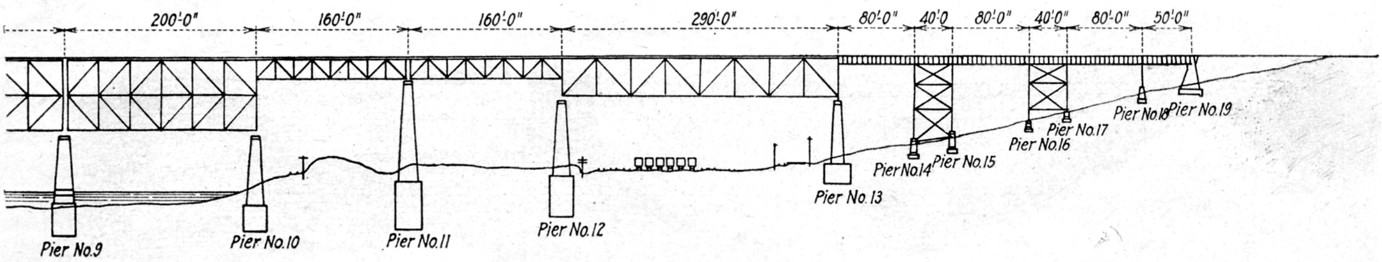
Portal excavation, cu. yd.	48,724
Tunnel excavation, cu. yd.	14,242
Facade concrete, cu. yd.	500
Lining concrete, cu. yd.	3,000
Packing, cu. yd.	448
Steel, lb.	470,511
Timbering, M. ft. b.m.	110.9



Portal at Pittsburgh End of Tunnel. An Especially Fine Concrete Finish Was Obtained Here

Structures

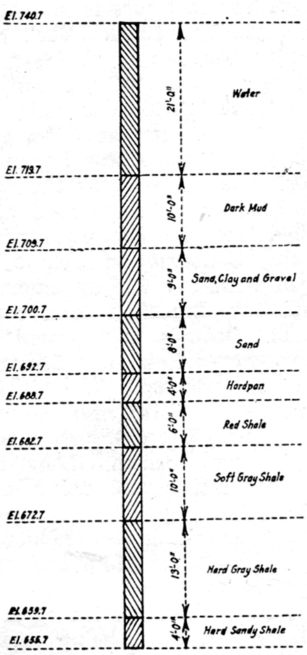
Table I is a list of the steel structures on the line, along with approximate span lengths and contractors' names. The largest concrete structures are three 25-ft. concrete arches under heavy fills and a skew underpass spanning a private road and drainage. There are also a number of 4x5-ft., 5x6-ft. and 8x8-ft. concrete box culverts and a number of concrete pipe drains, ranging from 24 to 60 in. in diameter. The railroad company will also have to



The Belle Vernon Side Is at the Right

construct three highway overpasses along the 17½-mile section of line. The structures were designed for E-65 loading. Bridge and culvert quantities are given below:

Foundation excavation, cu. yd.	53,730
Class C concrete, cu. yd.	8,508
Class B masonry, cu. yd.	35,000
Steel superstructure, lb.	13,785,130
Reinforcing steel, lb.	1,476,903



Test Hole Near Pier No. 8, Monongahela River Bridge

Two of the steel viaducts, spanning Mingo Creek and Pigeon Creek, are exceptionally long and high structures; at each of these crossings the elevation of base of rail is approximately 190 ft. above stream elevation.

All concrete in arches, culverts, viaduct pedestals and bridge piers and abutments had been placed by the first of the year. Peters Creek, Froman Run and Valley Inn viaducts and the steel truss at Sta. 132 were complete, and Mingo Creek and Pigeon Creek viaducts were under way.

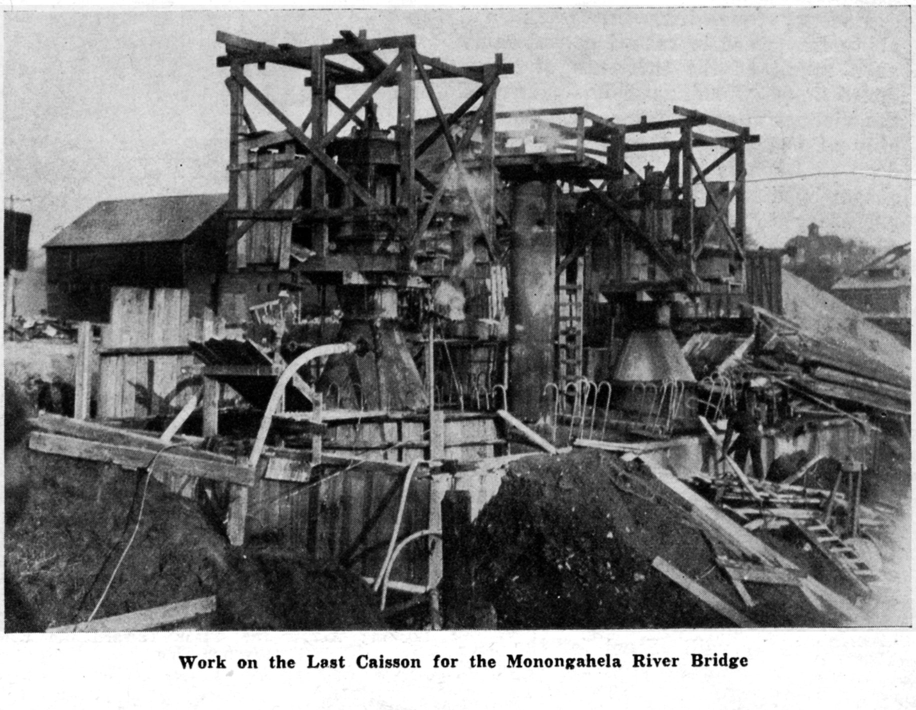
Centrally-Mixed Concrete.—With a few minor exceptions, all concrete placed on this job was centrally mixed. For this purpose the Vang Construction Co. operated three central mixing plants: one at Monongahela, Pa., one on the east side of the river at the Belle Vernon bridge site and a third floating plant on the Monongahela River at the bridge.

The two land plants were nearly identical in equipment. Both plants were situated on the river and aggregates were brought in in barges and delivered to bins by stiff-leg derricks or cranes equpped with clamshell buckets. Smith 56-S 2-yd. tilting mixers were used. Sacked cement was delivered to weighing hoppers by Barber-Greene belt conveyors. Water was controlled by Blaw-Knox measuring tanks. The floating plant employed a 1-yd. mixer and was used to mix and place the concrete for the bridge piers.

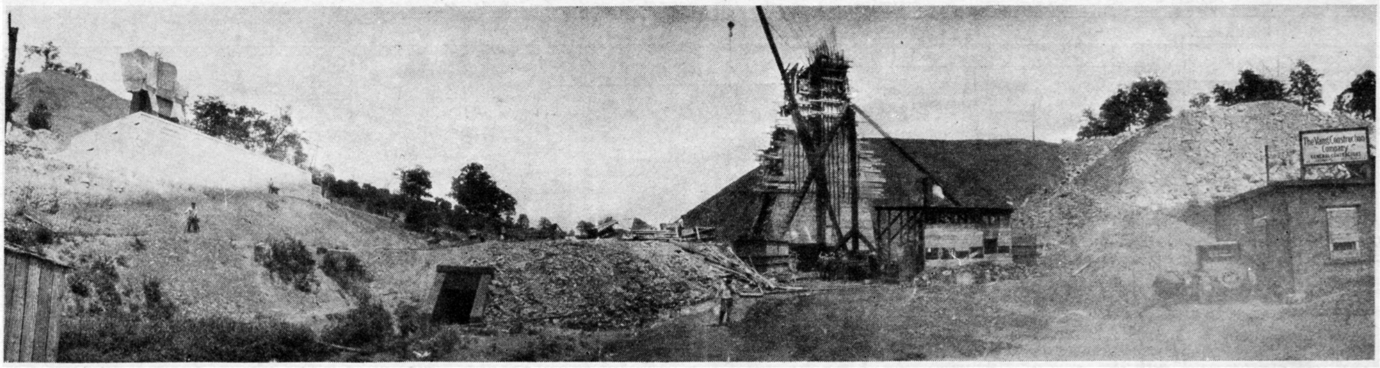
Concrete was hauled in open-body dump trucks. Most of these were 3-ton Dodge pneumatic-tired trucks. The Monongahela plant served nearly the whole line, and concrete was transported successfully from this plant as far as 14½ miles. The contractor ascribes his success in the long-distance hauling of concrete to the use of Celite to the amount of 3 per cent of the weight of cement, admitting that a workable mix at the end of such long hauls would not have been possible

Table I—Steel Structures on Connellsville Extension of P. & W. Va. Ry.

	Type of Structure	Crosses	Approx. Span, Ft.	Contractor
1.	Steel viaduct	Peters Creek Pennsylvania R. R.	750	American Bridge Co.
2.	Deck truss bridge	Road	200	American Bridge Co.
3.	Deck plate girder	Road	70	American Bridge Co.
4.	Steel viaduct	Froman Run Road Electric Railway	500	American Bridge Co.
5.	Steel viaduct	Mingo Creek Road	1,700	American Bridge Co.
6.	Steel viaduct and deck truss	Road (Valley Inn viaduct)	400	McClintic-Marshall Co.
7.	Steel viaduct	Pigeon Creek Pennsylvania R. R. Road	1,500	McClintic-Marshall Co.
8.	Through plate girder (double track)	Road	45	Fort Pitt Bridge Co.
9.	Steel viaduct	Maple Creek Electric railway Road	800	McClintic-Marshall Co.
10.	Steel viaduct	Road and tracks (Warner Mine)	500	American Bridge Co.
11.	Steel viaduct	Road and stream	800	American Bridge Co.
12.	Steel viaduct	Road and stream (Maple Terrace viaduct)	400	McClintic-Marshall Co.
13.	Steel viaduct	Road and stream	350	American Bridge Co.
14.	Steel viaduct	South Branch Maple Creek Road	350	American Bridge Co.
15.	Multiple-span truss bridge	Monongahela River Steam and electric railways Roads	2,610	American Bridge Co.



Work on the Last Caisson for the Monongahela River Bridge



East Abutment of Bridge at Sta. 132 Under Construction. Foundation Was Carried Down to Floor of Old Mine. Precast Cribbing Retains Fill in Front of West Abutment

otherwise. The finished concrete surfaces present an exceptionally smooth, uniform appearance. Much of the concrete was placed while low temperatures prevailed. An arch, 7 miles distant from the mixing plant, was poured at zero weather. In this case the concrete was hauled to the site at temperatures above 90 deg. It was found that the mix suffered a loss in temperature of about a degree for each mile hauled. Concrete strength averaged 2,500 lb. per square inch at 28 days. During the summer of 1929 the Monongahela plant operated at a rate of from 7,000 to 8,000 cu. yd. a month.

Conditions and Methods.—Pedestals and abutments were all carried down to a good bedding in rock. Where pedestals were located on the steep sides of a valley, this entailed considerable excavation, and in some cases the most economical method was to cut directly into the hillside from the bottom with a power shovel. At Mingo Creek viaduct, where the excavation for some of the hillside pedestals was made in this way, the spoil was piled at one side and used for backfilling upon completion of the concrete work. Other foundation pits were excavated with grab-buckets and by hand.

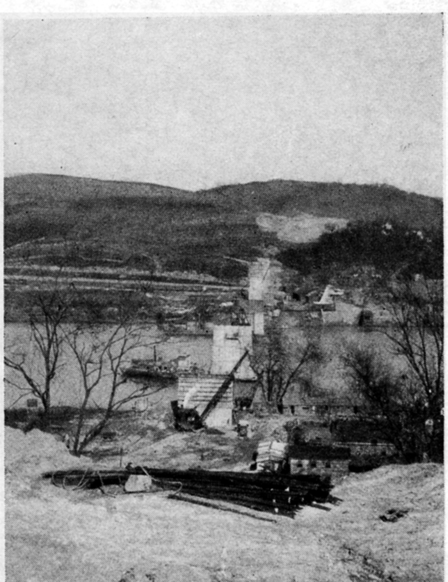
Masonry quantities in piers and abutments were increased considerably as a result of the existence of abandoned mine workings below many of the viaduct sites. In some cases, notably at the bridge at Sta. 132, where deep coal seams had been removed, as shown by diamond-drill borings, it was necessary to carry foundations 30 or 40 ft. deeper than the upper layers of rock which otherwise would have furnished a good bearing.

Concrete forms were built in the field. In delivering concrete the trucks backed up wooden ramps and discharged their loads into hoppers, from which the concrete was chuted to the forms or buggied across timber trestles. This scheme freed the trucks for immediate return to the mixing plant and eliminated driving over unsuitable ground. In the case of many of the hillside pedestals, this mode of delivery was the only one feasible.

Steel for Peters Creek viaduct was brought in by rail. Steel for the second structure on the line and for Valley Inn viaduct was trucked in over highways. Upon completion of the first two structures, a temporary timber trestle was built over the road crossing at Sta. 148 and steel for Froman Run viaduct was brought in over company rails. Following completion of this structure, steel for Mingo Creek viaduct was brought out in the same way. Steel for Pigeon Creek viaduct was delivered over the Monongahela & Washington branch of the Pennsylvania R. R. Viaducts at the lower end of the line will be erected in order, steel coming out over company rails.

Monongahela River Bridge.—The 2,610-ft. bridge over the Monongahela River is the largest and most difficult structure on the line. It will consist of eight deck-truss and nine plate-girder spans, carried on seven piers, nine steel trestle bents and the abutments. The spans range in length from 40 ft. to 450 ft., the length of the channel span. The channel span and the two adjacent trusses are 75 ft. deep and will carry tracks of the Pittsburgh Steel Co. on the lower level.

Foundations for six of the piers were sunk to rock as reinforced-concrete pneumatic caissons, varying from 25x45 ft. to 25x56 ft. in section. A section of one of the test pits is shown in an accompanying diagram. Each caisson was built with two muck locks and a central man lock. Timber cofferdams were fastened to the caissons by 12x12-in. timbers cast in the concrete, and pouring of the piers was begun inside the cofferdams as soon as the caissons were sealed off. Compressed air was furnished from the compressor boat of the Vang Construction Co., which is equipped with two 125-hp. steam boilers and two Ingersoll-Rand compressors. The boat is also provided with an emergency air chamber for treating cases of the "bends." The river piers were poured in lifts from the floating mixing plant. The footing for the seventh pier was excavated by driving steel sheet piling and using a grab-bucket.



Monongahela River Bridge, November, 1929, Looking Across the River Toward the Belle Vernon Side

Concrete work on the Monongahela River bridge is complete and erection of the steel has begun.

Personnel.—Construction of the Connellsville extension is being carried on under the direction of H. H. Temple, chief engineer, P. & W. Va. Ry., assisted by F. L. Riddle, construction engineer, and, in the field, W. C. Kline, assistant construction engineer. The line is divided into three residencies, over which R. B. Stone, G. S. Ferguson and E. H. Knight have supervision. L. E. Goerder is general superintendent for the Vang Construction Co.

Examinations for Architect.—The U. S. Civil Service Commission, Washington, D. C., has announced open competitive examinations for associate architect and assistant architect. Applications must be on file with the Civil Service Commission at Washington, D. C., not later than Feb. 12. The examinations are to fill vacancies occurring in the Office of the Supervising Architect, Treasury Department, in connection with the construction of public buildings in Washington, D. C., and elsewhere. The entrance salaries are $3,200 a year for the associate grade and $2,600 a year for the assistant grade. Higher-salaried positions are filled through promotion.