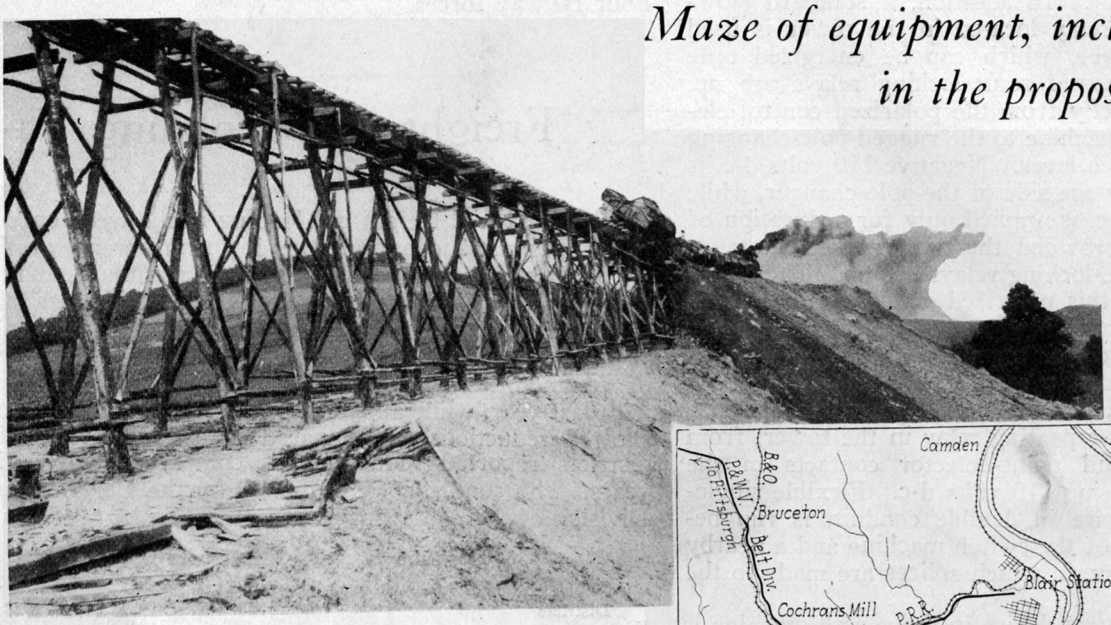
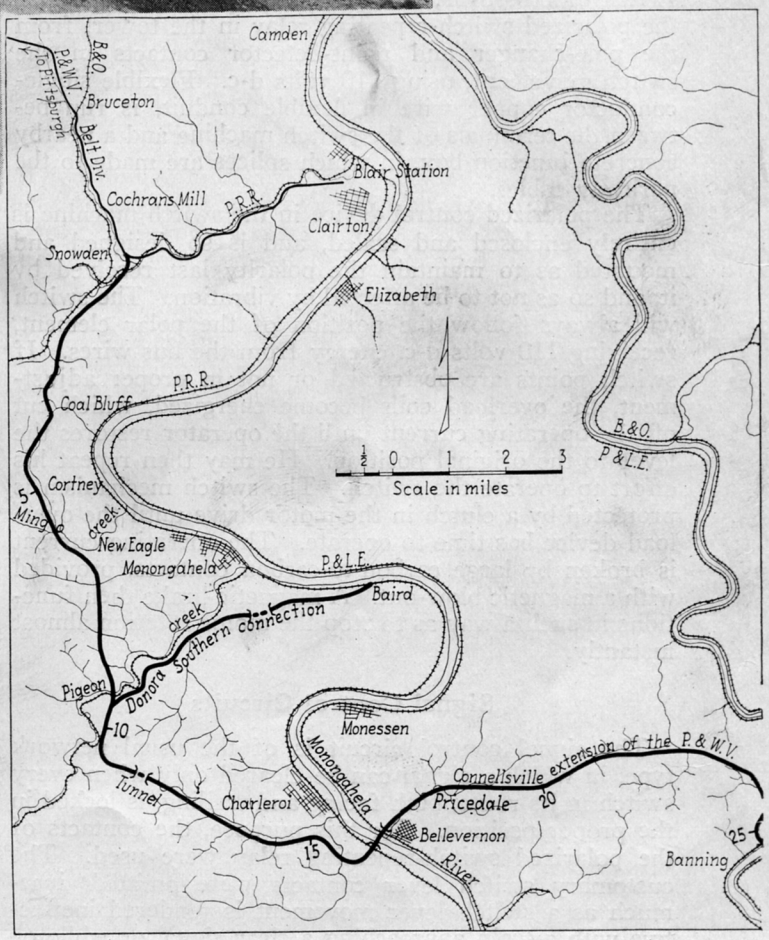
Many Achievements Feature

Maze of equipment, including 40 power in the proposed trunk line—



Construction Trestles and Narrow-Gage Equipment Were Used in Building Many of the Larger Fills



FROM the standpoints of purpose, difficulties encountered, speed of construction, equipment used and special structures, the new 38-mile single-track extension of the Pittsburgh & West Virginia to Connellsville, Pa., now about 75 per cent completed, is one of the most interesting and unusual pieces of railroad construction seen in this country in many years. In the first place, the new line is to be the connecting link in a proposed new trunk line from the central west to tidewater at Baltimore, Md., uniting the Wheeling & Lake Erie, the Pittsburgh & West Virginia and the Western Maryland. Speed has been the essence of the construction methods employed and at times hundreds of men and as many as 40 power shovels, supplemented by fleets of material-handling equipment, have been spread out over the work, producing a line of favorable grade and alinement through some of the roughest country in Pennsylvania. Altogether, approximately 7,100,000 cu. yd. of grading, largely in rock, will have been required when the work is completed, along with the placing of about 77,000 cu. yd. of concrete in piers, abutments, arches and other masonry structures. Two tunnels, with a combined length of 1,935 ft., will penetrate mountain ridges, and there will be 41 major bridges and viaducts. A number of these latter structures, including a 2,610-ft. part double-deck bridge over the Monongahela river, a 2,600-ft. single-deck bridge over the Youghiogheny river, and several long viaducts over 175 ft. in height, incorporate special features of design and construction and are, therefore, of unusual interest.

Plan and Location of New Line

The Connellsville extension, which was authorized by the Interstate Commerce Commission in June, 1928, extends in a southeasterly direction from a connection with the West Side Belt line of the Pittsburgh & West Virginia at Snowden, Pa., about 11 miles southeast of Pittsburgh, to Connellsville, a distance of 38 miles. From Snowden, the line strikes out over rough, rugged country and at a point about 16½ miles from Snowden, crosses the Monongahela river to Bellevernon, Pa. From here it extends almost due east for about 9 miles to a crossing of the Youghiogheny river at Banning, Pa., beyond which it continues in a southeasterly direction to Connellsville.

In less than 30 days after the line was authorized, grading was begun, although work under the first large contract, including the first 17½ miles of the line, was not started until about six months later. At the present

New Line of P. & W. Va.

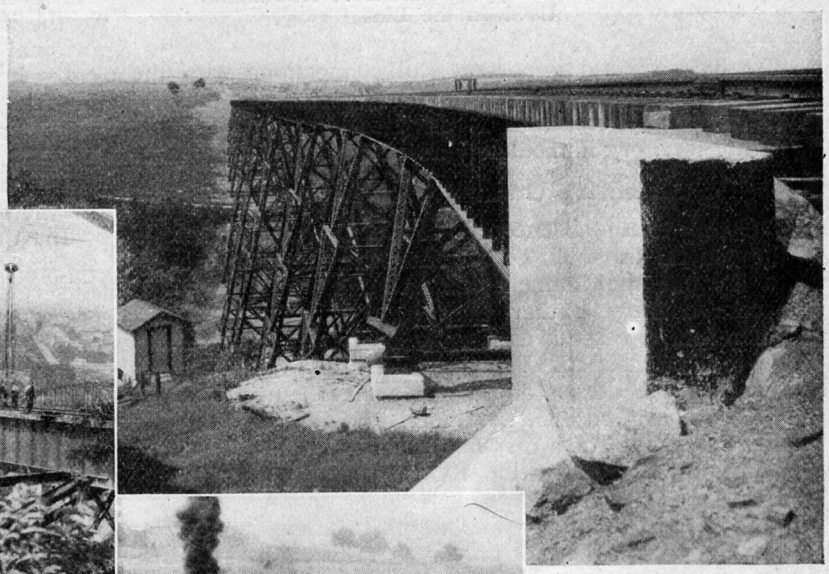
shovels, speeds work on 38-mile link
Bridge work of unusual interest

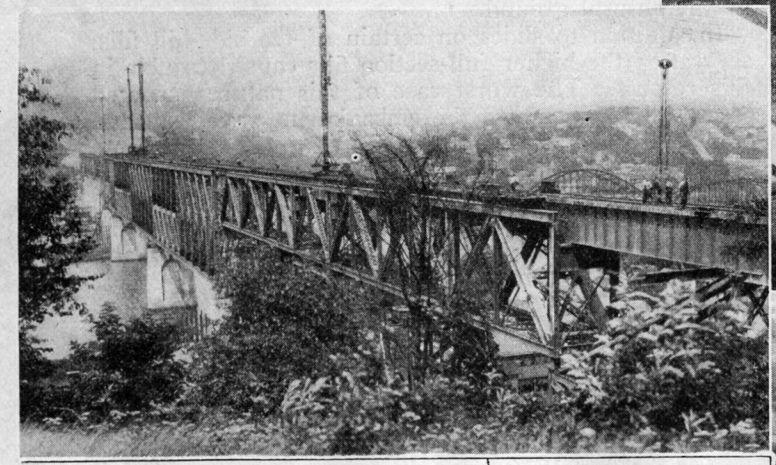
time this section, which includes the heaviest grading on the entire line, the bridge over the Monongahela river, and a 735-ft. tunnel, is completed, and work is progressing rapidly on the next 16 miles of the line to a point near Scottdale, Pa. This latter section includes fairly heavy grading, the 2,600-ft. bridge over the Youghiogheny river and one tunnel about 1,200 ft. long.

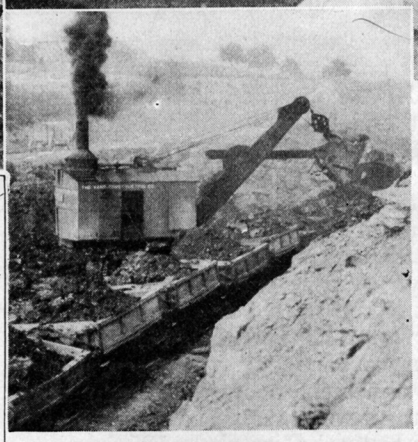
Work on the last five miles of the line to a connection with the Western Maryland at Connellsville has not yet been put under way, but because of the more favorable topography in this territory, this section of the line will require only a few months to construct when work is once started. At the present time, approximately 75 per cent of the work on the line as a whole has been completed, and it is expected that the entire line will be ready for operation late in the spring of 1931.

When completed, a new through route to the East will have been established via the W. & L. E. to Pittsburgh Junction, the P. & W. Va. for a distance of about 79 miles through the Pittsburgh district to Snowden, the new extension to Connellsville, and the Western Maryland to Baltimore. It is even possible that the roads included in this route will be combined under one management, as application for such a combination is now before the Interstate Commerce Commission.

In addition to being a connecting link in a new through route, it is expected that the new line, passing through the highly developed industrial section of the Monongahela River valley, will eventually originate much business. Already, a six-mile branch line, to be known as the Donora Southern connection, is planned, which will extend to Baird, Pa., on the Monongahela river, connecting with the Donora Southern railway of the American Steel & Wire Co. The new line will



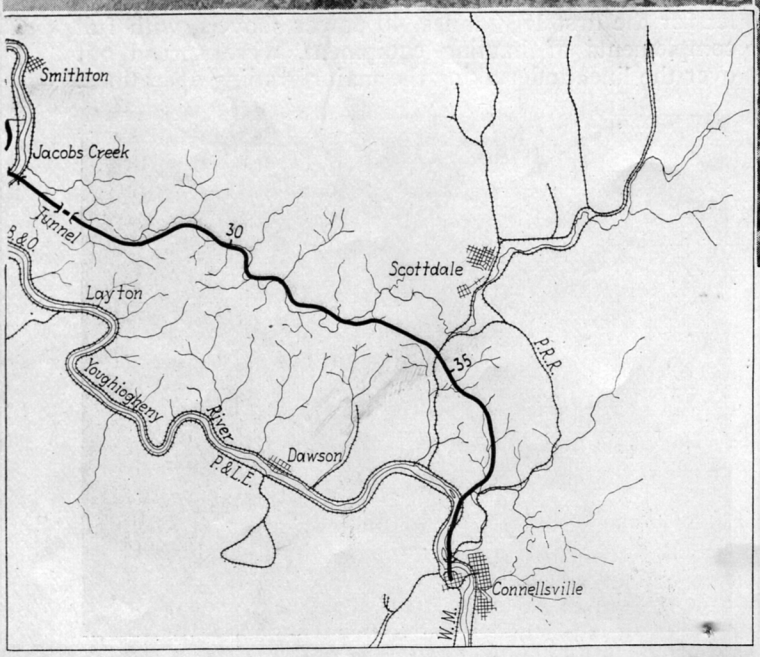




Above — The Pigeon Creek Viaduct, 1607 ft. Long and 190 ft. High

Left — The Monongahela River Bridge, One of the Three Large Bridges on the Line

Below — Forty Power Shovels Were Employed at One Time on the Grading



Map of the Connellsville Extension of the P. & W. Va., Showing Main Points of Interest

One of the Pier-Type Counterfort Abutments Used on the Line

also have several important rail connections with the view of tapping existing industrial plants and will, in all probability, stimulate development along a large part of the territory immediately adjoining it.

Extensive Grading Was Necessary

Owing to the absence of prominent water courses in the general direction of the new line, it was necessary to lay out the Connellsville extension as a high-line across country, rather than as a water-level route. Therefore, the line is essentially a series of cuts through the tops of hills and fills across sags, with steel viaducts spanning the deeper and wider valleys. From Snowden, at Elevation 885, the line rises and falls in an undulating grade for a distance of 11.8 miles, to a prominent summit at Elevation 1089, at the east end of the first tunnel.

From this point the line drops to Elevation 880 at the Monongahela River crossing, and then rises to Elevation 1059 at about M.P. 20.5. The line then descends to a level crossing of the Youghiogheny river at Elevation 935 and, at about M. P. 25.6, it begins to rise again to Elevation 1090 at about M. P. 34.1. From this point, which is near the end of the work under construction at the present time, the line will drop off to an elevation of about 909 at Connellsville.

In spite of the rough country encountered, a ruling grade of one per cent, compensated for curvature, has been obtained, and curvature has been held below 4 deg., except for several curves of 6 deg. To secure such favorable grades and alinement necessitated numerous heavy cuts and fills, the two tunnels and several high viaducts, two of which carry the line about 185 ft. above the stream level.

Grading Progress

Altogether, about 7,100,000 cu. yd. of grading will be necessary when the line is completed. Already, approximately 5,000,000 cu. yd. have been handled, 60 to 65 per cent of which was shale, slate, limestone and sandstone. About 3,100,000 cu. yd. of excavation was made in the first 17½ miles of the line, where several cuts from 80 ft. to 95 ft. deep were necessary, and one with a maximum depth of 100 ft. Fills in this section were unusually heavy, with a maximum height of 120 ft. in one case and heights between 80 ft. and 90 ft. in many other instances. The heaviest cut on the whole line is also on the first 17½ miles and involved the removal of about 285,000 cu. yd. of excavation, 60 per cent of which was rock, while the largest fill is on the section between the Monongahela and Youghiogheny rivers. This embankment, which is approximately 1,600 ft. long, required over 311,000 cu. yd. of fill.

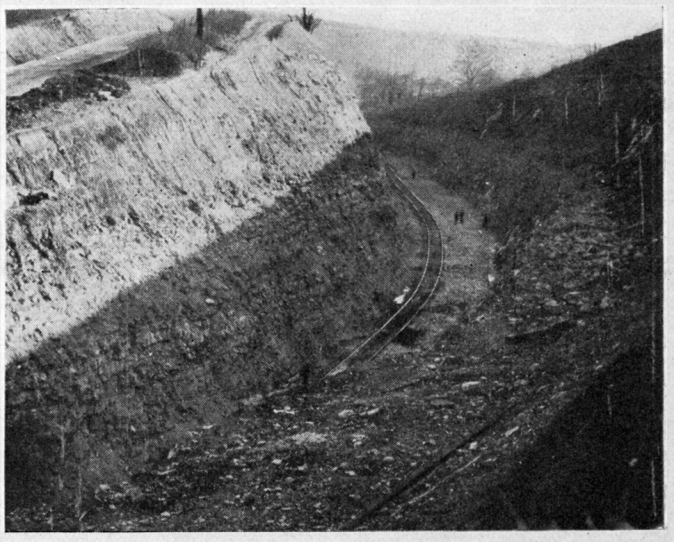
Throughout the territory traversed by the new line, test borings and observation of the work thus far completed have shown that rock lies generally from 10 ft. to 20 ft. below the surface, the top layer of the rock being a soft, readily disintegrating shale. The standard roadbed section is 20 ft. wide at subgrade on fills and 24 ft. wide in cuts. The side slopes being used in cuts and fills vary with the conditions encountered, but in general, a 1½ to 1 slope has been found satisfactory in earth cuts, a ¾ to 1 slope satisfactory in rock, and a 1½ to 1 slope suitable for fills.

Combination cut and fill sections were impossible along many parts of the line because the natural ground of the hillsides would not support the weight of the fills. At several points where cut and fill sections were tried in the interest of economy, serious slides occurred, the original ground giving way under the load. In these cases it was necessary to move the line back into the hillside to secure a stable roadbed. At one point in particular where a serious slide occurred, a high fill is being made with granulated slag in an effort to provide an embankment sufficiently light in weight to be carried by the natural ground.

In addition to slides on certain of the side-hill fills, several of the higher full-section fills caused trouble in this respect. The worst case of this nature occurred in a 120-ft. fill, where the embankment gave way and completely covered the lower end of a 450-ft. concrete box culvert through the fill. Without drainage, the entire fill was threatened by water impounded within it, and the condition was remedied only after an 8-ft. drainage tunnel had been cut through stable ground and the slide to the culvert opening.

As Many as 40 Shovels Employed

One of the outstanding features of the work on the new line has been the extensive use made of heavy grading equipment and the speed with which the work has been carried out. Shortly after the contract was let for the first 17½ miles, 40 power shovels, with full complements of hauling equipment, were spread out over the line, undertaking the major grading operations.



One of the Many Deep Cuts on the First 17½ Miles, Showing the Rock Penetrated

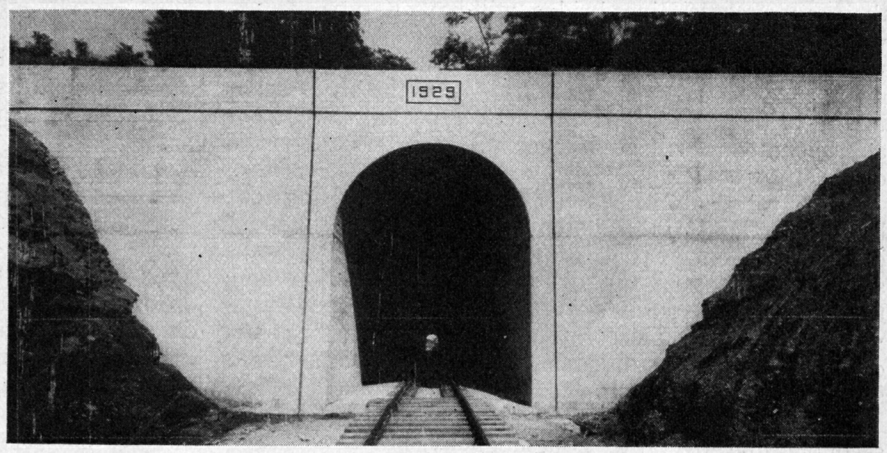
With this equipment, which included Erie, Marion, Koehring, Osgood and Thew shovels, Browning and Orton cranes, Linn tractors, Athey wagons, 4-yd. narrow-gage and 20-yd. standard-gage Western dump cars, and, at times, more than 200 Sterling, Mack, International and Dodge motor trucks, as much as 500,000 cu. yd. of material has been moved in a month.

Most of the lighter materials taken out were hauled to fills or to waste banks in the motor trucks, while rock excavation was hauled in narrow- and standard-gage dump cars. The haul varied with each cut, but in some cases was as long as 7,000 ft.

Heavy blasting operations, using Keystone drillers and Atlas explosives, were necessary in most of the rock excavation, the blast holes being sunk as deep as 20 ft. in some cases. In the deeper cuts, excavation was made in a series of 15-ft. to 20-ft. cuts, five or six such cuts being necessary in some cases.

Practically all of the higher fills were made with dump-car equipment hauled by Porter dinkeys and unloaded on construction trestles. Several of the fills were so high that it was necessary to carry them up in two or more lifts. The lower fills, for the most part, were made with the trucks, Linn tractors and Athey wagons pulled by Caterpillar "Sixties."

Wherever sliding of fills was anticipated, and especially in connection with certain of the side-hill fills with poor supporting material beneath them, it has been the practice to blast benches in the rock near the toe of the slopes to key the fills in place. This precaution has, no doubt, been of great benefit, because, even in spite of it, several of the higher fills have given trouble.



Tunnel No. 1, Showing Construction Features, Which Are Also Being Embodied in Tunnel No. 2

In the grading work now under way between the Monongahela river and Scottdale, the amount of equipment being used has been reduced somewhat because of the less severe conditions encountered. However, practically the same methods of carrying out the work are in force as were employed on the first 17½ miles, and an average of about 250,000 cu. yd. of material is being moved each month. It is expected that all of the grading as far as Scottdale will be completed late this fall, with the work on the remainder of the line well under way by that time.

Use K-Type Trusses in River Bridges

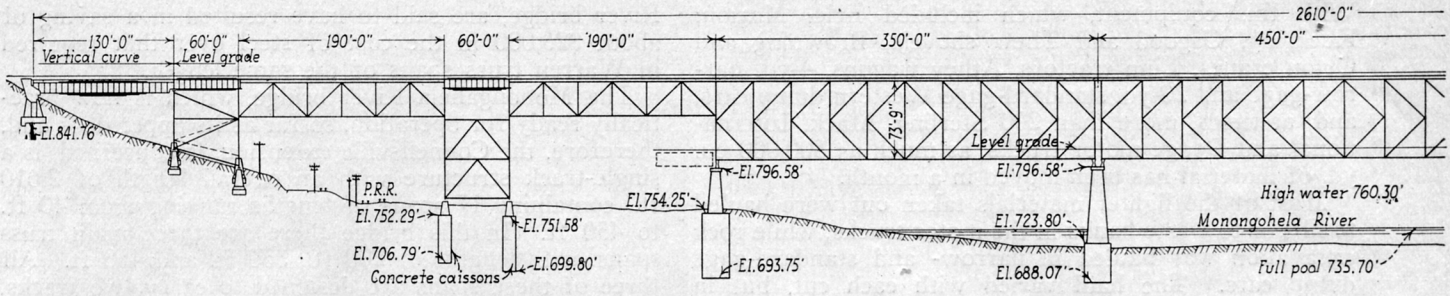
From the standpoint of permanent structures, the bridges on the new extension are as interesting as the grading, several new features of design and construction having been adopted to bring about the most economical results. Most prominent among these is the use of K-type trusses in the longer river spans, which, in the case of the three river spans of the Monongahela River bridge, are said to have resulted in a saving of about $25,000 in the cost of steel over that required in Warren truss spans of the same length.

The Monongahela River bridge, which is now practically ready for operation, so far as its upper deck and, therefore, the Connellsville extension, is concerned, is a single-track structure with an overall length of 2,610 ft., containing 17 spans of lengths ranging from 40 ft. to 450 ft. In this bridge there are three main truss spans, with lengths of 200 ft., 350 ft. and 450 ft. All three of these spans are designed to carry two tracks, one at the level of the top chords of the trusses and the other at the level of the lower chords, with separate approaches at each end for the two levels. The high-level track over the bridge, which is about 145 ft. above full pool level, will be used by the Connellsville line, while the low-level track will be used at a later date by the Monessen Southwestern, a subsidiary of the Pittsburgh Steel Company. This bridge, like all other bridges on the line, is designed for Cooper's E-65 Loading. The K-type trusses used in the river spans were adopted after consideration of both modified Baltimore and Warren trusses. An outline of these trusses is shown in the accompanying sketch of the bridge.

Advantages Claimed for K-Truss

While the K-truss is not a new development in bridge design, it has been used previously in this country in only a few structures. Lacking precedent in view of this situation, a most careful study was made of the K-truss by the Pittsburgh & West Virginia, which proved to the satisfaction of the railway's engineers that it was not only practical for the river crossing, but highly economical in material. In fact, it is said that 800 tons of steel were saved by the adoption of the K-type truss for the river spans of the Monongahela River bridge. Another special feature of interest pointed out as a result of the railroad's investigation is that in the K-truss, since the panels are shorter than is generally possible in other types of trusses, shorter members can be used and more frequent changes made in the size of chord sections, if desired. It was also observed that secondary stresses in the K-type truss are smaller than in any of the other types of trusses in common use.

The three long spans were erected entirely with tall guy derricks mounted on the top chords and advanced as the erection progressed. The spans flanking the main 450-ft. span were erected on falsework in the river, while the main span, owing to requirements imposed by the federal government because of heavy river traffic, was erected by cantilevering the steel from each



Line Elevation of the Monongahela River Bridge the Three

end. The foundations for all of the river piers for this bridge were put down to rock by the pneumatic process, the caissons being constructed of reinforced concrete.

Two Other Long Bridges Necessary

In addition to the Monongahela River bridge, two other river bridges were required, both over the Youghiogheny river; one at about M. P. 26.3 and the other near the end of the line, in Connellsville. Work on the second of these has not yet been started, but the first crossing of the Youghiogheny is now well under way; the substructure has been completed and the steelwork is being erected.

The bridge at the first crossing will be 2,600 ft. long, with 13 spans, ranging from 50 ft. to 370 ft. in length. The longest span, like the three main river spans of the Monongahela River bridge, will have K-type trusses, while the two other truss spans in the bridge, which will be 230 ft. long and flank the main span, will be made up with Warren trusses. All of the truss spans in the bridge will be of the deck type and all of the approach spans will be of deck plate girders supported on steel towers.

The river piers, of which there are four, rising to a height of about 100 ft. above the water level, are of concrete masonry carried down to rock. The two outside piers were in the dry during construction and, therefore, their footings were put down by open excavation. The west pier of the two water piers was put down in an open cofferdam, while the east pier was sunk in an open caisson.

Detailed plans have not yet been completed for the second bridge over the Youghiogheny, but it is understood that this bridge will be about 1,522 ft. in length, consisting of deck girder spans with one deck truss span over the tracks of the Baltimore & Ohio and one through truss over the channel of the Youghiogheny river, 250 ft. in length.

Several Long Viaducts Required

In addition to the river bridges, there will be many other major steel structures on the new line, 14 of these having been completed already on the first 17½ miles. These structures include several girder and truss bridges over highways, and steel viaducts ranging in length from 350 ft. to 1,700 ft. The three longest of these structures include one of 750 ft. over Peters creek on M. P. 1; one 1,607 ft. long over Pigeon creek on M. P. 9; and the longest one of 1,701 ft., which carries the line over Mingo creek at about M. P. 6. Base of rail on the two latter viaducts is approximately 195 ft. above stream elevation.

All of the viaducts are similar in construction, employing structural steel towers on concrete pedestals and deck girder spans. In the Mingo Creek viaduct there are 27 spans, with tower spans of 30 ft. and 55 ft. and with practically all intermediate spans 60 ft. or 118 ft. 4 in. in length.

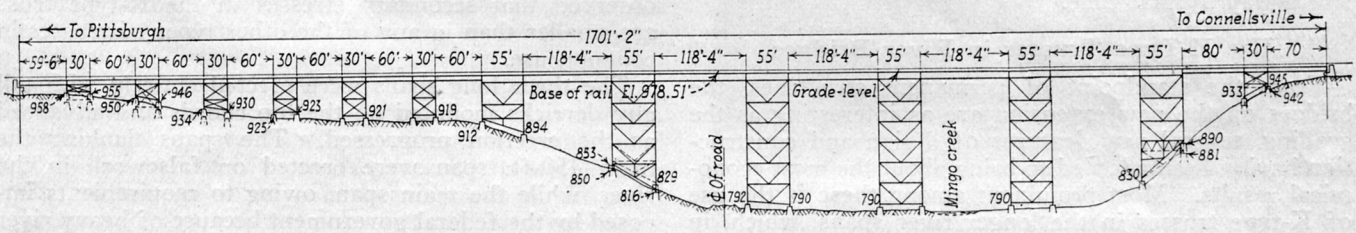
The most unusual feature of the viaducts, which is common to all, even the highest, is the tower construction, which employs full rolled sections wherever possible, thereby effecting a saving in material and reducing the fabrication costs. Typical of this practice is the use of rolled "H" sections for all of the tower posts. This gives the structures, particularly the higher ones, an unusually slender appearance. Aside from the initial saving effected through this type of construction, it is felt that the smooth sections employed will be less subject to corrosion and can be painted much more readily than built-up sections.

The viaducts and certain of the bridges have pier-type counterfort abutments of reinforced concrete, the bridge seats of which are enclosed on each side by 12-in. walls constructed monolithic with the backwall and continued to the rear of it as ear-like projections of sufficient length to keep the end slope of the embankment from encroaching on the bridge seat. It is estimated that the use of this type of abutment effected a saving of 40 per cent in concrete as compared with mass type abutments.

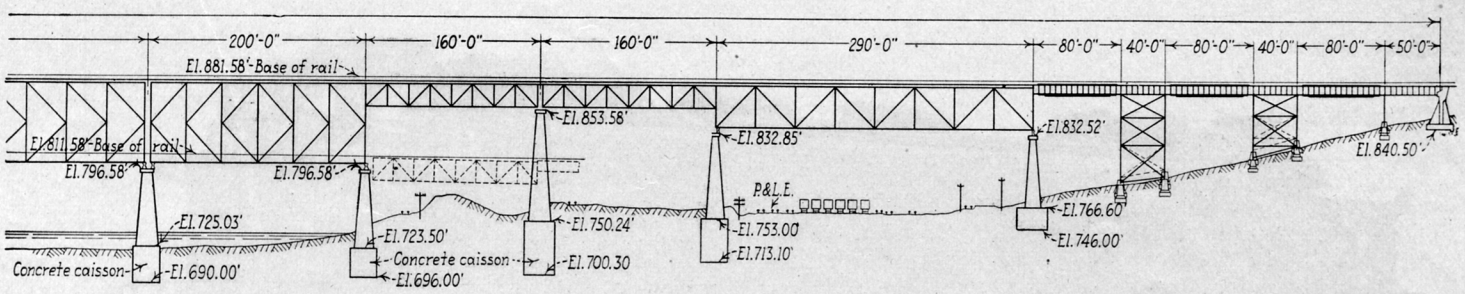
Most of the abutments were constructed with spread footings. The most unusual footing constructed was at a point where the abutment was to come directly over an old worked-out mine. Here, a hollow box of concrete construction was carried down a distance of 40 ft. to the floor of the old mine.

Two Tunnels Add to Work

Two tunnels were necessary on the line in order to avoid prohibitive grades and greatly increased mileage; the first of these, called tunnel No. 1, being 735 ft. long and located on Mile 11, while the other, called



Sketch Elevation of Mingo Creek Viaduct

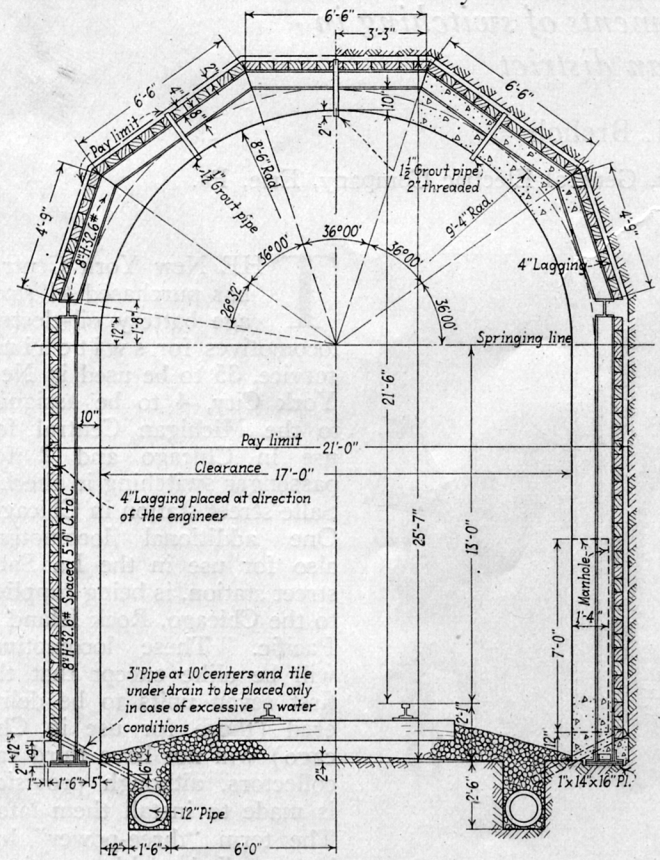


Showing K-Type Truss Construction Used in River Spans

tunnel No. 2, is 1,200 ft. long and is located on Mile 26. Tunnel No. 1 is completed, but work on Tunnel 2 is only about 75 per cent finished. Both tunnels are single-track bores of the same section, lined with concrete, with a crown height of 21½ ft. above top of rail and a clear width of 17 ft. between vertical side walls. The principal difference in the tunnels is that tunnel No. 1 has a concrete floor, while tunnel No. 2 will be provided with a ballasted roadbed directly on the tunnel floor. In both cases, steel timbering of 8-in., 32.6-lb. H-sections has been installed on 5-ft. centers or closer, as was found necessary, and backed with 4-in. lagging.

In constructing tunnel No. 1, which was driven through soft shale and slate chiefly, the work had to be carried forward with special care to prevent caveins. Two 4-ft. by 4-ft. pilot bores were first advanced at the spring lines, 10 ft. at a time, to permit setting of the wall plates, and the heading was then carried forward about 5 ft. at a time. About 14,200 cu. yd. of material was removed from the tunnel, most of which was handled by a ¾-yd. air-operated Erie shovel, loading 5-yd. narrow-gage dump cars.

Lining of the tunnel was done in sections, employing forms which could be advanced readily as the concrete



Tunnel Section, Showing Typical Construction Used

hardened. The concrete was delivered within the tunnel in 2-yd. narrow-gage cars operated on a temporary trestle. Placing of the concrete was all done by the workmen with shovels.

Tunnel No. 2 is now being advanced from its two ends, using methods similar to those employed in tunnel No. 1. Work in this tunnel, however has been found somewhat more difficult than in Tunnel 1, owing to the faulted character of the rock penetrated and the steep dip of the rock strata.

Concrete Prepared at Central Plants

All of the concrete used in the structures on the new line, with the exception of that used in certain of the river bridge piers, is being prepared in four central mixing plants, and is being transported out on the line in high-speed motor trucks. These central plants, which are located at Monongahela City, Bellevernon, Banning and Scottdale, are equipped with Blaw-Knox batchers, and measuring devices for controlling the water used and for weighing all of the aggregates. As suggested by this equipment, all concrete being used is prepared according to the water-cement ratio; 3,000-lb. concrete being used for bridge seats and copings, 2,500-lb. concrete for all neatwork above footings, and 2,000-lb. concrete for footings.

Open-body dump trucks of various types are being used for hauling the concrete, the usual load being about 3 cu. yd. Owing to the length of haul, which, in some cases has been as great as 12 miles, some difficulty was encountered at first in unloading the concrete from the trucks into the forms. This was overcome by adding 3 per cent of Celite to the mix. Seven and 28-day tests of the concrete throughout the work have shown it to be of unusually high quality.

All of the work on the Connellsville extension has been planned and is being carried out under the direction of H. H. Temple, chief engineer of the Pittsburgh & West Virginia, assisted by F. L. Riddle, construction engineer, A. N. Doud, bridge engineer, and W. C. Kline, assistant construction engineer, who has charge of field operations. All of the grading and masonry work is being done under a general contract by the Vang Construction Company, Pittsburgh, while the bridge and viaduct work is divided between the American Bridge Company and the McClintic-Marshall Company.

DURING THE LAST 10 YEARS over a million trees have been planted on territory adjacent to the Great Western (Great Britain) system, unsuitable for agricultural purposes or denuded of trees during the war. Altogether some 27,000 acres of land have been planted. Most of this is in Wales and in such famous districts as the Snowden Range, Cader Idris, near Dolgelley, Plynlimmon, on the Cambrian Coast at Devils Bridge near Aberystwyth, Tintern, Exmoor, Quantocks and the Forest of Dean. The nearest place to London on the G.W.R. which has thus become a State forest is Mortimer near Reading where some 2,188 acres of trees have been planted.