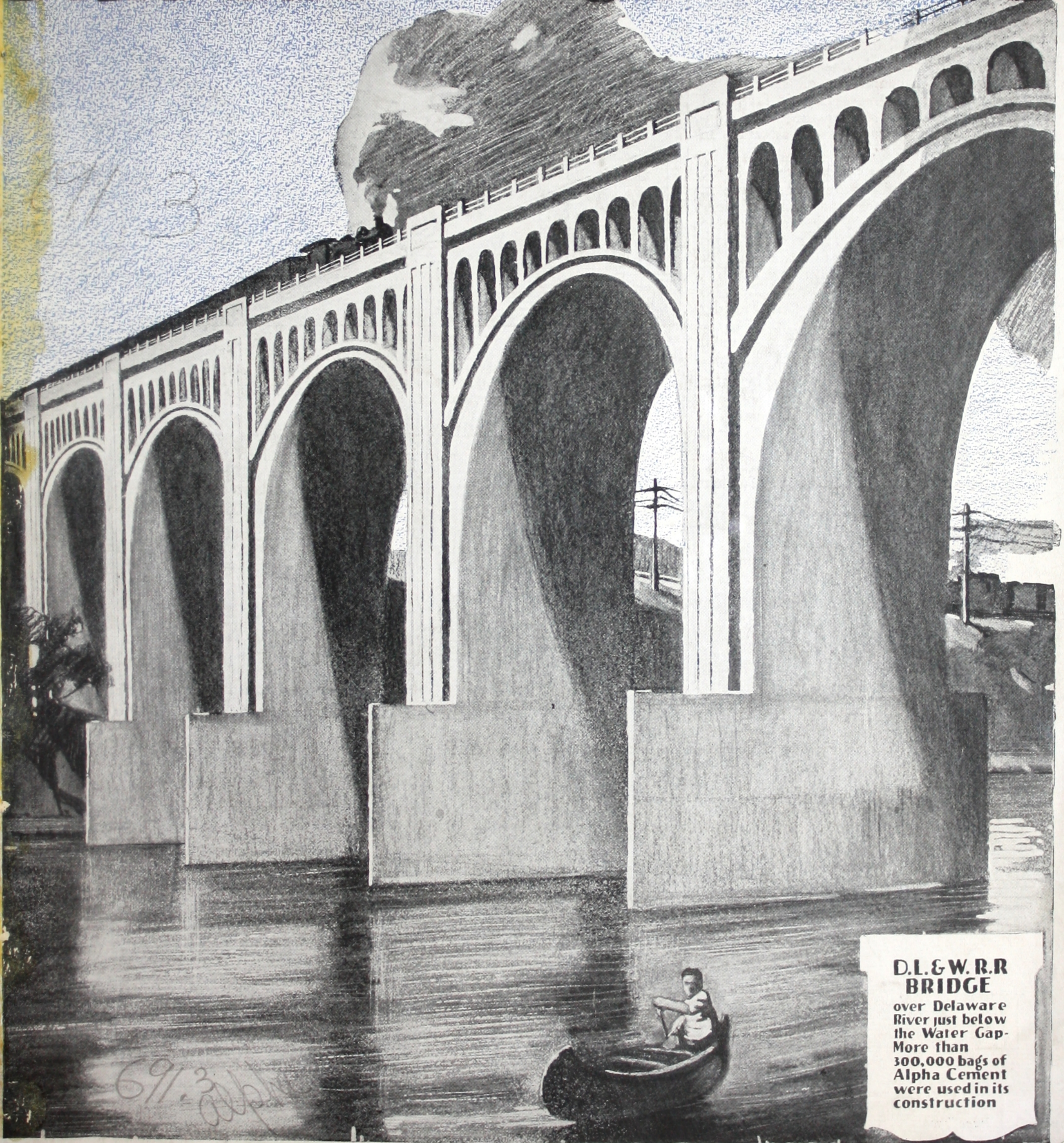
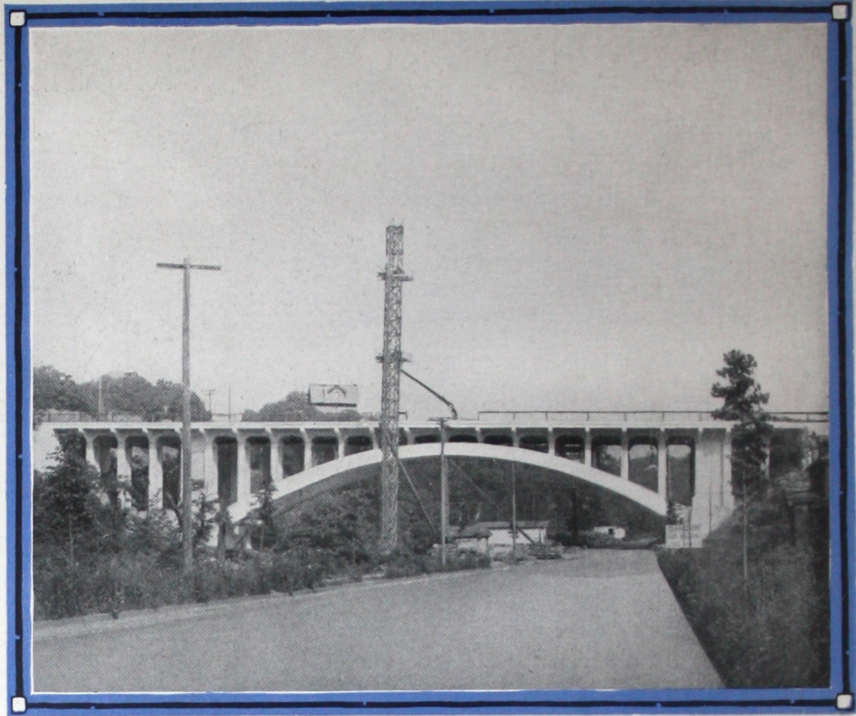
CONCRETE

FOR EVERLASTING BRIDGES and CULVERTS



D. L. & W. R. R BRIDGE
over Delaware River just below the Water Gap- More than 300,000 bags of Alpha Cement were used in its construction

EVERLASTING BRIDGES



Murray Avenue Bridge, Pittsburgh, Pa.
An example of open spandrel walls
ALPHA CEMENT used

CONCRETE bridges are everlasting. In artistic appearance, stability, permanence, low first cost and absence of maintenance cost, concrete has decided advantages over other materials for bridge construction. It is not surprising then, that concrete bridges are built by railroads and municipalities with such satisfactory results as to make concrete the foremost material for this work.

The concrete bridge can be planned to fit all conditions of service. So general is its adaptability, in fact, that engineers declare that the use of concrete marks a distinct advance in bridge construction.

The increasing weight of traffic in the form of rapidly moving automobiles, heavy motor trucks and farm machinery has made old wooden, light steel or iron bridges unsafe. The slow, cautious speed which must, for the sake of safety, be maintained across a rattling, swaying wooden bridge or a light metal structure has been experienced by everyone. In contrast, the concrete bridge by reason of its mass and design is as solid as the roadway at either end. The road surface continues in an unbroken stretch across the bridge.

Without ornamentation, concrete bridges present a pleasing appearance of permanent usefulness, because of their monolithic character and look of solidity. By slight additional expenditure architectural details can be added (practically impossible in any other type of construction) which at once beautify the structure and bring it into harmony with the surroundings.

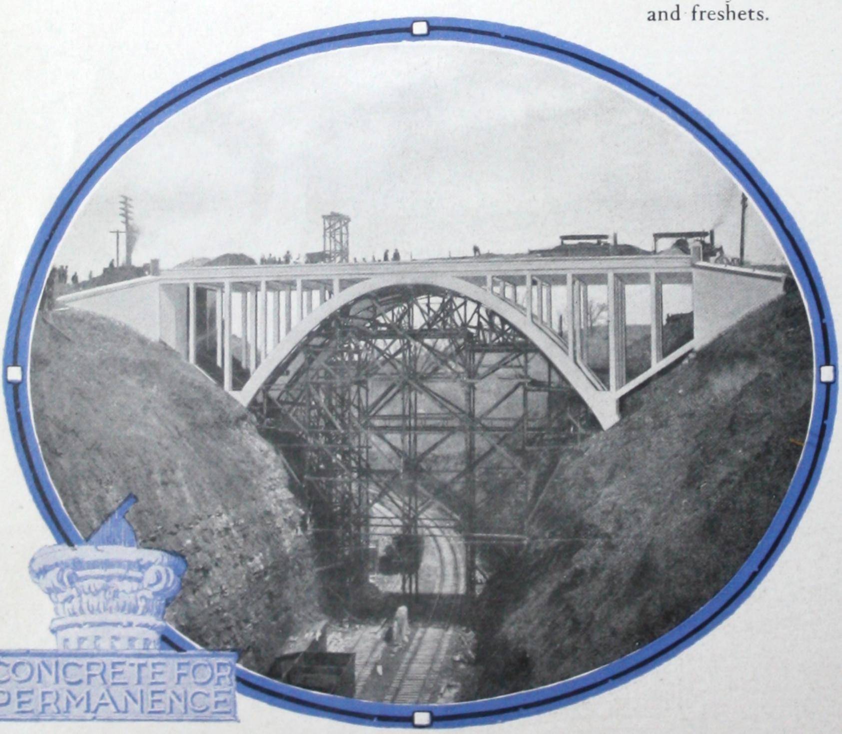
Concrete Advantages

Owing to its great weight and to the fact that it is constructed in practically one piece, the concrete bridge has been found by actual test to be the best type for resisting floods and freshets.

In point of permanence concrete outdistances all other bridge materials. The only material which approaches it is stone, and stone bridges require periodical inspection and repointing of mortar joints. Stone bridges are also limited as to the variety of design and length of span. The life of a steel or iron bridge is placed at from twenty to thirty years, and even this comparatively short service is dependent on constant maintenance in the form of scraping, painting and renewal of wooden floors and other parts.

A properly designed and constructed concrete bridge requires no maintenance. In fact, it grows stronger with age. Although a wooden or steel bridge may be slightly lower in first cost than one of concrete (even this is not always true), this increase in first cost of the concrete bridge is quickly offset when the maintenance cost and short life of other types are considered. The concrete bridge is by far the least expensive *per year of service*.

The life of a concrete bridge seems to be unlimited. There are records of concrete bridges built in Rome over two thousand years ago and still in use.



Scenery Hill Bridge, Scenery Hill, Washington County, Pa.
Showing open spandrel walls with divided arch ring
ALPHA CEMENT used exclusively

CONCRETE FOR PERMANENCE

Keeping Dollars at Home

A community bearing the expense of building a bridge is naturally interested in where this money will be distributed. Will it practically all go to distant points in payment for material and labor far removed from the community, or will it be largely expended in the immediate community for local labor and materials?

When used for the construction of a concrete bridge the bulk of the money is expended for sand, broken stone, lumber for forms, and labor—all, or mostly, obtainable from local sources.

Under skilled supervision, local labor does the work. Money for long transportation charges is saved for local expenditure. Proper sand and broken stone are obtainable in almost every community and the necessary lumber is purchased from the local dealer.

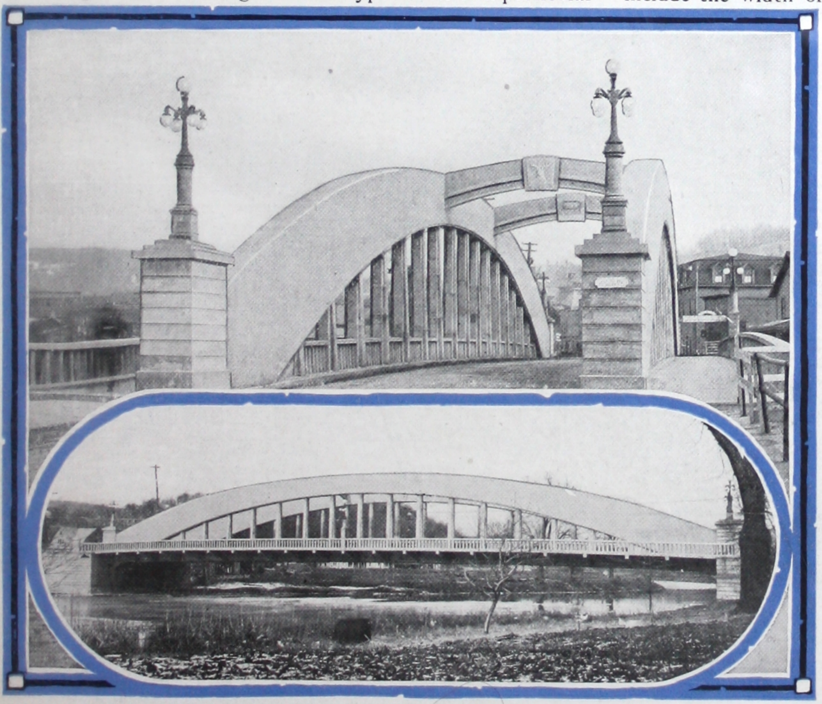
If reinforcing is used it is in the form of rods and while these may be manufactured at distant points their cost is so small a part of the entire cost as to keep the circulation of the larger part of the money expended for a concrete bridge in the community paying for the improvement.

Two views of Edgewood Avenue Bridge, New Haven, Ct. ALPHA CEMENT used exclusively.

TYPES OF CONCRETE BRIDGES

The adaptability of concrete in bridge construction is limited only by the length of single spans and by special types of bridges requiring alternate opening and closing (draw bridges). Single spans of concrete have been built, however, more than three hundred feet in length.

Concrete bridges may be divided into two general types—flat bridges and arch bridges. Each type has its own particular economic use. In the selection of type consideration must be given not only to the engineering points involved but also to the particular artistic effect desired.



Two views of Clarion River Bridge, Ridgway, Pa. ALPHA CEMENT used exclusively

Local Considerations

The length of the bridge from one abutment or pier to the next (the span) is generally fixed by local conditions. These include the width of the stream or street to be crossed, the location of the old abutments which in many cases can be used, the weight of the traffic anticipated and the support afforded by the ground upon which the foundations must rest. The foundation is the most important point to be considered in the construction of any type. Most bridge failures can be traced directly to the settlement of the foundations.

The width of a bridge is fixed by the amount and kind of traffic it carries, large amounts requiring a wider roadway than small amounts. If there is much pedestrian traffic sidewalks must be provided. The approaches also influence the width, a straight road on either side of the bridge requiring less width for safety than if the road curves immediately on either side of the bridge.

The height of the bridge is dictated by the clearance necessary under it, to permit of the free passage of water in time of extreme flood or to accommodate either street or railroad traffic under the bridge with sufficient head room. The height of the roadway approaches on either side of the bridge also plays an important part. The ideal condition is to have the bridge level with the road on both ends.

For the sake of appearance, the arch type of bridge is usually preferred. Its

New Decker's Creek Viaduct, Morgantown, W. Va.
24,000 bags of ALPHA CEMENT used

large mass absorbs all vibration of heavy and rapidly moving traffic.

When great headroom beneath the bridge is needed, together with considerable length of span, the flat-arch type is usually selected. Such bridges must be reinforced. When the arch is semi-circular, or nearly so, reinforcing is not required and the construction is simplified.

The arch type, on the other hand, requires a very stable foundation such as rock, hard pan or piling. When the road surface is not far above the stream the use of a number of short flat type spans is economic, and the roadway approaching the bridge need not be raised.

An economic selection of type and design depends upon a thorough knowledge of local conditions. The elevation of the road approaches above the stream, the elevation and quantity of water passing under the bridge in flood seasons, the kind of material upon which the foundation of the bridge must rest, the abrasive action of ice or wreckage carried down by floods, the weight and quantity of traffic, the quantities, class and cost of local materials available, and the plan of the road approaches—all play an important part.

Retain an Engineer

The services of an engineer in making the preliminary studies influencing the selection of type and in designing the bridge and supervising construction are most important. Trained in this class of work he more than saves his fee in the economy of design and the ultimate success of the structure.

Competent engineers are usually available for this work. State Highway Departments co-operate in furnishing designs and plans. The United States Office of Public Roads and Rural Engineering, at Washington, D. C., will upon request assist in fixing the type and proper design to be used.

But an engineer is required to examine local conditions and to interpret their influence on the type and design, and no bridge should be built without such expert advice.

The Flat Slab Type

The "Flat Slab Type" of bridge construction consists of one flat structure covering the entire width and length of each span and of uniform thickness throughout. It is the simplest type of bridge construction. Particularly adapted to bridges of short span, it is only economical up to spans of from ten to twenty feet. For greater lengths the slab must be made too thick for economy. The reinforcing is simple, consisting of steel bars running in the same direction as the roadway, placed near the

Bridge across N. Y., N. H. & H. R. R. tracks
at New Haven, Connecticut
ALPHA CEMENT used

bottom of the slab, and providing also reinforcement for the sheer strains in the slab at piers or abutments. Located in this way the bars take the pull or tension while the concrete takes the thrust or compression. The steel rods being completely surrounded by concrete are effectually protected from corrosion and require no attention.

The flat slab is particularly adapted for the replacement of small wooden bridges. Such structures often have stone abutments which, with repointing, can be used as abutments for the new bridge, the slab resting directly upon them. (For flat slab type bridges see cross section on blue-print, page 8, also illustration No. 4 on page 9.)

ALPHA THE GUARANTEED PORTLAND CEMENT

Union Railroad Bridge, East Pittsburgh, Pa. ALPHA CEMENT used exclusively.

Slab and Beam Type

For bridges with spans ranging from fifteen to about forty feet in length the "slab and beam" type is economical. The beams extending from one abutment to the next carry the weight and may be made whatever depth and distance apart may be required to carry the load with the use of a minimum quantity of material. As the beams and slab are cast in one piece, the slab furnishes part of the strength required. Thus an additional marked saving in concrete is effected. When this design is used the beams are said to be acting as "T beams."

The thickness of the slab over the beams may be cut down to the minimum by providing enough beams to allow fairly close spacing. However, each beam requires extra lumber for forms, additional labor for building, and more complex arrangement of reinforcing. This extra cost, when balanced against the saving in slab thickness, limits the economic number of beams which should be used. (For "slab and beam" type see cross section on blue-print, page 8, also illustration No. 6 on page 9.)

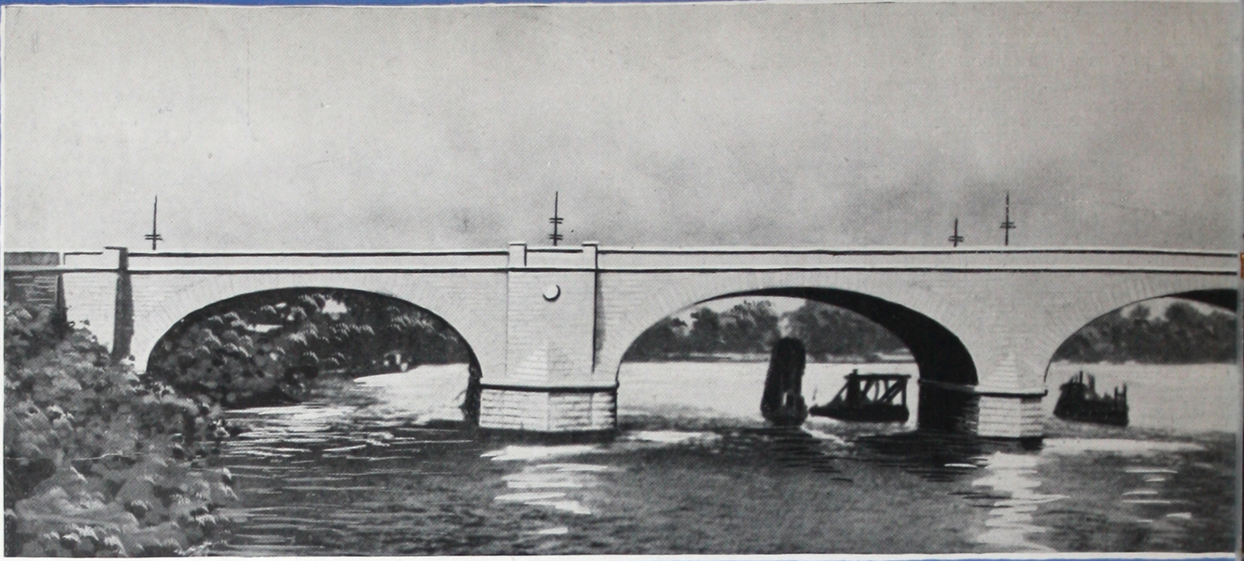
Through Girder Type

In principle the "through girder" type of bridge is the same as the "slab and beam" type. In place of a number of smaller beams two large beams are placed, one at either side of the bridge and extending between abutments. The floor slab is suspended between these beams. In the case of a wide bridge, small beams resting on the large beams (called girders) further strengthen and support the floor slabs.

The large girders are utilized as solid balustrades or guard rails. These can be given great depth. Their use as balustrades does not detract from the ornamental qualities of the bridge, since the flat surface can be relieved by paneling, insertion of colored tile, or any other form of ornamentation which does not materially lessen the thickness of the girder.

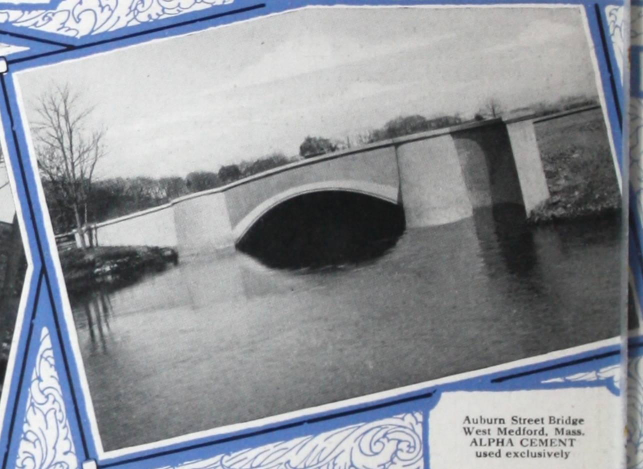
The "through girder" type is adapted to spans up to fifty or sixty feet in length, although at sixty feet the arch type is usually more economical. The arrangement and placing of the reinforcing (called fabricating the reinforcing) is complicated and requires a thoroughly experienced man to direct the work. Tests of bridges of this type by the Illinois State Highway Commission have demonstrated the remarkable strength of this type. A bridge designed for ordinary highway loads (from fifteen to twenty-two tons) has supported a load of forty-four tons placed at one point in the center of the bridge (concentrated load) with only a very slight and entirely safe deflection. (For "through girder" type see cross section on blue-print, page 8, and illustration No. 5 on page 9.)

Armory Bridge, West Medford, Mass. ALPHA CEMENT used exclusively



Bridge over the Connecticut River, at Ha
500,000 bags of ALPHA CEMENT

Campbell Avenue Bridge on
Derby Branch of the N. Y., N. H. & H. R. R.
ALPHA CEMENT used

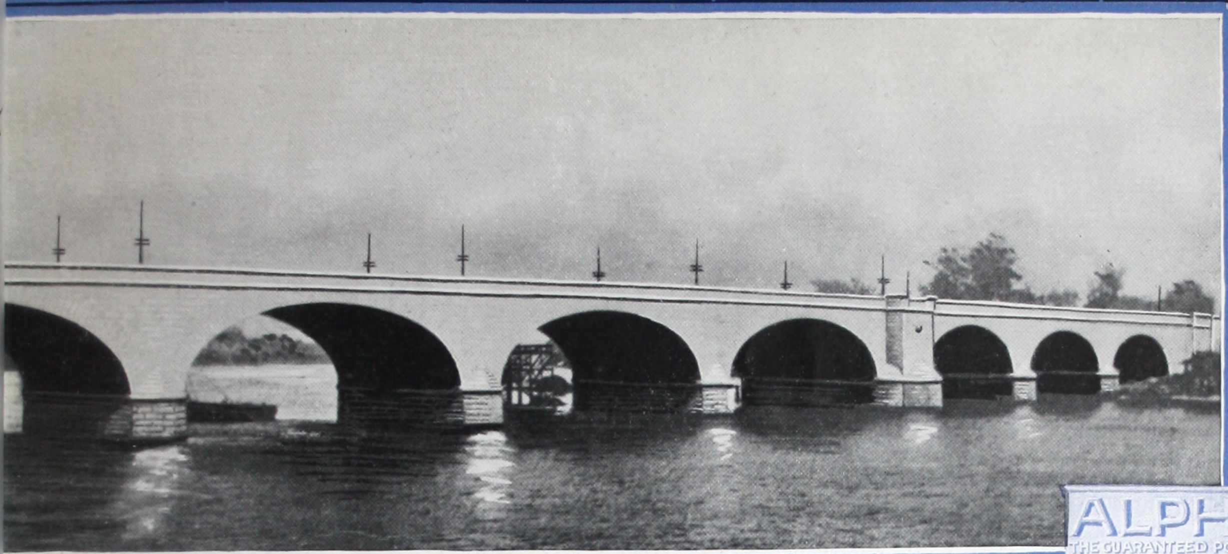


Auburn Street Bridge
West Medford, Mass.
ALPHA CEMENT
used exclusively

Stoney Run Bridge
Baltimore, Md.
60,000 bags of
ALPHA CEMENT
used

Humphrey Street Bridge
New Haven, Conn.
ALPHA CEMENT
used exclusively

CONCRETE FOR PERMANENCE



Connect River, at Hartford, Conn.
ags of A A CEMENT used

ALPHA
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CEMENT

Bridge at Belvidere, N. J.
over Pequest Creek
ALPHA CEMENT used exclusively

N. Y., N. H. & H. R. R.
Bridge over Mill River,
New Haven, Conn.
ALPHA CEMENT
used exclusively

South Third Street
Bridge over the Lehigh
River, Easton, Pa.
40,000 bags of ALPHA
CEMENT used

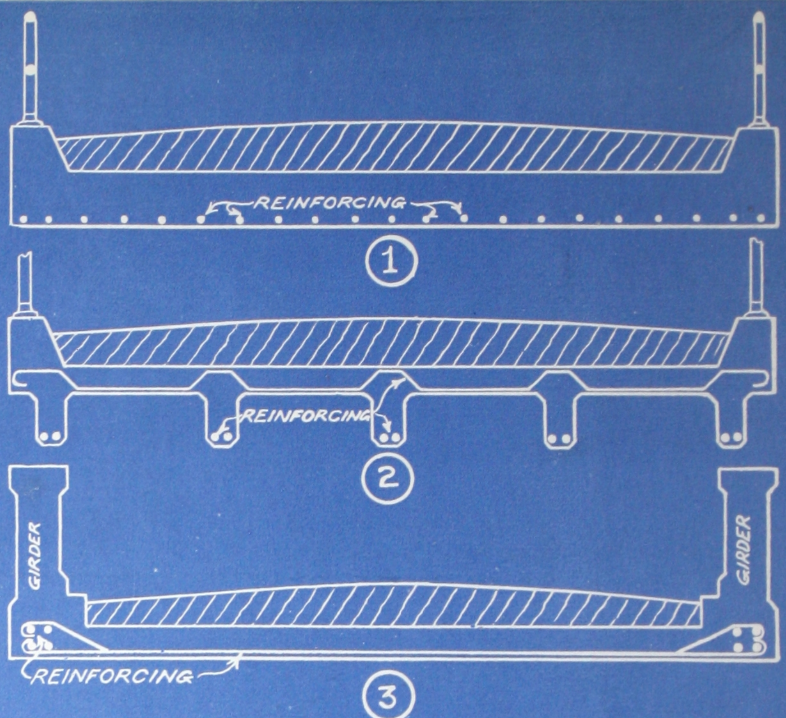
Edmondson Ave. Bridge
Baltimore, Md.
100,000 bags of
ALPHA CEMENT used

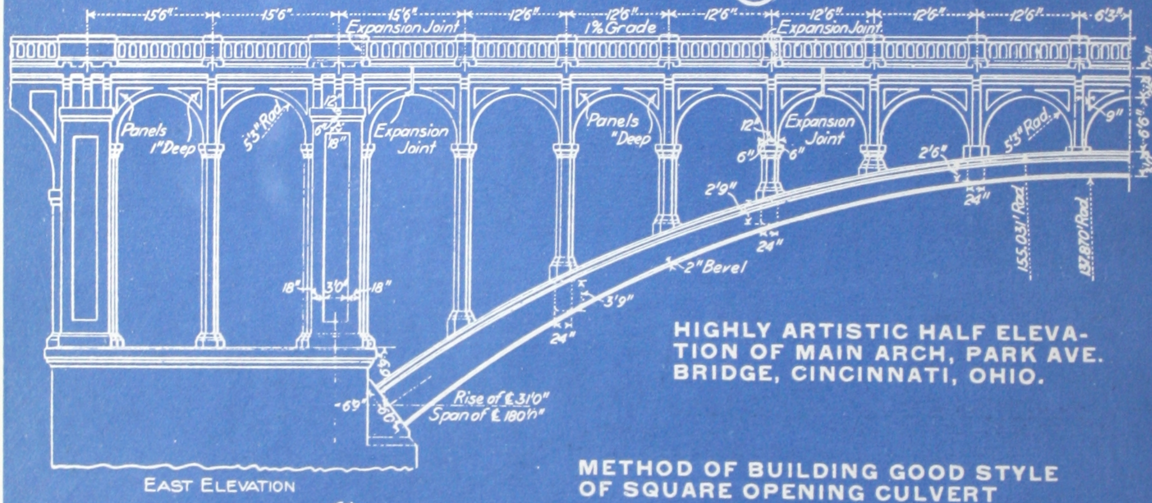
DIAGRAMMATIC VIEW OF FLAT BRIDGE SUPERSTRUCTURES

① SLAB

② SLAB and BEAM

③ THROUGH GIRDER





HIGHLY ARTISTIC HALF ELEVATION OF MAIN ARCH, PARK AVE. BRIDGE, CINCINNATI, OHIO.

EAST ELEVATION

METHOD OF BUILDING GOOD STYLE OF SQUARE OPENING CULVERT

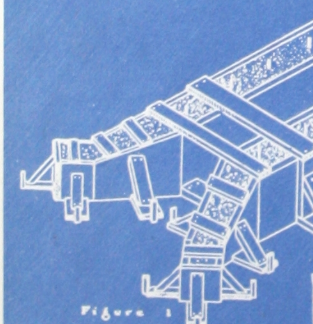


Figure 1

View of Culvert showing construction of wall forms and braces. Iron dowels are shown, placed at intervals, to carry metal lath reinforcement shown Fig. 2.

When wall forms are removed, a 3" concrete bottom is laid before work on top member is commenced.

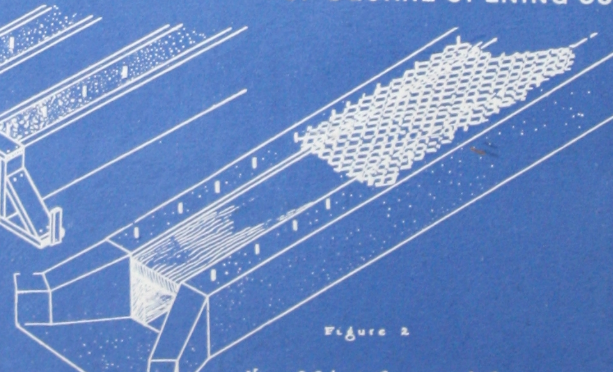


Figure 2

View of Culvert after removal of forms shown in Figure 1. 2" Plank is used (not nailed) as support for top member which is shown on the right.

Plan of End

End of Culvert with 2" planks still in place

Encased Steel Beams and Slabs

Steel I-beams are sometimes used in place of concrete beams, particularly where they can be saved in good condition from the old bridge. The concrete slab construction is the same as previously described. The steel beams are entirely covered by concrete (encased) and are thus protected against corrosion. The temporary wood forms to hold the concrete in place may sometimes be hung from the lower flange of the I-beams, thus doing away with the false work underneath.

Plain Arch Type

Unreinforced concrete arch bridges are practically the same as the familiar arch, and hence require little description. The concrete is cast in large units, the only joints being at the end of each day's work. For semi-circular or nearly semi-circular arches no reinforcing is employed. Such concrete arches are much cheaper than stone arches, since no expensive cutting and fitting of individual stones are necessary. (See illustration No. 1 on page 9.)

Reinforced Arch Type

Reinforcing steel is used in all arches where the "rise" (the difference between the height of the arch at the center and the ends) is small compared with the "span" (the length of the arch between abutments). Such types are best suited to bridges where great length is required without great head room. The depth (thickness) of the arch ring can be made comparatively small, thus lessening the amount of the required material. Concrete bridges of over three hundred feet span have been built of this type. (An example of the reinforced arch type is shown in illustration No. 2 on page 9.)

Spandrel Walls for Arches

The walls between the curve of the arch and the line of the roadway are called "spandrel walls." In small arch bridges these walls hold the back fill required to bring the road to grade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2


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(1) Plain arch type of concrete bridge with artistic concrete balustrade.

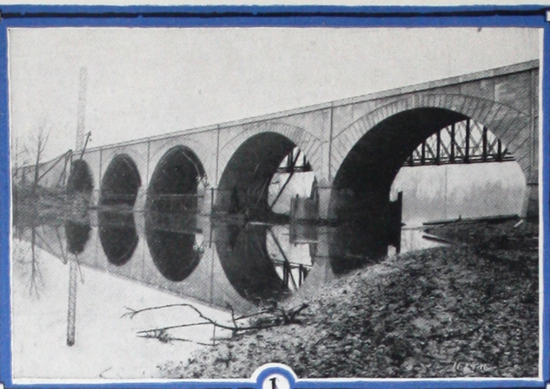
(2) Reinforced arch bridge with panelled guard wall and flaring wing walls

(3) Showing the fill in a plain arch bridge. Note substantial pre-cast concrete balustrade.

(4) Flat slab type of concrete bridge. Back River Bridge, Baltimore, Md. ALPHA CEMENT used.

(5) Wing walls for a through girder type of bridge. Fill for approach to be made.

(6) A viaduct type of flat slab and beam bridge.



over the arch itself. These must be designed and reinforced to withstand pressure of the fill. (A good example of closed spandrel walls is shown in illustration No. 1 on page 10.)

As the length of the arch increases the amount of fill increases and the size and thickness of the spandrel walls increase, so that it becomes economy to design "open" or unfilled spandrel walls. The roadway is carried on a concrete deck floor resting on columns which in turn extend down to and rest on the arch ring. In this design both the amount of concrete and the dead weight of the bridge structure are lessened. When open spandrel walls are used it is often the custom to divide the arch ring into two or more ribs, thus saving material. The longest concrete spans are built in this way. (See illustration at bottom of page 2.)

Foundations

Arch bridges require an absolutely stable and unyielding foundation, since the weight of the bridge and traffic is transferred into a thrust at the abutments or ends. The abutments must be of sufficient weight and size to withstand this thrust without yielding, otherwise the bridge fails. Nor can foundations be neglected in short span flat types since a slight settlement in either abutment causes an unequal distribution of the load and may lead to a partial failure of one or two of the beams or girders. (See foundation construction illustrations, page 12.)

Wing Walls

Where abutments (the structure on which the ends of the bridge rest) are at the edge of a stream they must be provided with wing walls to protect the foundation and also the road fill behind them from washing away. Many small bridges are not provided with wing walls and frequently trouble from undermining results. (See illustrations Nos. 2 and 5 on page 9.)

CONSTRUCTION DETAILS

The following points should be carefully considered in concrete bridge construction.

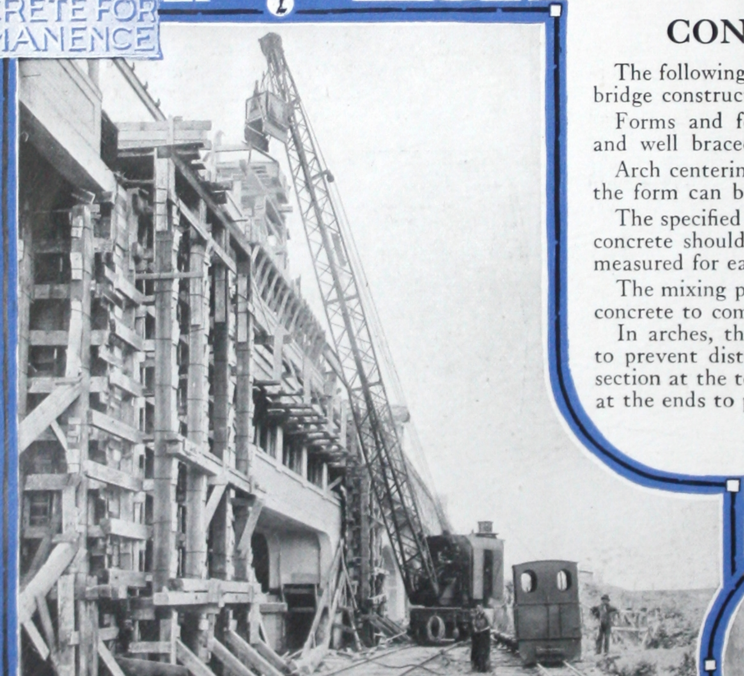
Forms and form supports (called centering) must be strong and well braced to support the weight of the green concrete.

Arch centering must be provided with jacks or wedges so that the form can be readily handled.

The specified amounts of sand and stone going to make up the concrete should be rigidly adhered to and should be accurately measured for each batch.

The mixing plant should be of sufficient size to provide enough concrete to complete large sections in a single day.

In arches, the centering should be loaded evenly at each end to prevent distortion of the forms. It is customary to place a section at the top of the arch at the same time concrete is placed at the ends to prevent the form from rising at the center.



(1) A good example of the closed spandrel wall type of concrete bridge.

(2) An unusual type of concrete bridge at Wilkes-Barre, Pa. The concrete slab floor is suspended from arches supported by concrete piers. ALPHA CEMENT used exclusively.

(3) Showing an efficient method of pouring concrete into forms. *Photo by Brown Hoisting Mch. Co., Cleveland, O.*

(4) Centering for a plain arch bridge.

Spandrel walls are usually provided with joints to allow for slight movement without cracking.

Reinforcing should be accurately placed in the position shown on plans.

As all concrete is subjected to a certain amount of contraction and expansion, provision should be made for this.

Bridges should be given a one-eighth inch coat of coal tar pitch immediately on top of the concrete of the arch ring or bridge floor and on the inside of the spandrel walls to prevent any possible seepage of water through them.

It is best to have a slight fill over the concrete, so as to provide a cushion of earth.

Drainage at ends of arch bridges and at sides of flat types should be provided by the use of pipes through the concrete. In many cases abutments and wing walls should also be drained.

Where spandrel walls join the arch ring provide mechanical bond by steel rods, partly in the arch ring and partly in the spandrel walls. In girder or slab bridges allow one end to be free to move slightly on the abutment, to take care of changes in length due to variation in temperature.

CONCRETE CULVERTS

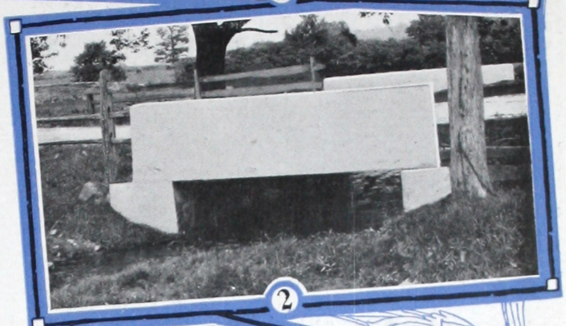
A culvert is really a miniature bridge with the water flowing over the concrete bottom of the culvert. All the advantages of concrete as a bridge material of construction are applicable to culverts. Concrete culverts are inexpensive to build, artistic in appearance, everlasting. They eliminate practically all expense for maintenance. They can be easily constructed by anyone.

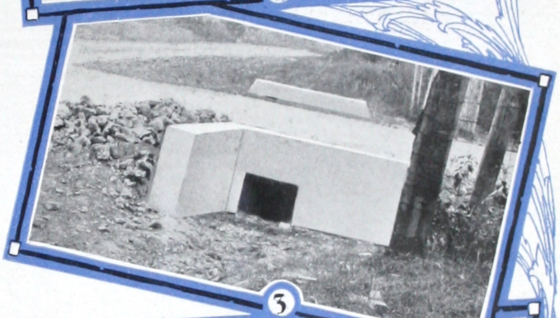
Pipe Culverts

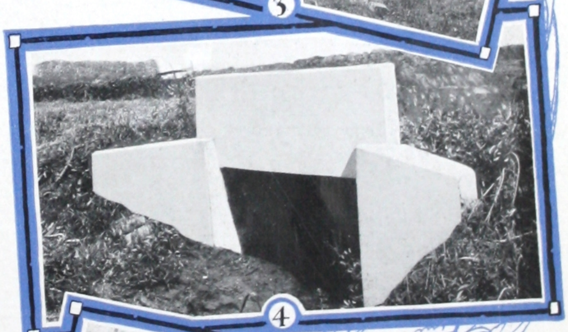
The pipe culvert is the simplest form of culvert. The concrete pipes are cast in simple hand molds with either plain or bell and spigot ends. Nothing smaller than 12-inch pipe should be used since leaves, dirt and sticks may clog up the smaller sizes. Pipe culverts must always be parallel with head walls to prevent the undermining of the roadway. The largest pipe culvert should not be over 36 inches in diameter. Provide a fill of earth over the concrete pipe.

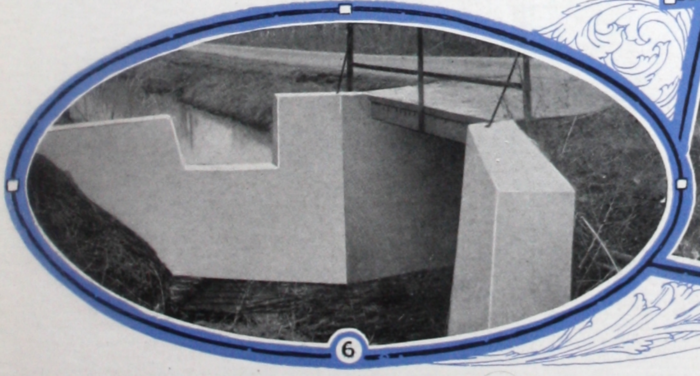
Box Culverts

As the name implies, a box culvert is merely a long box of concrete with small reinforcing rods in top and bottom. The bottom forms a paving for the water to run over without scouring. Box culverts are usually from two to five feet square.









(1) Showing safety of concrete culvert in striking contrast to inefficient wood structure. The latter collapsed under a heavy load.

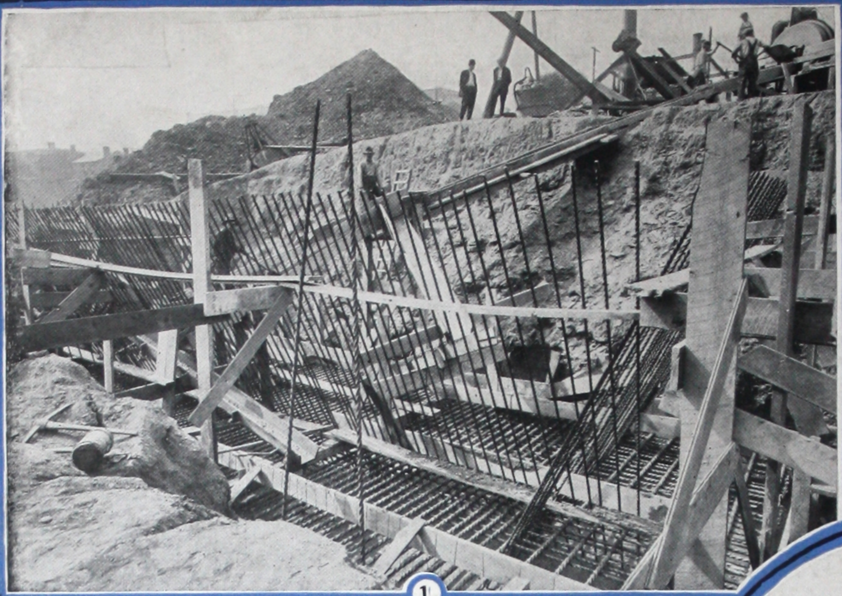
(2) Flat slab culvert with concrete guard walls.

(3) Small box culvert with wing wall.

(4) Flat slab culvert with flaring wing wall.

(5) Flat slab culvert with straight wing wall.

(6) Flat slab culvert with pipe guard rails. The wing wall at left provides for drainage.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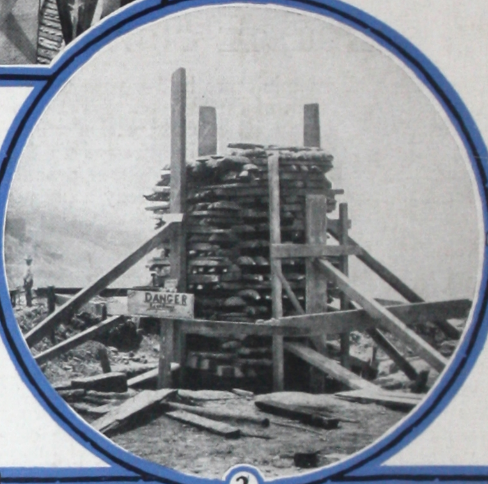
CONCRETE FOR PERMANENCE



2

Arch Culverts

Arch culverts are preferable for sizes up to ten feet span of opening where the depth of fill on top of the culvert is great, or when the weight of traffic is heavy, such as under steam or trolley roads.

The arch may be either plain or reinforced and should always be provided with a concrete floor. (For various types of culverts see illustrations on page 11. For one method of construction see bottom of blue-print, page 8.)

ALPHA—The Guaranteed Portland Cement

The concrete bridge or culvert will always stand for everlasting service, strength and beauty. Built with good cement according to modern engineering practice and approved standards of concrete construction, it is a profitable investment for the community or corporation that erects it.

ALPHA Cement is tested hourly at all ALPHA plants for quality and uniformity. Each bag carries a guarantee stamp that it will invariably meet standard specifications. The experienced bridge engineer and contractor knows that he can depend on ALPHA for best results, because ALPHA represents over a quarter of a century of experience in making superior Portland Cement.

The ALPHA plants are on six trunk-line railroads. One plant is on the Hudson River, ideally situated for coast, canal and export shipment.

Our handbook, "ALPHA Cement—How to Use It," (96 pages, well illustrated) gives plans and methods for successfully and economically building many permanent concrete structures. Free on request if you mention the building or improvement that you have in mind.

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Work on Bloomfield Bridge, Pittsburgh, Pa.

(1) Setting up steel reinforcing rods before placing the concrete.
(2) Test load of 60 tons of pig iron billets on a concrete pile.
(3) Main piers of concrete poured in cavities in shale hillside.

Photos by courtesy of Pittsburgh Industrial Development Commission