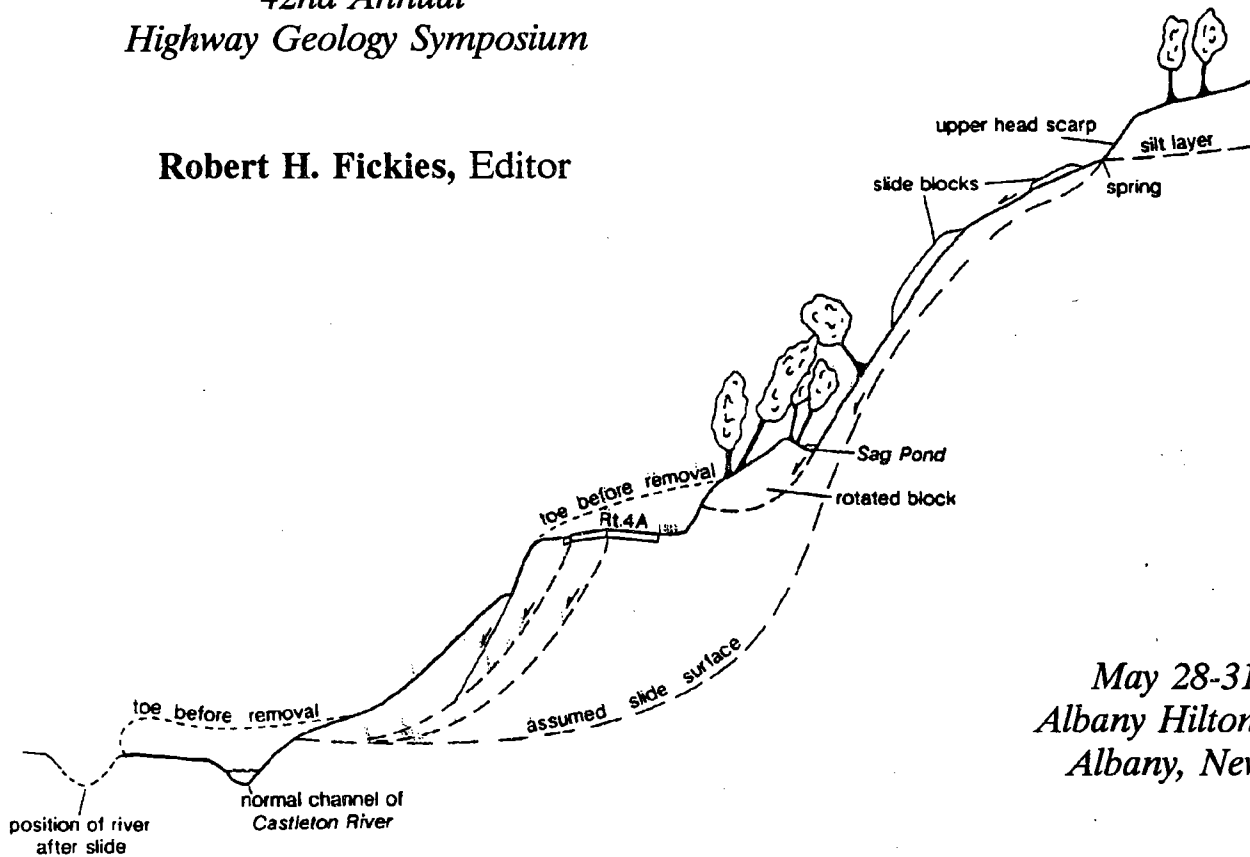


"Geologic Complexities in the Highway Environment"

*Proceedings of the
42nd Annual
Highway Geology Symposium*

Robert H. Fickies, Editor



May 28-31, 1991
Albany Hilton Hotel
Albany, New York



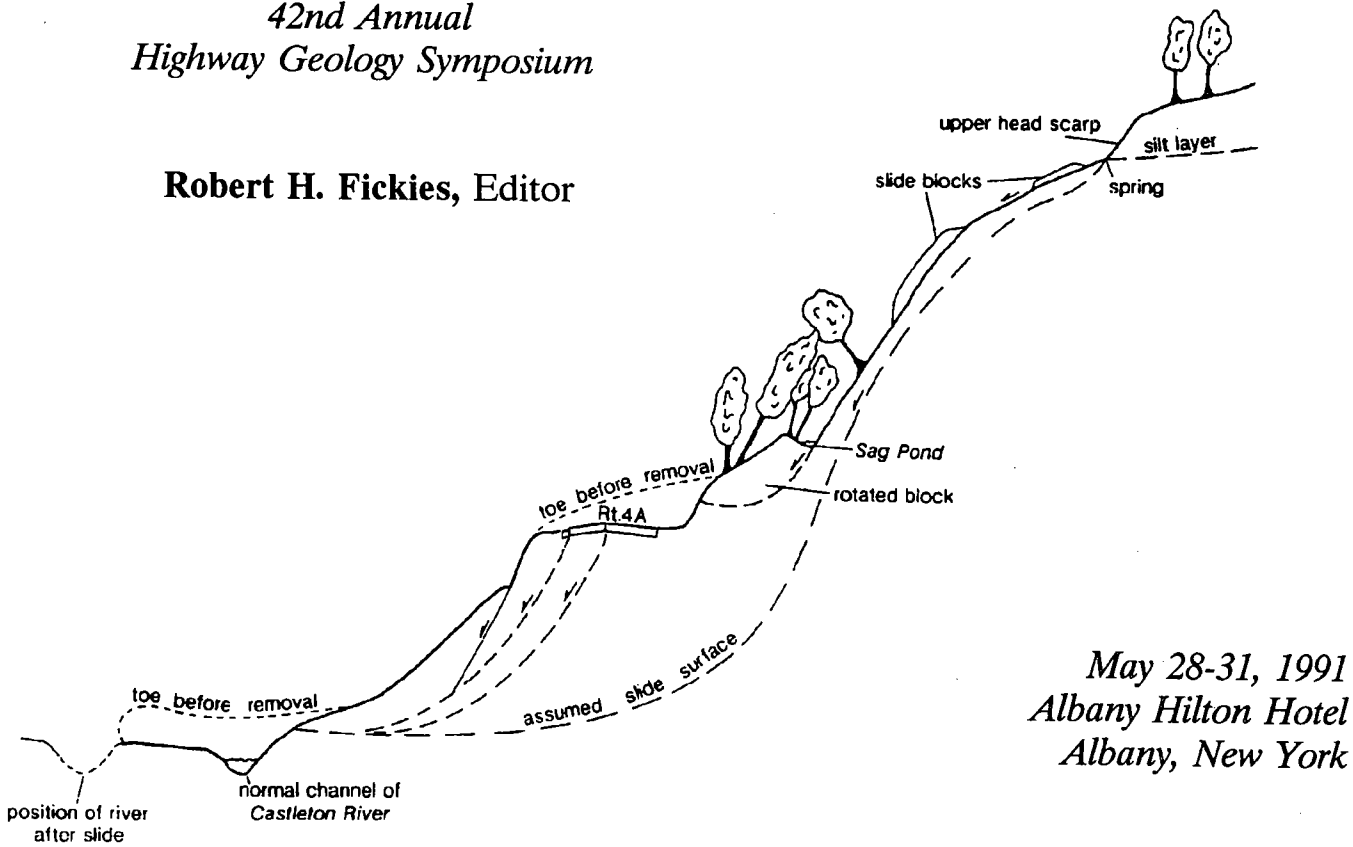
New York State Department of Transportation

MARIO M. QUOMO, Governor
FRANKLIN E. WHITE, Commissioner

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co-sponsored by

*American Society of Civil Engineers • American Institute of Professional Geologists
New York State Department of Transportation • New York State Geological Survey*

April, 1993

42nd PROCEEDINGS VOLUME, HIGHWAY GEOLOGY SYMPOSIUM
DEDICATED TO
BURRELL S. WHITLOW
(1929-1990)



Burrell Stewart Whitlow was born in Vinton, Virginia in 1929. He was educated at the Virginia Military Institute where he received a bachelor of science degree in civil engineering, in 1951.

Burrell Whitlow served in the U.S. Army in Iceland from 1951 to 1953, attaining the rank of captain. Following his return to the United States, he constructed bridges for the Commonwealth of Virginia for a year, following which he spent several years in graduate school at Virginia Tech, studying geology and geophysics. In 1956, he joined Hayes, Seay, Mattern & Mattern in Roanoke, and eventually rose to the position of senior associate. In 1972, Mr. Whitlow became founder and president of Geotechnics Inc., a geotechnical consulting firm in Roanoke.

Mr. Whitlow was a Registered Professional Geologist and Certified Professional Geologist, a member of the American Institute of Professional Geologists and the American Society of Civil Engineers, and a former president of the Virginia Section of the American Institute of Professional Geologists.

Burrell Whitlow was an active member of the Highway Geology Symposium, being involved during the 1950's, contributing to the origination of the symposium. He received the H.G.S. National Medallion Award in 1978, and later served as Vice Chairman of the Steering Committee in 1979 and 1980.

Several of Burrell Whitlow's more memorable technical papers include, *"A Return to Reason - The Application of Simple Geology to Complex Urban Problems," "The General Practice of Engineering Geology,"* and *"The Investigation of Deterioration in Concrete Roadway Slab of the Robert E. Lee Bridge, Richmond, Virginia."*

He was the National Academy of Sciences Representative for a 1968 Lecture Tour of Foreign Countries, which included the Soviet Union, Denmark, Poland, and Czechoslovakia. He had a harrowing experience on the morning of August 21st, while in Prague with a group of about 4,500 geologists. As related by Jerry Eggleston in the Virginia Military Institute Alumni Review, "He awoke to the sound of low-flying planes and looked out the window and mumbled, "Oh, nyet" when he saw and heard tanks clanking along the streets. The Russians weren't coming - they were there. Whit had been invaded!" Two days later, he escaped by crossing the Czech Border into West Germany.

Burrell Whitlow was known for his uncompromising character. He never jeopardized his personal honor and integrity regardless of the situation or the potential profits. Burrell also believed very strongly in his duty and responsibility to his family. Mr. Burrell Whitlow passed away at his home in Vinton, Virginia, on October 11, 1990.

Harry Moore

42nd Annual Highway Geology Symposium Program Agenda

TUESDAY, 28 MAY, 1991

Geotechnical Borings - Sponsored by the Transportation Research Board in conjunction with the 42nd Highway Geology Symposium.

10:00 AM to 5:00 PM - Exhibitor Display
6:00 PM to 9:00 PM - Exhibitor's Night and Registration

WEDNESDAY, 29 MAY, 1991

8:00 AM to 5:00 PM - Registration
10:00 AM to 5:00 PM - Exhibitor Display

8:30 AM Welcome: Harry Moore, Chairman HGS Steering Committee

8:40 AM Opening Remarks:
Verne C. McGuffey, Chairman
42nd Highway Geology Symposium

8:50 AM Keynote Address: "Geology of New York"
Dr. Robert Fakundiny, State Geologist;
New York State Geological Survey

10:30 AM to 12 Noon

TECHNICAL SESSION I

Geologic Innovations on the Pennsylvania Turnpike
B. Bydlon; Pennsylvania Turnpike Commission

Seismic Refraction Technique Applied to Highway Design in a Strip Mined Area of Southwestern Pennsylvania
D. Rudenko, H. Ackermann; Vibra-Tech Engineers
W. Lawrence; Geomechanics

Evaluation of Acid Leachate Potential in Highway Construction
M. Decker, G. Jacobsen; Haley & Aldrich

Quarry Layers - Stratigraphic Units that Serve the Public Interest
S. Stokowski; Stone Products Consultants

12 Noon to 1:30 PM Lunch

TECHNICAL SESSION II

Roadways in Karst Terrane
J. Fischer, R. Greene; Geoscience Services

Highway Construction in Karst Terranes: Avoiding and Remediating Collapse Features
J. Mellett; New York University
B. Maccarillo; New Jersey DOT

Application of Non-destructive Testing Techniques to Slope Stability and Sinkhole Monitoring
H. R. Hardy; Pennsylvania State University

Rock Slope Excavation and Stabilization Methods in Highway Construction: Interstate 287 Extension, New Jersey
S. Brandon; Golder Associates

3:20 PM to 5:00 PM

Rock Slope Investigations at Selected Hudson Valley Sites
L. Hale; Dunn Geoscience Engineering Co., P.C.

Rock Slope Inventory, Evaluation and Remediation for Sections Along the New York State Thruway
J. Burke, S. LeFevre; Clough Harbour & Associates

A Design for a Temporary Reusable Rock Catchment Barrier
R. Cross; New York State Thruway Authority

A Field Trip Review
C. Bolton; New York State DOT

THURSDAY, 30 MAY, 1991

Field Trip to West Point Area, including a stop on the New York State Thruway.

6:00 PM to 7:00 PM Social Hour

7:00 PM to 9:30 PM Banquet

Speaker - Anson Piper; Adirondack Community
College

10:00 AM to 12 Noon

Measurement of Scour at Selected Bridges in NY
G. Butch; USGS Water Resources Division

FRIDAY, 31 MAY, 1991

TECHNICAL SESSION III

8:00 AM to 9:40 AM

Complex Geology at Complex Sites
L. Abramson; Parsons, Brinkerhoff, Quade & Douglas

Treated Aggregate in an Asphaltic Concrete Road: An
Apparent Success

J. Dunn, G. Banino; Dunn Geoscience Corporation
D. LaGrand; General Electric Co.

Improving Aggregate Quality by Chemical Treatment
P. Hudec, F. Achampong; University of Windsor

Highway Bridge Failure by Foundation Scour and
Instability

A. Parola, D. Hagerty; University of Louisville

Ground Penetration Radar Study of Riverbed Scour in
New York State

W. Horne; Clarkson University

Clues to Landslide Identification and Investigation
V. McGuffey; New York State DOT

Slope Failure Probability for Mixed Layer Soils

S. Thornton; University of Arkansas

S. Garnett; Grubbs, Garner & Hoskyn

Northern New England Landslides

C. Baskerville; Central Connecticut State University

G. Ohlmacher; Mary Washington College

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NATIONAL STEERING COMMITTEE**

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Clayton L. Bolton, Jr., New York State Department of Transportation

Vance Bryant, Dunn Geoscience Corp.

Richard H. Cross, New York State Thruway Authority

Mark Dore, New York State Office of General Services

Robert H. Fickies, New York State Geological Survey

Stephen E. Sweeney, New York State Department of Transportation

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Geotechnical Innovations on the Pennsylvania Turnpike

**By Bernard T. Bydlon
Assistant Program Manager - East
Pennsylvania Turnpike Commission**

INTRODUCTION

America's first superhighway, the Pennsylvania Turnpike, opened its original section, from Carlisle to Irwin, in October 1940. The Turnpike expanded in November 1950, with the opening of the Philadelphia Extension, from Carlisle to Valley Forge. A Western Extension from Irwin to the Ohio state line was added in December 1951, expanding the Turnpike. The Delaware River Extension, from Valley Forge to the Delaware River, opened in November 1954, and the Northeast Extension, from Norristown to Scranton, was opened in November, 1957.¹

Currently, celebrating its 50th year in service, the Turnpike is conducting a vast rehabilitation and expansion program. Many previously undisclosed geological complexities for the construction industry have been encountered in this program.²

The Pennsylvania Turnpike has used new construction technology. For example, geogrids allow widening of highway slopes when limitations exist on final slope angle and right-of-way. The Turnpike has also used gabion mattresses and a geoweb product to stabilize existing slopes under bridges. In addition, the Turnpike has made extensive use of reinforced earth walls and post-and-plank walls to widen the existing roadway with minimal property acquisition or slope buildup in areas of limited right-of-way.

A new Lehigh Tunnel is under construction in northeastern Pennsylvania, 13 miles north of Allentown. This is the first vehicular tunnel to be constructed in the United States by means of the New Austrian Tunneling Method. Soil nailing is being used at the north tunnel approach.

Rock cuts present difficult problems in construction and maintenance. The Turnpike has undertaken a system-

wide study of all rock cuts and classified them on the basis of need for repair. The Turnpike has undertaken feasibility studies, preliminary designs, final designs and completed construction on certain cuts. Factors to be considered include existing roadway, existing right-of-way, traffic volumes, construction time, and construction cost. Each cut must be evaluated differently based on these factors and each cut presents site-specific geological problems as well.

GENERAL

Geoweb is a web of material that looks similar to a honeycomb. The honeycomb is backfilled with stone about the size of subbase material. The Turnpike used Geoweb as an experimental product to protect bridge abutment slopes, and it proved successful. Another product, gabion mattress, has been used very successfully to protect bridge abutment slopes and also in stream diversions.

As part of an accelerated construction program, certain sections of the existing roadway, or shoulders had to be widened. The widening necessary ranged from 2" to 16". Sections involved included in this widening were bridge structures, cut sections, and fill sections.

In areas where sufficient right-of-way was available, cut sections were laid back to a satisfactory slope angle. In areas of limited right-of-way, an alternative method was needed. The method used most on the Pennsylvania Turnpike is post-and-plank walls (see Figure 1). A soil nailing wall was used on the Lehigh Tunnel No. 2 project. This procedure allowed for a steeper slope angle without excessive excavation at the tunnel's north portal.

Fill sections that required widening were built up by

Typical Roadway Cross Section Geotechnical Innovations

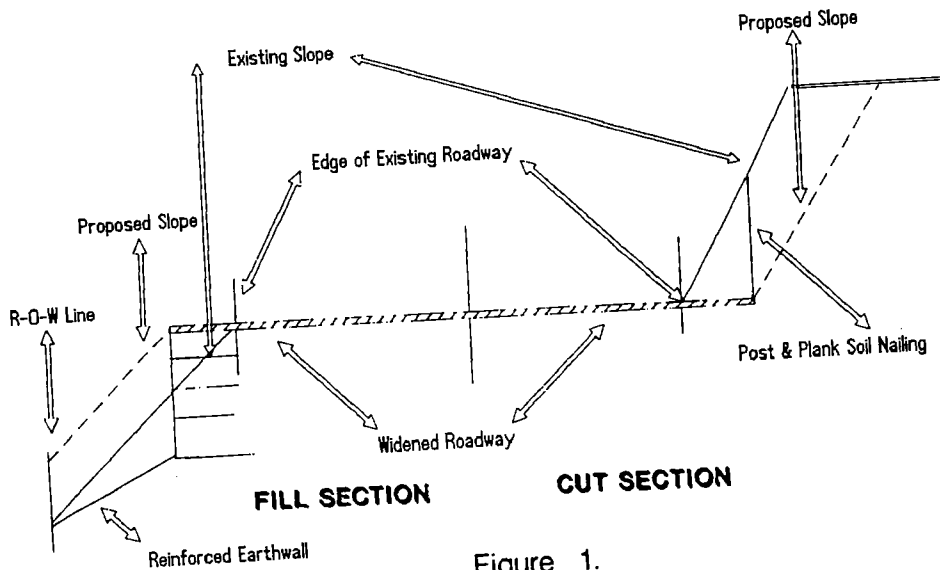


Figure 1.

means of conventional slope-building techniques. In areas of limited right-of-way, the Pennsylvania Turnpike has made extensive use of reinforced earth walls (see Figure 1). In addition, Also, geogrid products have been used to build up fill slopes. The geogrid increases the soil's tensile strength and allows for a steeper slope than those provided by conventional construction.

LEHIGH TUNNEL No. 2

Background

The only remaining section on the Pennsylvania Turnpike with only two lanes available to traffic is at the Lehigh Tunnel approximately 13 miles north of Allentown. The two-lane Lehigh Tunnel No. 1 was constructed and opened to traffic in 1957. Estimates of traffic volumes made during planning of the Turnpike's Northeast Extension warranted only a single two-lane tunnel.

In the early 1970s, bids were solicited for the

construction of a new Lehigh Tunnel. However, the Lehigh Tunnel No. 2 project was put on hold for 16 years because the original bids were far above estimates. In the mid-1980s, though, increased traffic volumes and weekend backlogs at the tunnel warranted a new search for possible alternatives. These alternatives were a bypass around the mountain or Lehigh Tunnel No. 2. The bypass was ruled out because it would have to pass through an environmentally sensitive area of the Appalachian Trail. In addition, in Act 61 the Pennsylvania Legislature mandated the construction of a tunnel as part of the Turnpike Expansion.

The original Lehigh Tunnel No. 2 bid documents were revised and updated. The bids included construction by means of a conventional tunneling method or the New Austrian Tunneling Method (NATM). The conventional method, similar to that used for Tunnel No. 1, included a cast-in-place reinforced concrete arch. The NATM, used predominantly in Europe, takes advantage of the inherent strength of rock masses.³

Geological Cross Section Along Lehigh Tunnel

(NOT TO SCALE)

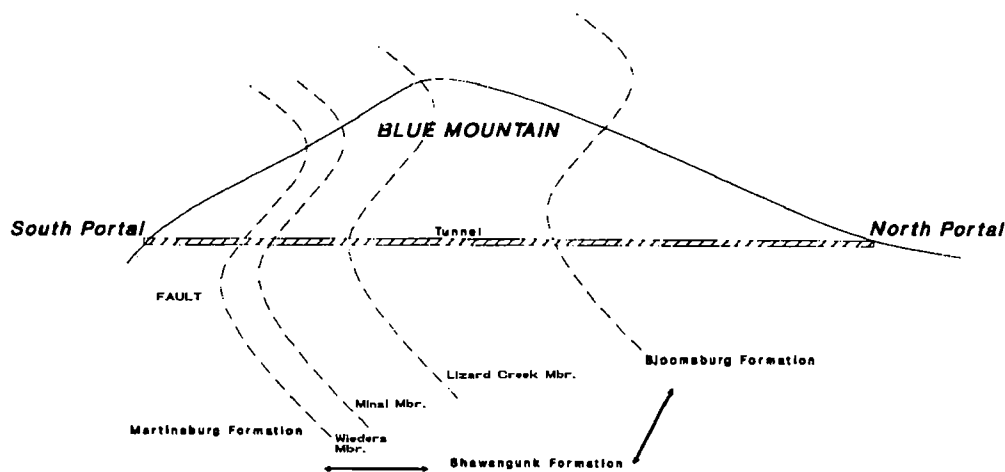


Figure 2.

Geology

Lehigh Tunnel No. 2 is set inside the Blue Mountain in Pennsylvania. The Appalachian Trail runs directly across the tunnel, at the top of the mountain. Figure 2 plots the mountain's stratigraphy.

The rock strata in this area are sedimentary and dip from 30° to 40° towards the south. Rock types include shale, siltstone, sandstone, conglomerate, and quartzite. The rock formations are from the Late Ordovician to the Early Silurian Periods. The Lehigh Gap is an exposed rock surface eroded and weathered by the Lehigh River after millions of years.

A rock classification system was developed to distinguish the various construction sequences necessary to support the initial tunnel lining. The following classes were used:

Rock Class 1 - Sound rock, moderately jointed,

stable during construction. (Ex. conglomerate, sandstone, consolidated shale)

Rock Class 2 - Moderately to closely jointed rock, roof conditions moderate, general rock mass with limited stand-up time (1 day) (Ex. consolidated sandstone, shale, siltstone)

Rock Class 3 - Fractured rock with closely spaced joints and shear zones, roof conditions brittle, rock mass unstable, stand-up time of several hours. (Ex. fractured sandstone, shale, siltstone)

Rock Class 4 - Weathered rock, intensely sheared fault zones, poor roof conditions, rock mass unstable, short stand-up time, support of excavation face required. (Ex. highly fractured sandstone, shale, siltstone.)

Rock Class 5 - Decomposed rock, roof conditions very poor, roof needs pre-support.

REGULAR CROSS SECTION

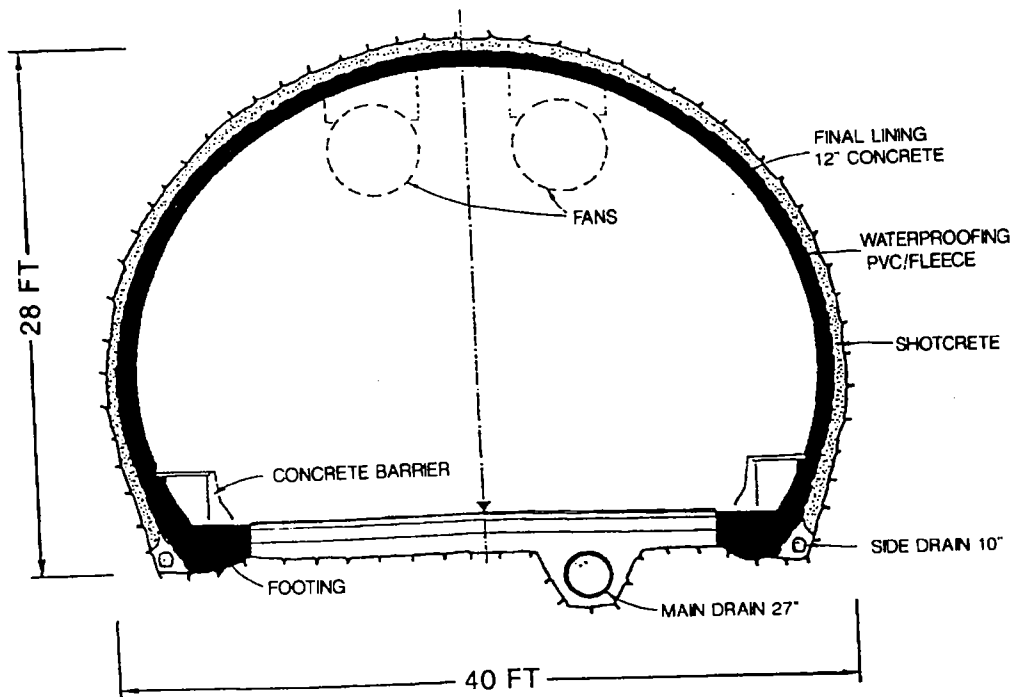


Figure 3.

Construction

During the bid phase of the project, bids were accepted for either the conventional tunneling method or the NATM. The lowest bid for the tunnel construction contract, in excess of \$37 million, was for use of the NATM. This project would be first application of NATM to build a vehicular tunnel in the United States. The only other NATM projects in the U.S. at the time were the Mt. Lebanon Railroad Tunnel, and a section of tunnel for the Washington, D.C. Metro subway.

Figure 3 is the typical cross section for Lehigh Tunnel No. 2. As depicted in the diagram, the tunnel includes an initial lining, a waterproofing membrane, and a final concrete lining.

NATM is a very flexible construction method. It adapts itself to varying rock conditions underground. After excavation, an initial application of shotcrete stabilizes the newly created load-bearing arch. Depending on rock class, treatments of the initial lining include rock bolts

and additional shotcreting with mesh and lattice girders. Deformations are constantly monitored to ensure that supports in place are sufficient to maintain the inner strength of the arch. The treatments of the initial lining are listed by rock class in Table I.

Tunnel construction has been progressing rapidly. The amounts of rock encountered, by rock class are shown in Table II.

At present, all excavation inside the tunnel is complete. The final waterproof lining is near completion. It is expected that all concrete final lining pours will be completed by mid-April 1991. Items that remain to be completed include roadway (inside tunnel and approaches), coating of concrete lining, lighting, fan installation, and portal construction. It is anticipated that Lehigh Tunnel No. 2 will be opened to traffic in November 1991.⁴

