

Nicholson Pin Piles on Interstate 78 Structure Dig In

By Donald A. Bruce, Peter J. Nicholson,
Nicholson Construction Company

The I-78 dual highway crosses the Delaware River between Pennsylvania and New Jersey (Warren Co.) on new seven span, multigirder bridges. Generally bridge foundations on the Pennsylvania side incorporated driven H piles whereas the river piers and the New Jersey piers were foreseen as founded on solid rock. This proved to be valid except for pier E-6 on the eastbound structure.

Excavation for the footing to the planned elevation had revealed that rock was nonexistent. Further excavation to an elevation 15-20' below revealed only random rock thicknesses of several feet and a highly irregular bedrock surface. The excavation was filled with lean mix concrete and the foundation design reconsidered.

Various options reviewed included:

- enlarged spread footings
- H piles in predrilled holes
- elimination of the pier
- relocation of the pier
- deep bored piling.

Only the last option proved feasible and two alternates were considered:

- 6 large diameter (36") caissons each of working load 360 tons
- 24 minipiles each of nominal working load 100 tons (allowing a 11% redundancy, reflecting the highly variable rock conditions).

The owner decided on the latter option on grounds of cost, program time and the ability to demonstrate the effectiveness of the system by a test pile installed in advance.

A further technical advantage was the action of minipiles in transferring load by skin friction as opposed to end bearing: the impossibility of pile failure by "punching through" into any soft underbed immediately under founding level was therefore eliminated.

Site and Ground Conditions

The bedrock was a Cambro-Ordovician dolomitic limestone referred to locally as the Allentown Limestone. It proved to be moderately/highly fissured, cherty, and very susceptible to karstic weathering. Major clay filled beds were intersected even over 100' below the surface e.g. 50' soft brown silty clay below 106' at Pile 24. Dipping 55° to the southeast, the rock mass proved highly variable laterally and vertically. The "solid" bedrock surface, as revealed in site investigation holes, and by the subsequent pile drilling is shown in *Figure 10*.

Design

The owner's design regulations permitted:

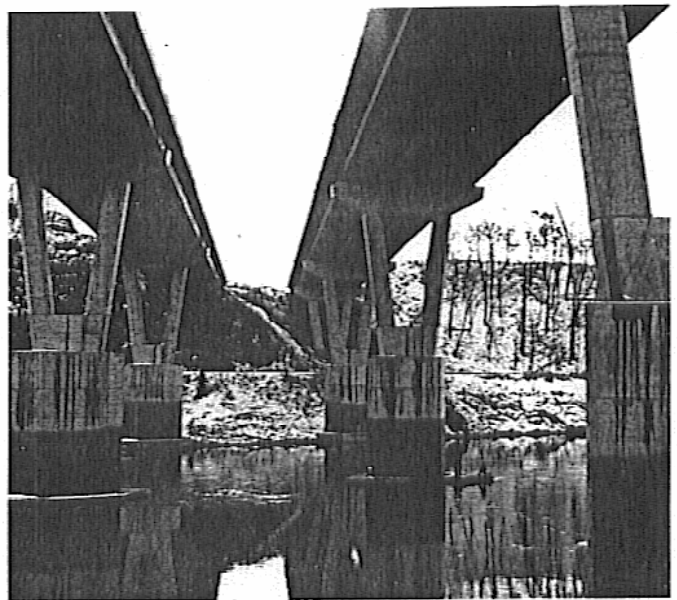
- maximum average rock/grout bond at working load (100 tons) of 50 psi.

- maximum allowable reinforcement steel stress ("fa") at working load equivalent to 45% fc.

These factors led to the selection of:

- a load transfer zone, 8½" diameter and 15' long in competent rock.
- the use of a 55 ksi low alloy steel pipe of o. d. 7" and wall thickness 0.408" as pile reinforcement.

Recognizing that the rock was likely to be very variable,



I-78 Dual Highway Bridge Pier E-6 supported by Nicholson Pin Piles. Pier E-6 is right bridge in background crossing Delaware River into New Jersey.



Diesel Hydraulic Track Drills for Nicholson Pin Pile Installation I-78 Bridge, Warren County, NJ between New Jersey and Pennsylvania.

provision was made to allow the 15' bond zone to not necessarily be continuous, in most piles subject to the following restrictions:

- the lower part of the zone to contain at least 10' of continuous sound rock
- soft interbeds to be less than 3' thick
- a zone of acceptable load bearing rock to be at least 5' thick
- regrouting and redrilling of interbeds within the overall bond zone to be undertaken

Piles 1, 6, 17, 18, 19, 23 and 24 were required to have a continuous 15' bond zone.

Construction

The sequence of installation was as follows:

- install 10.75" o.d. casing through the backfill and socket into the concrete of the cap.
- drill with 10" down-the-hole hammer through the concrete footing.
- install 9.625" casing through the less competent upper horizons (normally 30-45'). Survey linearity and grout in place.
- drill 8.5" hole (by hammer or rotary) to ensure minimum of 15' bond zone as described above.
- flush hole and install 7" o.d. reinforcing pipe. Survey for verticality (not more than 2% deviation allowable).
- tremie grout hole pile and pressure to 50 psi.

Verification of each pile alignment was made through the use of an "R" Single Shot Direction Survey Instrument, manufactured by Eastman-Whipstock. Each pile was surveyed at top, bottom and mid depth. The results indicated

that every pile fell within the criterion, with most being within 1% deviation.

Grout was mixed in a colloidal mixer and injected by Moyno pump. A neat Type III mix of w - 0.5 was used providing 3-day crushing strengths of over 3500 psi.

Throughout construction, the very adverse geological conditions posed major drilling problems. These were resolved, at length, by repeated pregrouting and redrilling. Great care was taken to provide bond zones in accordance with the design provisions. *Figure 11* summarizes the actual total drilled lengths.

Regarding the anticipated caisson tip elevations, also shown in *Figure 11*, these would have been in all cases shorter than subsequently proved necessary to found safely the minipiles. Poor or voided rock was consistently found below these anticipated elevations, further supporting the decision to use minipiles.

Overall the total drilled length of 1920 lin. ft. corresponded with the total foreseen quantity of 1710 lin. ft. However, variations from 43' less to 30' more (with respect to foreseen) were recorded on individual piles highlighting the variability of the rock. Overall, a volume of grout equivalent to four times the nominal hole volume drilled, was injected, with much of this being consumed in the zone above rockhead during pregrouting operations. The level of maximum takes corresponded with ground water level.

Testing and Performance

A separate test pile, 30' long with only 5.33' of bond was load tested in accordance with ASTM D1143 "Quick Load Test Method" to 205 tons, using rock anchors as reaction. This particular socket length was selected as a test load, the average grout-rock and grout-steel bonds would be 304 psi and 250 psi respectively—both considered to be at or near ultimate values. An outer sleeve of p. v. c. pipe extending to the top of the rock socket ensured load transfer only in the socket. A 6" thick wooden plug was attached to the bottom of the steel pipe to ensure no load could be transferred in end bearing.

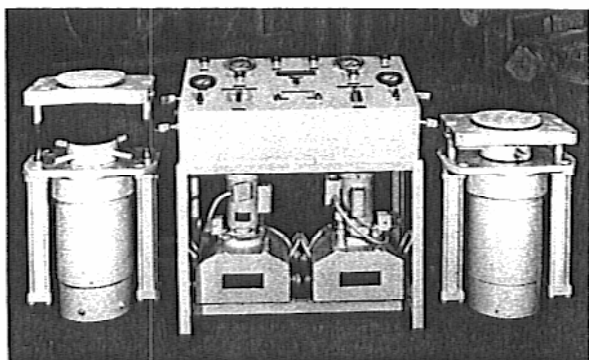
The total settlements recorded at each successive cycle to 205 tons were 0.367" and 0.373" respectively. Creep of 0.011" was recorded over 60 minutes hold at these loads. The permanent set after this operation was 0.07".

The next day testing was continued to higher levels, but at 224 tons the material of the upper casing began to fail. Until that point, the pile was performing exactly as it had during the previous testing sequence. (Total displacement of 0.371" at 215 tons, but 0.452" at 224 tons.)

In addition, during installation of the reinforcing pile in the last (and deepest) pile (Nr24), a thread parted and a 130' length of pipe fell into the 200' deep hole. Borehole TV revealed the casing to be further ruptured 30' above the bottom of the hole, due to its impact with the bottom. After various attempts at recovery and recoupling, it was decided to grout the pile, having previously suspended a 20' long, 4½" diameter 150 Ksi steel pin, with centralizers, from 62' to 82' below the top. The intention of this pin was to ensure effective load transfer across the upper discontinuity. A very rigorous extended load test was then executed to 170 tons. The performance of the pile proved excellent, (e.g. total displacement 0.187" at 170 tons, 0.010" creep in 24 hours, permanent set of 0.009") and it was judged capable to safely perform its function in service.

The bridge is now complete and the performance of Pier 6E has proved exceptional.

JACKS FOR RENT



Complete Hydraulic Systems to any capacity are available for sale or rental up to 1,000 tons.

Small Diameter Shields and Pipe Jacking Equipment always available for immediate rental and shipment anywhere.



**elgood
mayo** corp.

Box 1413, Lancaster, Pa. 17604
In New York Call: (718) 330-1965
Other States Call: (717) 397-6201

PHIA Proposes New Economic

A network of economic generator-type highways has been proposed to link with the Interstate Highway System in Pennsylvania.

Citing the success of the super-highways in Pennsylvania that will be completed in their entirety next year, Robert E. Hetherington, managing director of the Pennsylvania Highway Information Association said, "now is the time to begin something new."

Speaking to executives of the Defense Transportation Association during National Transportation Week, Hetherington said the nation's 41,000 mile network of interstate roads and bridges has been a success story.

"The nation has changed dramatically since these roads were first planned in the 1950s," Hetherington said. "America has to build on these successes."

The few remaining segments of Pennsylvania's 1,300 miles of Interstate are to be completed in 1990, he said. Most of this mileage is in suburban Philadelphia and the Lehigh Valley near Allentown.

"Lifeline" Routes

Hetherington said the highway system continues to be the "lifeline for moving people and products." He explained that the major highway connectors in the Harrisburg area are a

striking example as industry and trucking terminals have located adjacent to these interstate routes.

Stressing the value of roads and Pennsylvania's unique location, Hetherington said, "the state cannot rest on its laurels. We must provide for the future by laying the groundwork now."

He pointed out that a study PHIA commissioned a year ago estimated that more than 2,700 jobs are created for every \$100 million spent for new highway work. "A key element of the

study shows \$36 million in direct benefits result from this expenditure," he pointed out.

Outlining the PHIA program, Hetherington said, the "Primary highways in the Commonwealth hold the key to our proposal." The primary system was the major road network identified by states and the federal government before the Interstate highways were authorized in 1956.

"What we have to do now is build on this system," he explained.

AMOCO FABRICS COMPANY

PROPEX 2002 GROUND STABILIZATION FABRIC



Engineering fabrics for roadways - access, haul, and permanent. Truck and rail terminal loading areas, parking lots, and other load bearing areas.

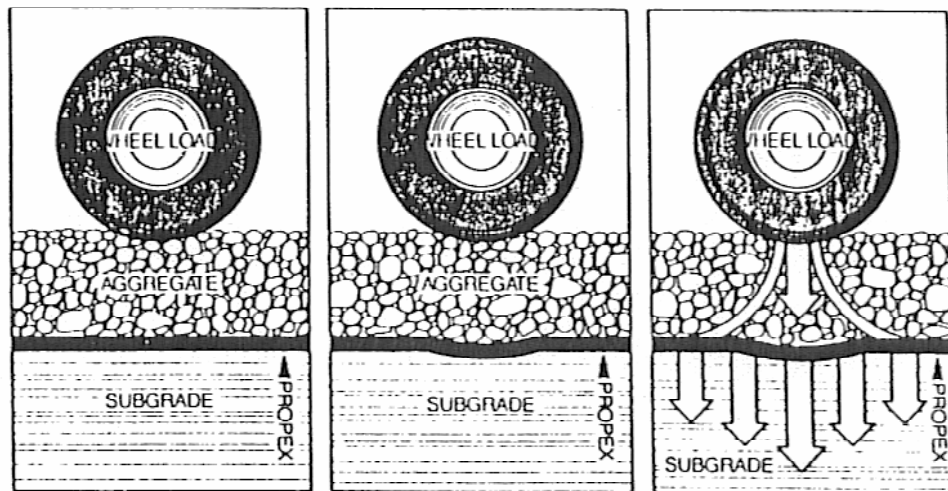
ProPex 2002 has been acclaimed a state-of-the-art construction boon by people in engineering and construction. It excels in on-the-job performance when used on easily saturated low load bearing subgrades. A proven performer that saves you money four ways.

1. Reduces subgrade preparation time and in most conditions eliminates the need for additional subgrade materials.
2. Saves from 30 to 40% of aggregate required for stabilization.
3. Saves inclement-weather downtime, because work can continue under most conditions.
4. Reduces costly maintenance repair and upkeep.

The functions of separation, filtration, and reinforcement that help eliminate rutting and water pockets that cause voids are illustrated below.

Pin Pile— From Page 37

We hear a great deal about the tide of "European technologies" lapping at our shores. There is no doubt that pin piling was born in Europe, but it is equally certain that it is reaching a new maturity in this country. It has grown in response to the changing face of our construction industry and has developed its own particular national identity in the process: pin piles of exceptional length and capacity are being installed. There is an intensity of activity in certain of our older eastern cities unrivaled anywhere in the world. As redevelopment of our cities and industrial centers continues, we can expect the growth of pin piling to proceed apace, and the special national "flavor" to intensify.



Separation

ProPex 2002 prevents the costly loss of aggregate into the subgrade during compaction and subsequent traffic loads.

Filtration

ProPex 2002 is a tough, permeable, woven fabric that allows moisture to pass through but prevents subgrade fines from infiltrating up into aggregate.

Reinforcement

ProPex 2002 has high modulus and tensile strength that helps spread concentrated loads over a much greater area.

PRESIDENT
RICHARD E. WAGMAN

VICE PRESIDENT
ROBERT H. KALBACH

TREASURE
LEWIS J. HOOVER

EXECUTIVE VICE PRESIDENT
HENRY L. HECK

IMMEDIATE PAST PRESIDENT
RUSSELL C. SWANK, JR.

DISTRICT VICE PRESIDENTS
*JOHN J. McCORMICK, JR.
R. EDWARD NESTLERODE, SR.
RICHARD D. VANDERPOOL
*JOE LAROCK
E. LORRAINE LYNN
*JAMES GLASGOW
RICHARD KAHLER
*DONALD L. DETWILER
*LaVERNE BRACKEN
LEWIS J. HOOVER
*W. LOGAN DICKERSON

BOARD OF DIRECTORS

Edward M. Atkinson	John R. Kibblehouse
John F. Banks	Phillip J. Kreis
Alan J. Bauman	John H. Laver
Lawrence Benintend	Patrick P. Loftus
Frank M. Bingman, Jr.	Victor D. Macomber
James C. Byerly	Richard M. Marino
Francis A. Canuso	Louis Marsolino
Frank Colona	Richard Mashuda
Timothy J. Crotty	Victor Mashuda
Richard D. Crowley, Jr.	Ray H. Mekis
William J. Cummings	Peter D. Melchiorre
David L. Dillon	Harry W. Merz, Jr.
George Dunn	Gordon Nagle
M. Lee Eberhart, Jr.	Peter J. Nicholson
James F. Eckman	William J. O'Connor, Jr.
Bernard E. Elmer	John V. Rignani
Robert B. Fay, Jr.	Stephen P. Russell
Joseph S. Finston	John P. Rutter
Antonino Genoese	Harold J. Schneider
Francesco Genoese	Wilmer R. Schultz
Richard J. Halloran	Basil A. Shorb, III
Roger F. Herzog	Thomas B. Smith, II
Thomas L. Holmbeck	Savilla M. Stuttard
Joseph R. Julian	Russell C. Swank, III
Richard H. Kahler	James Wohlfarth

LIFE DIRECTORS

Robert R. Buckley	R. E. Hirschman
Donald L. Detwiler	Donald B. Stabler
Leo P. Russell	Anthony A. Benintend
George B. Searle	Harold G. Green
W. Logan Dickerson	James Julian
J. Paul Skelly	James D. Morrissey, Jr.
David H. Schaper	John Kaminski
Dale W. Detwiler	

*Life Director

HIGHWAY BUILDER



PHONE: (717) 238-2513

SUMMER, 1989

VOLUME 68, NUMBER 2

Official Publication
ASSOCIATED PENNSYLVANIA CONSTRUCTORS

DAVE HUNT
Associate Editor

ROBERT E. HETHERINGTON
Editor
Deputy Executive Secretary

CINDY REISINGER
Advertising Manager

In This Issue

Supreme Court Ruling	4
President's Goals	6
Larson FHWA Head	8
Around the State	10
APC Convention	12-13
Federal Engineer	15-18
APC Invitational	20-21
Personnel Moves	23
Potpourri	24
Bridge Inspection	26-27
U.S. 220 to Open	28
Connecticut Bridge in PA	30
ASHE Convention	34
Nicholson Piles on I-78	36-37
PHIA Proposes New Routes	38-39
Personnel Seminars	41
Where to Buy	42-43
Mapmaker Retires	44
Professional Directory	45
Editorials	46



1989 APC Executive Committee. Back row (from left): Rick Vanderpool, Pat Loftus, Jack Banks, and Bob Hirschman. Middle row: Dave Dillon, Richard Halloran, George Searle, Pete Nicholson, and Bob Buckley. Front row: Henry Heck, Bob Kalbach, Rich Wagman, and Lew Hoover. Missing from the photo are Don Detwiler and Russ Swank, Jr.

HIGHWAY BUILDER is published quarterly by the Associated Pennsylvania Constructors in the interest of the highway industry. Editorial material does not reflect policy of Association. Publication Office, 800 North Third Street, Harrisburg, PA 17102. Yearly subscription is \$8.00, foreign subscription \$25.00, single copies \$2.00. Title Registered in U.S. Patent Office.

CIRCULATION covers all highway and heavy constructors in Pennsylvania and surrounding states. Miscellaneous coverage throughout United States. Circulation also includes engineers, public officials, aggregate producers, suppliers, equipment dealers and other allied with the highway industry.

ADVERTISING RATES will be forwarded upon request by HIGHWAY BUILDER, 800 North Third Street, Harrisburg, PA 17102. Rates were last changed in January 1984.

PUBLICATION DATE—February, May, August, November— or Seasons of Year.