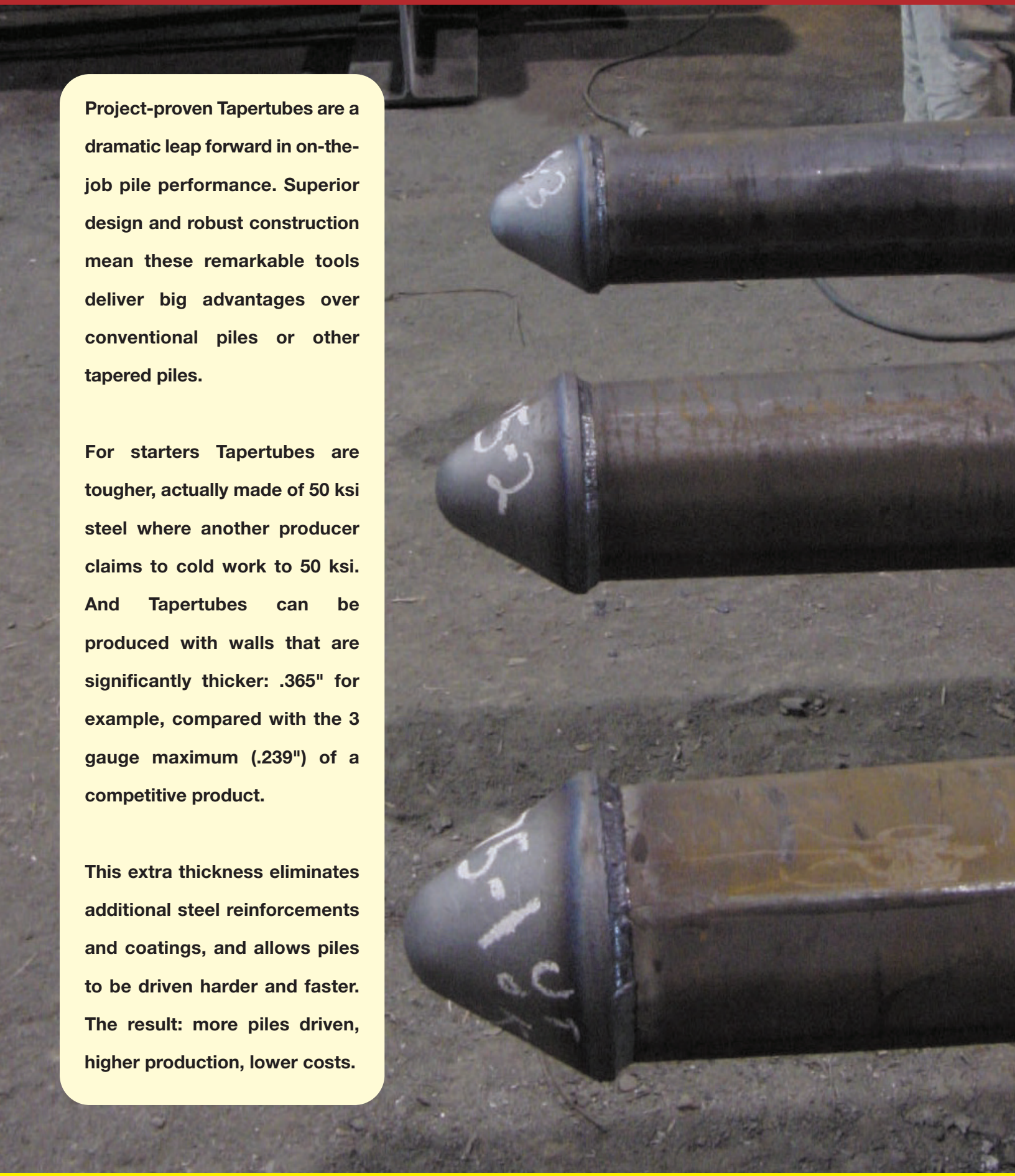
SUCCESS IS BUILT ON A FIRM FOUNDATION

TAPERTUBE®... The Ideal Piles for Land or Marine Projects

DFP Foundation Products, LLC

TAPERTUBE®: THE SHAPE OF THE FUTURE



Project-proven Tapertubes are a dramatic leap forward in on-the-job pile performance. Superior design and robust construction mean these remarkable tools deliver big advantages over conventional piles or other tapered piles.

For starters Tapertubes are tougher, actually made of 50 ksi steel where another producer claims to cold work to 50 ksi. And Tapertubes can be produced with walls that are significantly thicker: .365" for example, compared with the 3 gauge maximum (.239") of a competitive product.

This extra thickness eliminates additional steel reinforcements and coatings, and allows piles to be driven harder and faster. The result: more piles driven, higher production, lower costs.

TAPERTUBE ADVANTAGES

- Made from 50 ksi steel, higher grades available upon request
- High capacities for shorter driven lengths
- Conventional equipment and installation methods
- Reduces concrete volume requirements
- Factory attached cast steel points
- Tapertube diameters are made to match standard pipe sizes or even non-standard pipe sizes
- Directly driven... no mandrel or butt reinforcement required
- Full-butt welded splices for direct bearing of pipe extension on Tapertube
- Drive-fit DFP S-1800 sleeves may be used instead of welding to extend piles
- Heavier thickness provides greater drivability, eliminates need for coating and reinforcement

TAPERTUBE INSTALLATIONS

- LaGuardia Airport Central Terminal Bldg. Roadway Structures & West Parking Garage.
- British Airways Terminal, John F. Kennedy International Airport (JFK), Queens, NY
- International Arrivals Building, JFK
- MacMillen Pier, Provincetown, MA
- Borough of Queens Parking Garage, Queens, NY
- American Airlines Roadway Structure, JFK
- Light Rail, JFK-Van Wyck Expressway
- Jamaica Station, Long Island Railroad
- Cargo Facility, JFK
- NYSDOT Kusciuszko Bridge
- NYTA Armstrong Stadium Replacement
- and over 100 additional public and private projects

Some soil conditions that would otherwise not carry much load using a straight-sided pile will carry a substantially higher load when the pile is tapered. The combination of bearing and frictional resistance produced by the wedge shape of the taper is greater than the side friction and end bearing of a cylindrical pile.

DEVELOPMENT OF TAPERTUBE®

The advantages of a tapered shape for a pile have been known for many years. Some soil conditions that would otherwise not carry much load using a straight-sided pile will carry a substantially higher load when the pile is tapered. The combination of bearing and frictional resistance produced by the wedge shape of the taper is greater than the side friction and end bearing of a cylindrical pile.

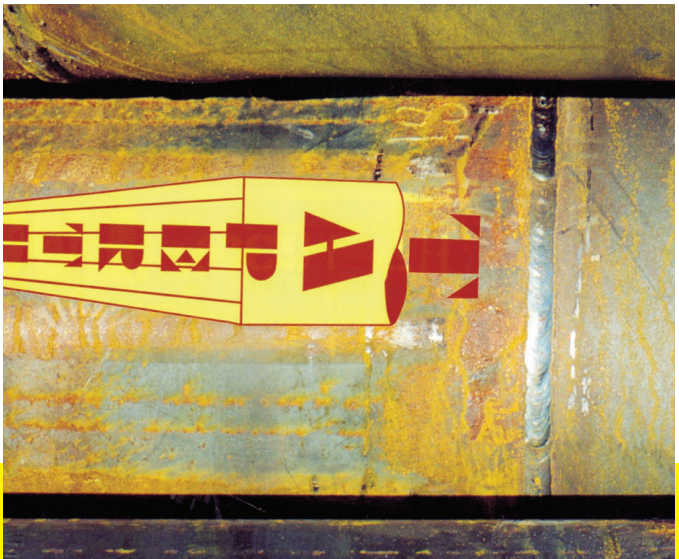
Timber piles were the first tapered piles. Perhaps the designer of the tree engineered the shape of the trunk with piles in mind. Using the trunk as a pile must have come easily to ancient pile drivers; placing the small end down was obviously a better way to drive a tree trunk into the ground.

Tapertube Piles Lead The Way

There have been other tapered piles to come to the market. The Raymond Standard Taper pile that was a true tapered pile along with the Step-Taper pile have both disappeared from the scene. The Union Metal Monotube is still available although the product is now owned by another entity since the demise of the Union Metal Manufacturing Co. All of the tapered products produced as tubular steel piles, that are filled with concrete after installation, can be manufactured in sheet metal gage thickness only. The one exception to that is the patented TAPERTUBE® PILE.

Engineers today are striving to increase pile capacities in order to reduce costs. Increased pile loads reduce the number of piles required. Reducing the number of piles usually results in an added cost benefit by reducing pile cap sizes. Increased pile capacities require piles to be driven harder with more efficient equipment. This has created a need for a stronger and stiffer, more reliable pile that is less likely to be damaged during driving.

Butt-welded joint between Tapertube section and pipe extension. Field splices can be made using DFP S-1800 Drive Fit splice.



An improved tapered steel pile had been the subject of discussion between Stanley Merjan of Underpinning & Foundation Constructors, Inc. (UFC) and myself for a number of years. The opportunity to develop and test such a pile came with the advent of the work to build the Light Rail System at John F. Kennedy International Airport in Queens, New York. The job would require more than 6,000-150 ton capacity piles to be driven through upper layers of fill and peat, and into a sand stratum (typical “N” values from 10 to 30) that extends to depths of more than 100 ft. Slattery-Skanska, the General Contractor for the Light Rail system, decided to implement an extensive pile testing program to determine the most suitable pile to be used for the job. UFC, the pile contractor selected for this work, offered to test the TAPERTUBE pile in addition to cylindrical pipe piles and tapered fluted piles as originally planned. The test program included driving and load testing piles at three sites along the route of the LRS within the airport. All of the piles were driven with a Junttan HHK-7 hydraulic hammer delivering more than 45,000 ft-lbs of energy.

The TAPERTUBE piles tested at the airport were configured with a 25’ long tapered section having a bottom diameter of 8”, top diameter of 18”, fabricated with 0.312”, 50 ksi steel as a 12-sided polygon. A cast steel point was welded to the bottom of the taper, and the polygonal shape was mechanically circularized at the top of the taper. The extension, 18” dia. X 0.375” steel pipe, was butt welded to the top of the tapered section. After driving, the piles were filled with 5,000 p.s.i. concrete. (This is the same pile design used on all JFK Projects with loads from 150 tons to 210 tons.)

Tapertube Piles Show Superiority

The results of the testing (see tables on page 6) conclusively showed the superiority of the tapered piles over the cylindrical piles. Both of the tapered pile types produced excellent test results. However, the TAPERTUBE piles demonstrated some significant advantages as compared to the fluted piles. Some of these included lower driving stresses with no deformation of the butt during driving and a butt welded splice joining the tapered section to the pipe that developed the full strength of the pile. The heavier wall thickness of the TAPERTUBE pile required a smaller reinforcing steel cage in the top of the pile (for lateral capacity) and eliminated the need for corrosion protection. The fluted piles having a thickness of 0.239” (3 gauge) yielded driving stresses that were close to the yield strength of the steel and

required welded plate reinforcement to prevent buckling of the butt during driving. The fluted cylindrical extension telescoped into the tapered section and was joined by a lap weld that did not develop the full strength of the section, a heavy cage was required in the top of the pile, and a 16 mil thick coal tar epoxy coating for the top 35 feet of the pile to prevent corrosion. Furthermore, all of the TAPERTUBE piles remained dry after driving; several fluted piles leaked water, apparently the result of split seams.

Evaluation of the tests for the newly developed TAPERTUBE piles was not completed by the time it was necessary to start production pile driving for the LRS. The fluted piles, in common use at JFK for many years, were chosen for the section of the work within the airport. Within several months the contract for 1,300 piles at the British Airways Terminal at JFK was bid, and a UFC proposal to substitute 150 ton capacity TAPERTUBE piles for 150 ton capacity fluted piles (which were already tested for this job) was accepted on the basis of the results of the LRS test program.

Soon after the start of the British Airways work UFC was called in to complete the first phase of the piling for the International Arrivals Building (IAB) at JFK where 1,500-180 ton capacity fluted piles were being driven. UFC successfully completed this stage of the work with the fluted piles. However, it was evident that the maximum 3 gauge steel thickness of these piles was inadequate to accommodate the driving stresses generated by the 180 ton capacity requirement. A number of piles collapsed and many leaked due to the hard driving. To, avoid these problems UFC proposed the substitution of TAPERTUBE piles for the next phase which required 1,000 piles, and the proposal was accepted.

The testing and subsequent installation of production piles for both British Airways and the IAB went very well. Pile installation rates averaged 12 or more per 8 hour shift (compared to less than 6 per shift for the prior work at the IAB), no piles were damaged, and none leaked.

Successful Installation Demonstrates Benefits of Tapertube Piles

These successful installations demonstrated the benefits of the TAPERTUBE piles, and resulted in the review of the use of TAPERTUBE piles for the remaining 1,700 piles for the Light Rail System. This work extended beyond the airport limits along the median of the Van Wyck Expressway to the terminus at Jamaica Station. The TAPERTUBE tests performed by UFC indicated that higher capacities would be viable for this extension. 200 ton capacity piles were proposed and successfully tested. The increased capacity reduced the number of piles required by 25%, resulting in significant savings of money, but more important, shortened by two months the time required to construct the work along an exceptionally busy stretch of roadway.

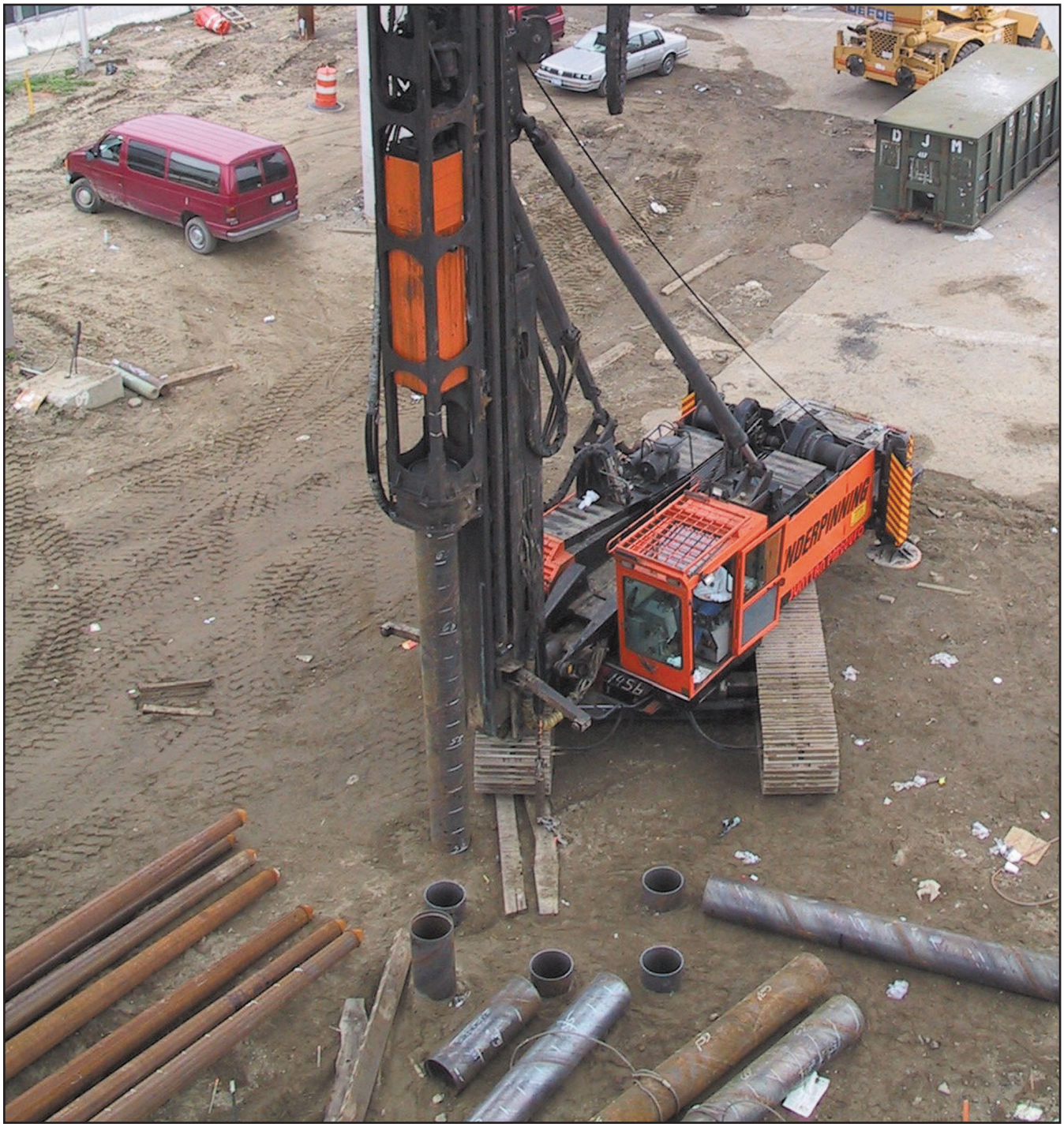
Other jobs that are currently under way with TAPERTUBE piles include the roadway structures for American Airlines at JFK (650-180 ton piles) and the new terminal for the Light Rail System at Jamaica Station (300-210 ton capacity piles). The requisite driving resistance that is required with the HHK-7 hammer range from about 17 blows per foot for 150 ton capacity to about 30 blows per foot for 210 ton capacity. Lateral capacities of 20 tons and uplift capacities of 50 tons have been established for these piles.

COMPRESSION TESTS						
SITE	PILE NO.	PILE LENGTH (FT)	FINAL BLOWS / FT.	DESIGN CAP (TONS)	MAX. PDA CAP (TONS)	ULT. CAP. TEST (TONS)
LIGHT RAIL SYSTEM	OMSF 10	52	41	150	315	>425
	CTA 10	64	25	150	283	425
BRITISH AIRWAYS	L2M-P3	59	18	120	300	375
	L4M-P27	45	50	150	375	>390
	L4M-P28	50	28	150	368	>375
	COL25-#66	55	20	150	275	380
ARRIVALS BUILDING	#1239	58	21	180	275	>430

LATERAL TESTS					
SITE	PILE NO.	PILE LENGTH (FT)	FINAL BLOWS / FT.	FINAL LATERAL TEST LOAD (TONS)	DEFL. @ FINAL LOAD (IN)
LIGHT RAIL SYSTEM	CTA-9	64	25	25	<.4
BRITISH AIRWAYS	COL 25-#552	60	22	25	0.8
ARRIVALS BUILDING	1239	60	21	18	.4

UPLIFT TESTS					
SITE	PILE NO.	PILE LENGTH (FT)	FINAL BLOWS / FT.	FINAL UPLIFT TEST LOAD (TONS)	DEFL. @ FINAL LOAD (IN)
LIGHT RAIL SYSTEM	OMSF 3	65	40	44	<.07
	FED CIRC 13	60	33	50	<.06
BRITISH AIRWAYS	COL 22-#124	45	21	100	0.1
	COL 13-#372	45	20	100	0.1
ARRIVALS BUILDING	#1243	58	24	100	<.18

TAPERTUBE piles can be made in various shapes and sizes to accommodate soil and capacity considerations. The polygonal tapered lower section usually has 12 sides, with bottom and top diameters that may vary from 8 inches to 24 inches over a length of 10 to 35 feet. Grade 50 steel is used for this section with a thickness that can range from 3/16" to 5/8". Circularization of the top of the polygon conforms to the diameter of the steel pipe extension, and a butt weld assures development of the full strength of the piling elements. These piles have demonstrated their effectiveness in granular soils. Past use of tapered piles in cohesive soils indicate the probable success of TAPERTUBE piles for these conditions, but no tests have been done to date.



MACMILLIAN PIER - PROVINCETOWN, MA

TAPERTUBE® Piles were chosen to replace pipe piles that were unable to hold the load because of apparent soil relaxation.

A forensic engineer was hired by the Town in March of 2001 to evaluate the load tests done on the pipe piles that were installed under the contract specification. These piles were 12 ¾" OD x.500 wall A.S.T.M. A-252 Grade 2 to be driven to twice the design load of 80 tons.The forensic engineer found the testing was done properly.

The Boston office of Haley & Aldrich first contacted us February 5, 2001 about this project. After some discussion, I suggested that the TAPERTUBE Pile might be the solution to the problem. Several long conference calls and exchanges of information followed. They also viewed the information available on our web site to learn more about the TAPERTUBE Piles. Soon after, they decided to set up a test pile program at the job to determine if the TAPERTUBE pile would solve the soil relaxation problem.

The job had been delayed almost five months and all parties were anxious to get the job moving. The contractor, AGM Marine from Mushpee, MA was authorized to order six 12 ¾" piles plus six 14" piles all 60' long with extra pipe for splicing. All material 50 ksi yield.

The piles arrived at the job site mid March and John Dougherty and I drove to the site to observe the unloading and installation. The driving was to begin on Tuesday March 20. Five piles were installed three on Tuesday and two on Wednesday. The weather was turning bad and no work would be done on Thursday or Friday.

On March 27 I called Haley & Aldrich office and was told that the TAPERTUBE Piles were re-driven with no loss in capacity.

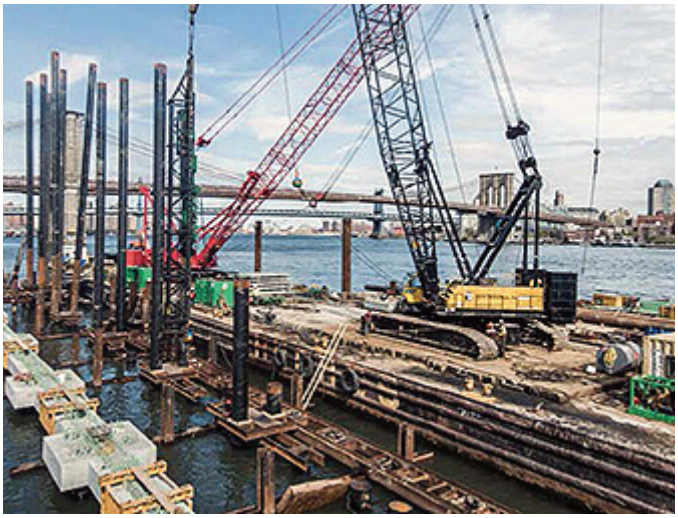
Order For Production Piles

We received an order for production piles following the completion of testing. The pile chosen was the 8" x 14"x 15' x .375 wall with a 14" x .375 wall pipe extension; all 50 ksi material. A total of 208 TAPERTUBE Piles were ordered for the project. All of the piles were coated with coal tar epoxy.

This project marked the first use of the TAPERTUBE Piles in a marine environment.

The TAPERTUBE Pile has demonstrated many times, to be a tough useful tool and capable of carrying heavy loads in friction under difficult conditions in both public and private work.

The South Street Seaport is a historic area in NYC borough of Manhattan where Fulton Street meets the East River and adjacent to the Financial District. In 1982 the redevelopment turned the Museum into a greater tourist attraction by the development of a shopping area. In 2012 Hurricane Sandy heavily damaged the Seaport. Howard Hughes Corporation, the Seaports owner, announced the reconstruction of the site and revitalization of the area.



In 2010 Trevcon Construction, a New Jersey based marine contractor, had received a contract for construction work for New York Belt Parkway in Brooklyn. Part of the work included some temporary structures. They were looking for a pile to carry 200 tons without being filled with concrete. They inquired if DFP Foundation Products LLC could produce a TAPERTUBE® PILE in 24" diameter with a .500" wall in 50 ksi steel. We responded that this was not a problem. We supplied a drawing of the proposed pile and it was approved and ordered.

The piles were successfully installed and when they were no longer needed they were removed and stored.

In 2014 the project for the replacement of New York City Pier 17 that is located in the Borough of Manhattan along the East River. Pier 17 reconstruction was awarded to Trevcon Construction by Hunter Roberts Construction Group. The project owner is the Howard Hughes Corporation.

The project work called for the demolition of all existing pier, structures, concrete piles and caps, plans and timber fender system and the construction of a new 133,651 square foot pier.

The original design called for 846 ea. 24" open-end piles and the entire Pier 17 as one pier. The revised pier and pile design due to the new flood maps requirement, as the result of Hurricane Sandy, reduced the total pile count to 810 for the entire Pier 17. Pier 17 was divided into two piers. The first is The Main Pier, which the new building will sit upon. This Pier was designed by CH2M Hill. The second is The Ancillary Pier, which was designed by McLaren. *[This information was supplied by Danny Li Assistant VP of Trevcon who was in charge of the construction.]*

When Trevcon did the static and dynamic tests for the straight pipe pile, they could not achieve a 200 ton capacity called for. Using the TAPERTUBE spliced to 24" pipe produced the 250 ton piles required.

80 Piles Extracted From Temporary Piles

There were two pile capacities - 434 piles at 150 tons and 376 piles at 250 tons. All 250 ton piles were TAPERTUBE. Approximately 80 of these piles were extracted piles in storage from the temporary piles from the Belt Parkway project. The balance were new.

The TAPERTUBE used for this project were 12.5" x 24" x 20' x .500" wall 50 ksi steel fitted with a cast steel driving point made to ASTM A-148 Grade 90/60, also made by DFP Foundation Products, LLC.

The taper of the TAPERTUBE PILE increases the load capacity for a friction pile. The increase in capacity in addition to the side friction and toe bearing, comes from what has been demonstrated conclusively by Kodikara ca. 1990 as *"cylindrical cavity expansion"*. Essentially, for the tapered section to further penetrate the soil, it must displace the surrounding soil to enlarge the cavity and therefore becomes a third mechanism in load capacity.

TAPERTUBE® Piles were chosen by Underpinning & Foundation Skanska to complete the terminal foundations at the International Arrivals Terminal at JFK International Airport after Underpinning &Foundation had been asked to replace the original contractor who had been removed from the project. Over 1,000 TAPERTUBE Piles were installed to complete this project. The pile design loads on this project were 180 tons. I am quoting from the U&F web site; "Underpinning professionals recognized the inherent inefficiencies of the original pile design and submitted a value engineering substitution that proved to be superior in all respects."

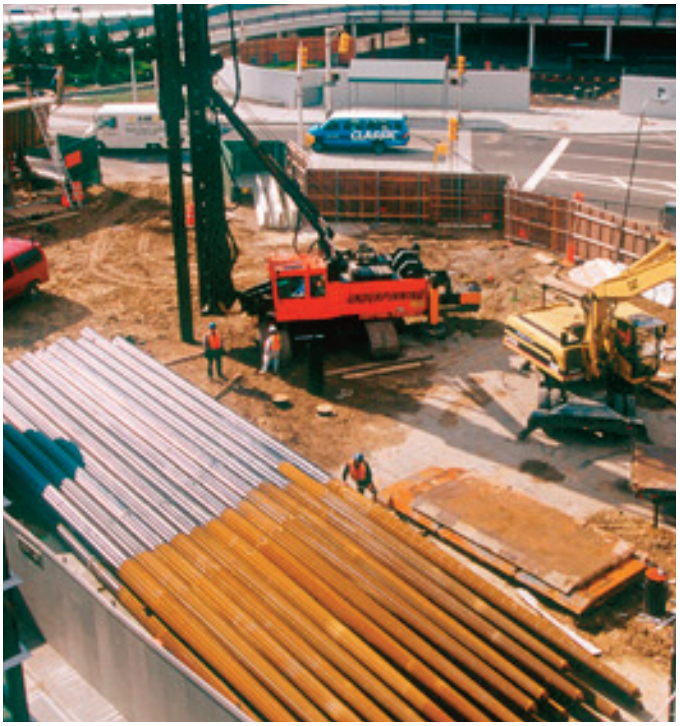
Tapertube Piles Substantially Heavier Than Competitors

The TAPERTUBE is a substantially heavier pile than the originally chosen Monotube pile. The TAPERTUBE Pile selected for this project was 8" tip, 18" top and 25' long and made using .312" 50 ksi steel. The piles were extended using 18"x.375" steel pipe ASTM A-252 grade 3 with a 50 ksi yield. The heavier pile is able to be installed at a faster rate which translates to more piles installed per shift.

The TAPERTUBE has several advantages over the other pile aside from its ability to be made with heavier gage steel. The TAPERTUBE is manufactured using a 50 ksi minimum yield steel; it does not depend on the cold working of lower grade steel to produce its strength. Any gain in strength derived from cold working of the steel is a possible advantage but is not relied upon. TAPERTUBE can also be made using higher yield steel such as 60 ksi or higher.

Another advantage is that the large end of the taper is rounded to match the diameter of standard steel pipe that is butt-welded to the taper. The use of steel pipe to extend the pile has itself many advantages such as, it provides one with the ability to increase the wall of the pipe to account for high lateral loads or increased corrosion protection. Pipe also has the advantage of easily being spliced by welding or with DFP S-1800 splicer.

TAPERTUBE Piles are an excellent choice for piles that must be soil supported. Ask DFP Foundation Products LLC for more information.



There are three major airports in the New York metropolitan area. JFK (John F. Kennedy), LGA (LaGuardia) - both located in Queens County NYC and EWR (Liberty International) located in Newark NJ. LGA has been called by some, the worst airport in the country.

LGA first opened as a commercial airport in 1939. The Port Authority of New York and New Jersey took over operations in 1947. The original main terminal was replaced in 1964 by the present facility that was designed for the passenger loads of that era. Today the passenger volume has substantially increased making the terminal inadequate and in need of replacement. There are presently four terminals, "A" the Marine Terminal, "B" considered the main terminal, and "C" & "D". The reconstruction will eventually include changes to the entire facility including new roadways, parking garages and many changes to the airside to accommodate larger air equipment. In addition, there will be a water taxi servicing Manhattan.

Light Rail Service Discussed

There has been talk of a light rail service from the airport to the public rail system. In this writer's opinion, it would be a great service to the traveling public to connect this new line to the present Air Train that moves passengers from JFK to mass transit at Jamaica Avenue via the Van Wyck Expressway. The Light Rail could be extended via the Grand Central Parkway to LGA. This would give the traveling public the ability to travel to and from LGA and JFK. This is something many must do to take different flight from the other airport. It would also give travelers from LGA the option to use public transit to travel to Long Island or to Manhattan. Presently, from JFK one may take the Air Train to the Howard Beach Station to connect with NYC Mass Transit. This would give air passengers traveling from LGA many more options for travel and possibly reduce vehicular traffic at both airports and the always crowded roadways between.

LGA CTB reconstruction actually started in 2013 with the construction of the East-End Substation/Heating and Refrigeration Plant Contract LGA 124.191 where 210 ea. 8" x 18" x 25' x .312" TAPERTUBE® PILES were installed. Following that project was the East-End Parking Garage Contract 124.201 where 454 ea. 8" x 18" x 25' x .312" TAPERTUBE were installed.

Skanska / Walsh Joint Venture were awarded the LGA CTB contract to construct the New Central Terminal and West Parking

Garage and Automated Tram, Retail and Hotel Complex, a reportedly four-billion-dollar project. It has also been reported that DELTA Airlines, who owns and operates terminals "C" and "D" will replace both terminals and connect to the New Central Terminal.

The work underway, as far as the pile foundations is concerned, is the construction of the West Parking Garage where 800 ea. 12"x 18"x 15'x .375" TAPERTUBE PILES have been ordered. Also ordered are 325 ea. 12" x 18" x 15' x .375" piles for a new Central Heating & Refrigeration Plant. The Roadway Piles ordered to date have been 300 plus a new order for 1,080. All Roadway Piles are 12" x 24" x 25' x .438". The TAPERTUBE PILES will be extended by butt welding straight pipe to the large end of the TAPERTUBE before installation. The total number of piles ordered to date amount to 2,500 of both sizes combined. There has been an additional request for 1,300 TAPERTUBE PILES for the Head House (the terminal building). This will bring the total number of TAPERTURE PILES to date to about 3,800.

With very good results from load tests, the original estimated quantities of 3,700 ea. 18" piles and 4,200 ea. 24" piles are likely to be reduced and allow each pile to carry additional load.

The TAPERTUBE PILES are supplied by DFP Foundation Products, LLC of Franklin Lakes, N.J. DFP supplies the tapered section of the pile along with the conical driving point. We usually deliver the product to a pipe supplier who attach the point and butt weld the pipe extensions to the TAPERTUBE. This allows the pile contractor to receive the piles to full installed length. If additional length is required, a drive-fit splice or weld fit splice also manufactured by DFP can be supplied.

WE INVITE YOUR INQUIRIES

DFP Foundation Products invites you to contact us. We'll be glad to provide additional literature, respond to questions or concerns, and provide just facts, no high-powered sales pitches.

Speak to Jack Dougherty, designer of the Tapertube, or one of our engineers, by calling 201-337-5748.

DFP Foundation Products, LLC

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