



**Schnabel**  
ENGINEERING



INTERNATIONAL WORKSHOP ON MICROPILES

# A Brief History of Micropiling in Washington, DC

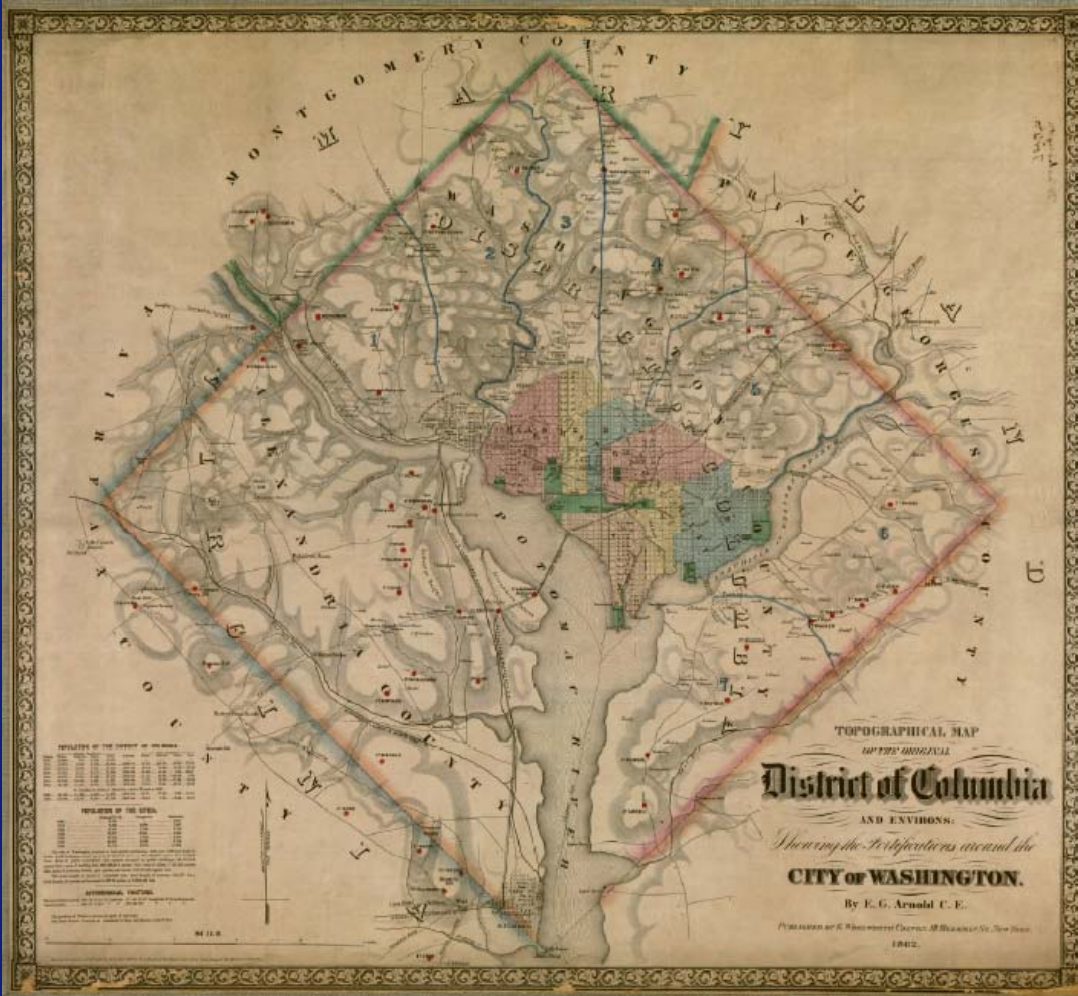
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International Workshop on Micropiles  
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# Outline

- City Layout
- Geologic Review
- Summary Table
- Case Histories
- Closure

# How was the District Located



Map Collections: 1500-2004. Library of Congress. < g3851s cw0674000 <http://hdl.loc.gov/loc.gmd/g3851s.cw0674000>>

- In 1790 the US Senate passed the Residence Act
- 10-mile square encompassing much of the Potomac and Anacostia tidewaters
- Accessible but defensible

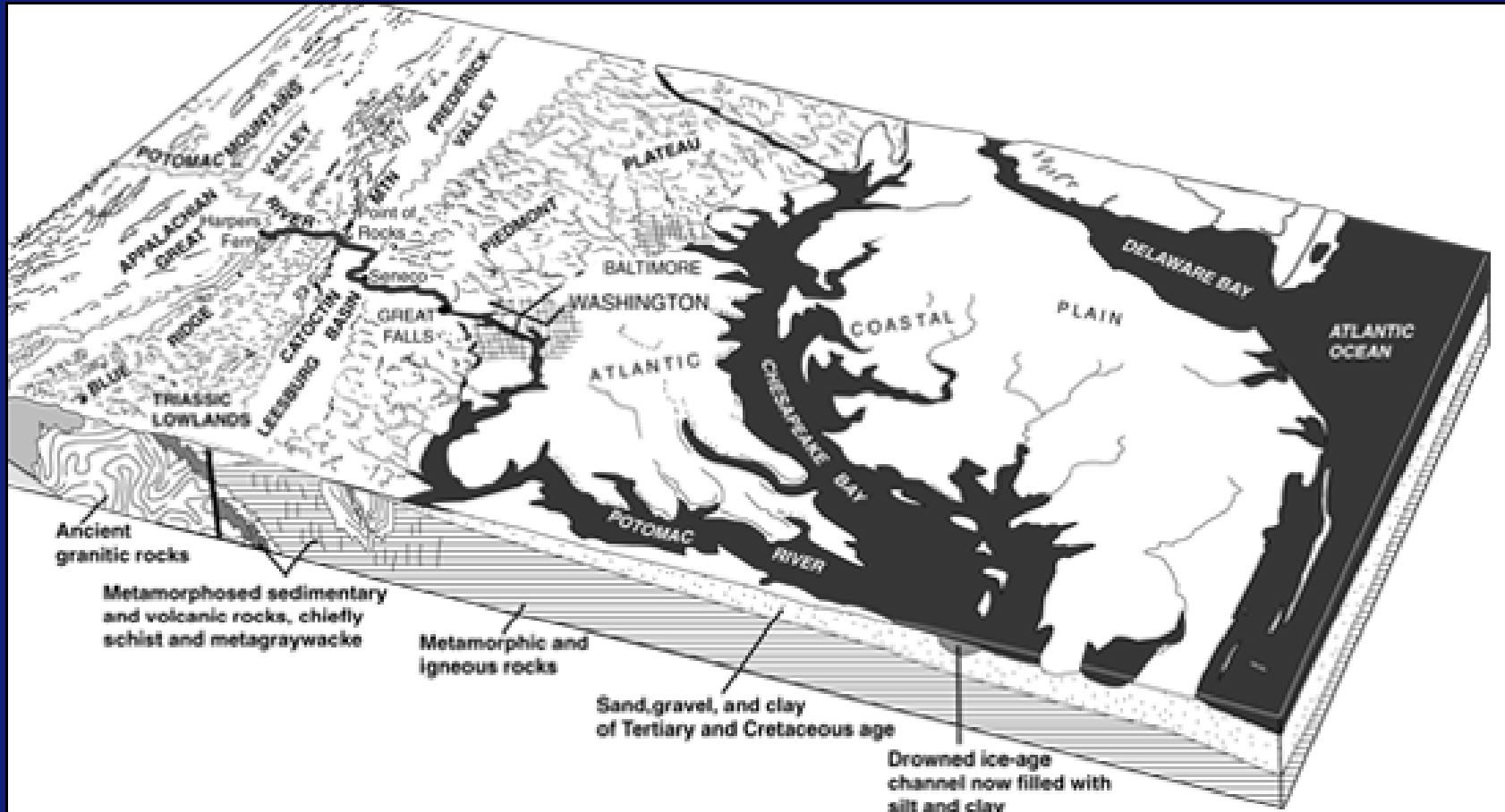
# City Map 1818



- L'Enfant city plan:
  - Broad avenues radiating from the Capitol
  - A garden-lined "grand avenue" that later became the National Mall
- DC growth largely influenced by the local geology

Map Collections: 1500-2004. Library of Congress.  
< g3850 ct001437 <http://hdl.loc.gov/loc.gmd/g3850.ct001437>>

# Geologic Setting



*Building Stones from our Nation's Capital, U.S. Department of Interior and U.S. Geological Survey, 1999.*

# Micropile Advantages in the District

- Ability to deal with challenging and highly variable ground conditions
- Tight access construction environments
- Sensitive character of many buildings and structures
- Environmental restrictions

# Summary Table

## General Project Design Details

Year	Project	Installation Conditions	Micropile Design and Construct				Micropile Type	# of Piles
			L (ft)	$\phi$ (in)	Reinforcement Details	Grouting Details		
	Smithsonian Institute Castle	Very restrictive access.	69-77	5½	#11 full length, 5½-inch casing above bond zone	w/c=0.5 140 psi	Type B	21
1991	Postal Square	Existing basement with 8-17 ft of headroom.	51-58	7	25-30 ft of 7-inch casing (N80) plus 25 ft of 1? inch rebar in bond zone	w/c=0.45 80-110 psi	Type B	609
2003	Potomac Center North	Existing basement with only 7 ft of headroom. The exterior piles installed through abandoned building foundations.	20-35	5-10	TITAN 30/16, 52/26, 103/78		TITAN	188
2009	Georgetown Library	Installed inside existing building with only 11 ft of headroom.	37	8	#11 full length, 7-inch casing (N80) above bond zone	w/c=0.45 e tremie	Type A	19

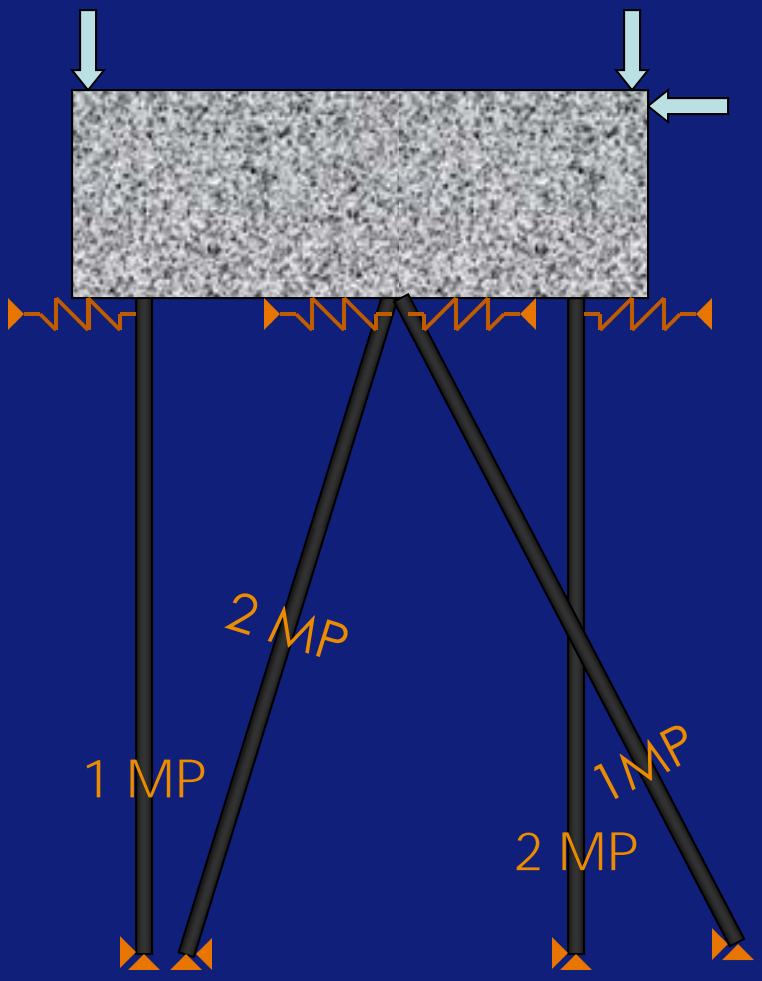


# Cases Histories

- Katzen Arts Center
- One NoMa Station
- Children's National Medical Center
- Bowen Building
- Dulles Airport



# Katzen Arts Center

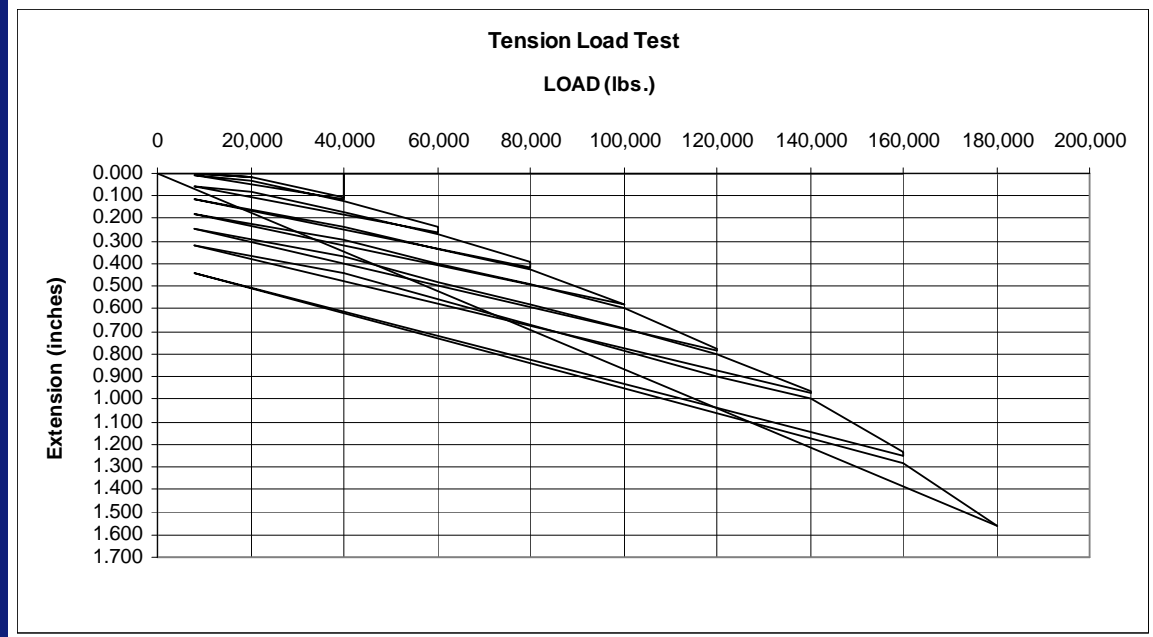


		LOAD (lbs)			
		500	225,000	262,500	300,000
Micropile Type	# of Piles	Ground Conditions			
Type A	109	5 ft of sandy silt terrace deposits on top of 15 to 20 ft of silty sand residual soils underlain by 10 to 30 ft of disintegrated gneiss			
DEFORMATION (in)	0.300				
	Micropile Design and Construction Details				
L (ft)	$\phi$ (in)	Reinforcement Details	Grouting Details	Drilling Method Tools	Drilling Fluid
50 - 65	6	#18 full length. 5 1/2-inch casing (N80) upper 12 ft	w/c=0.45 tremie	Downhole hammer	Air

# One NoMa Station



Micropile Design and Construction Details					
L (ft)	$\phi$ (in)	Reinforcement Details	Grouting Details	Drilling Method Tools	Drilling Fluid
50	6	TITAN 40/16 full length	w/c=0.45 dynamic	Self Drilling Hollow Bars, Modified Bit	Grout

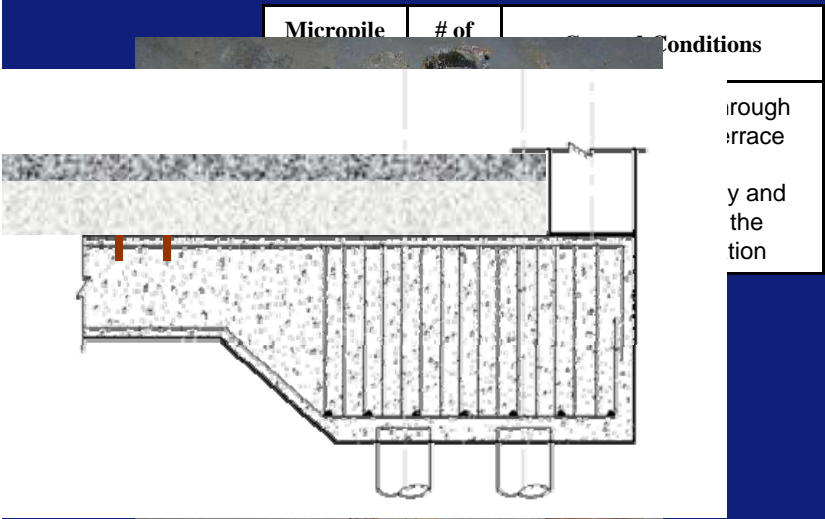
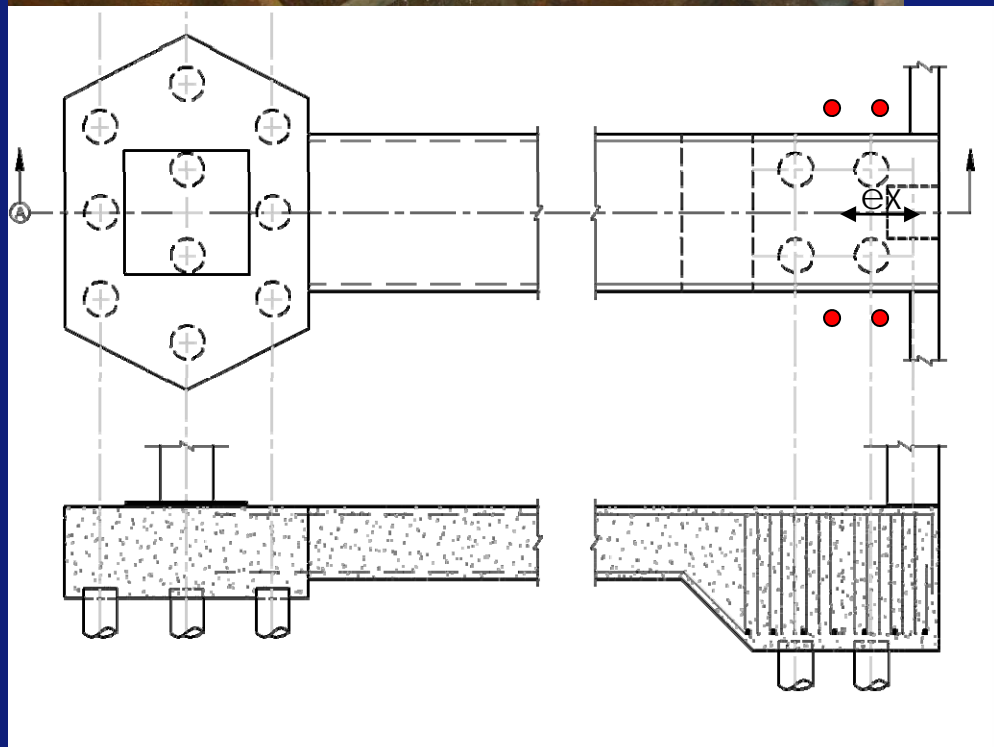


Micropile Type	# of Piles	Ground Conditions
TITAN	34	30 ft of very soft lean clay alluvial deposits on top of dense to very dense silty sand deposits

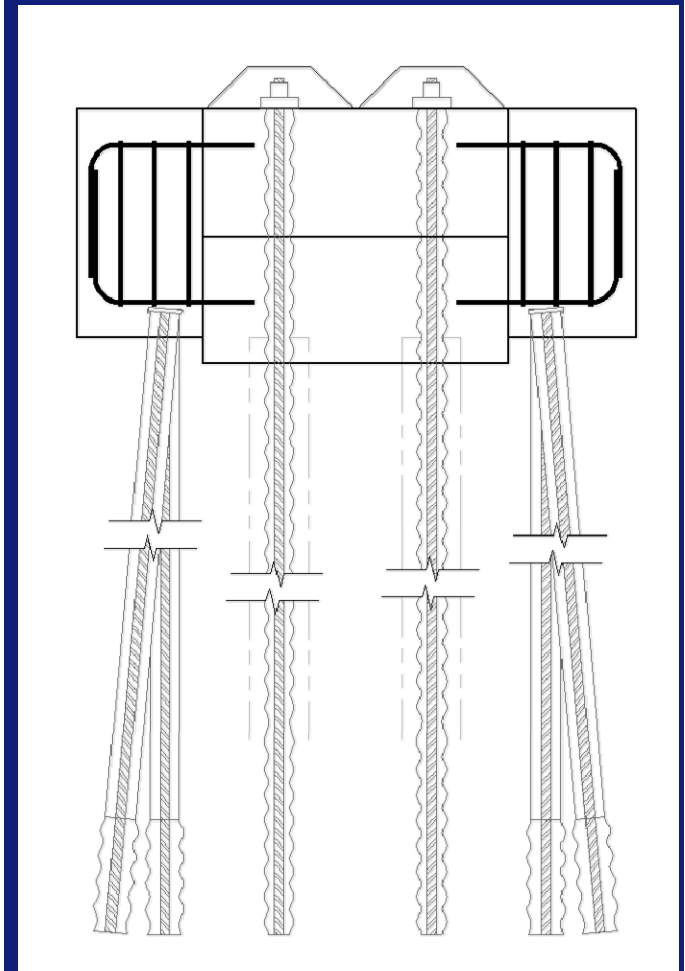
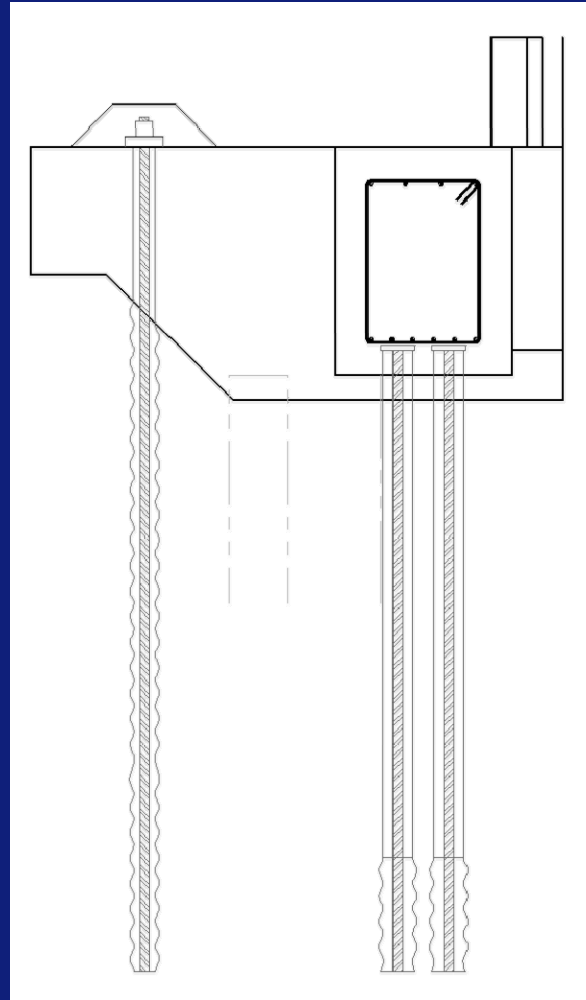
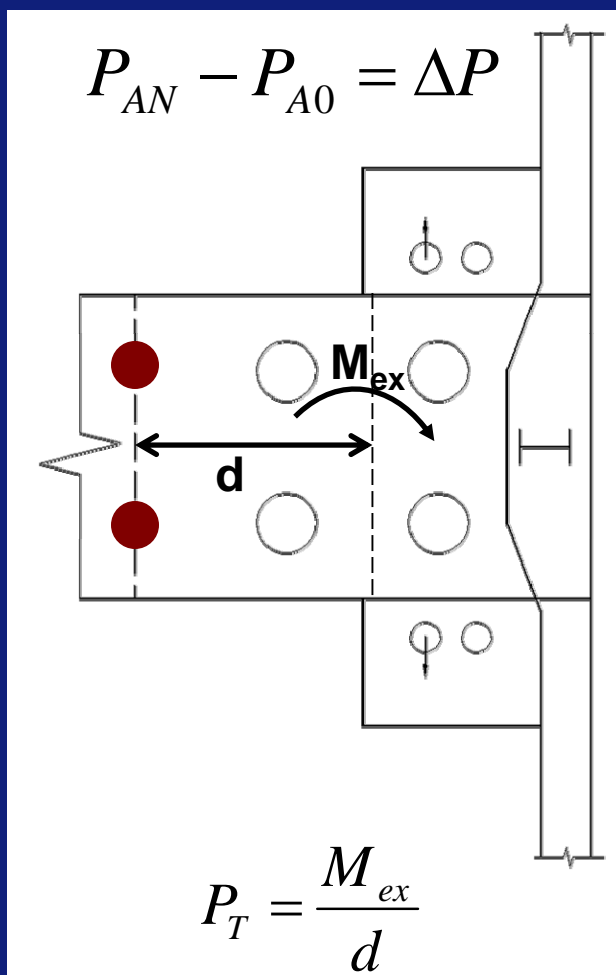
# Children's National Medical Center



Micropile Design and Construction Details					
L (ft)	$\phi$ (in)	Reinforcement Details	Grouting Details	Drilling Method Tools	Drilling Fluid
40	6-8	TITAN 73/53 full length. 8-inch casing (N80) above bond zone	w/c=0.45 dynamic	Self Drilling Hollow Bars, 175mm	Grout



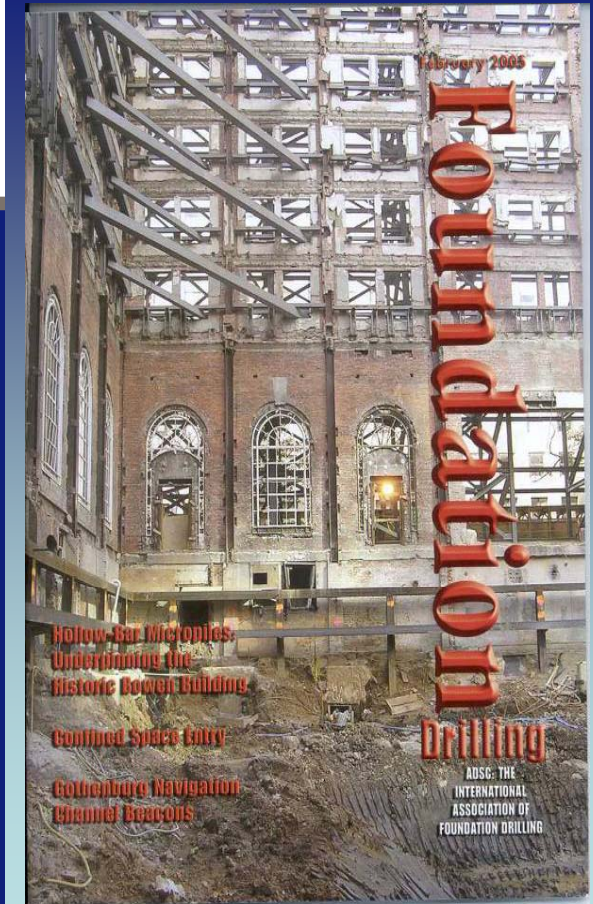
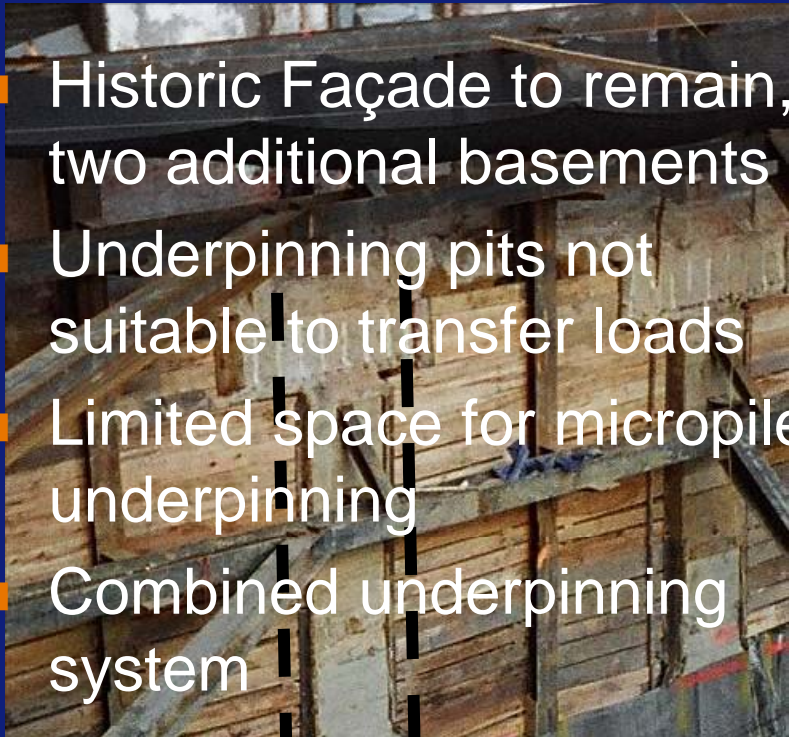
# Design Approach – Tension Micropiles





# BOWEN BUILDING

- Historic Façade to remain, two additional basements
- Underpinning pits not suitable to transfer loads
- Limited space for micropile underpinning
- Combined underpinning system



Micropile Design and Construction Details						Micropile Type	# of Piles	Ground Conditions
L (ft)	$\phi$ (in)	Reinforcement Details	Grouting Details	Drilling Method Tools	Drilling Fluid			
64	4 1/2	TITAN 52/26 full length	w/c=0.45 dynamic	Self Drilling Hollow Bars, 115mm	Grout	TITAN	94	Fill over sand and clay Terrace deposits on top of interbedded Potomac clay and sands on top of gneiss



# Dulles Airport

Micropile Type	# of Piles	Ground Conditions
Type A	220	25 ft of fill and residual soils on top of siltstone
Type A	34	25 ft of fill and residual soils on top of siltstone



Micropile Design and Construction Details					
L (ft)	$\phi$ (in)	Reinforcement Details	Grouting Details	Drilling Method Tools	Drilling Fluid
70	8	7-inch casing (N80) full length	w/c=0.45 tremie	Downhole hammer	Air
13 - 20	6-8	#18-20 full length. No unbonded zone thru potential slip surface	w/c=0.45 tremie	Downhole hammer	Air

# Conclusions

- DC market is territorial
- General contractors first explore old fashioned and outdated alternatives
- Quest for more profitable buildings and reuse of existing structures
- Local practices developed from conventional bar reinforced and cased micropiles to the use of injection bore hollow-core bars
- Verification load tests are the norm
- Design criteria conservative in terms of bond strength
- Synergy between equipment manufacturers, materials suppliers, specialty contractors and consultants
- Continued education for both owners and architects



# Questions

