International Society of Micropiles
15th Workshop
Vail, CO May 31-June 02, 2023

Reticulated Micropiles for Restoration of Historic Structures Foundations after Natural and Manmade Disasters

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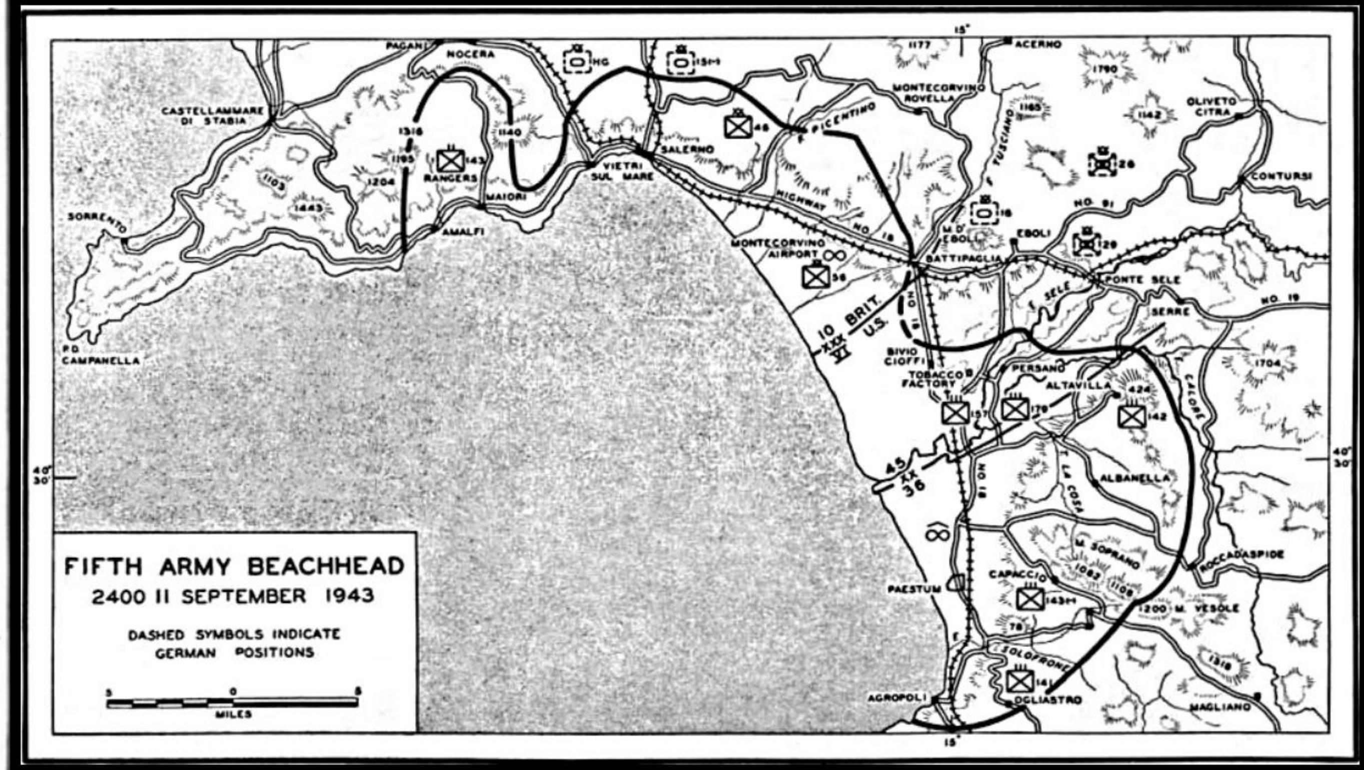
Structural, Geotechnical, Preservation, Seismic Engineer

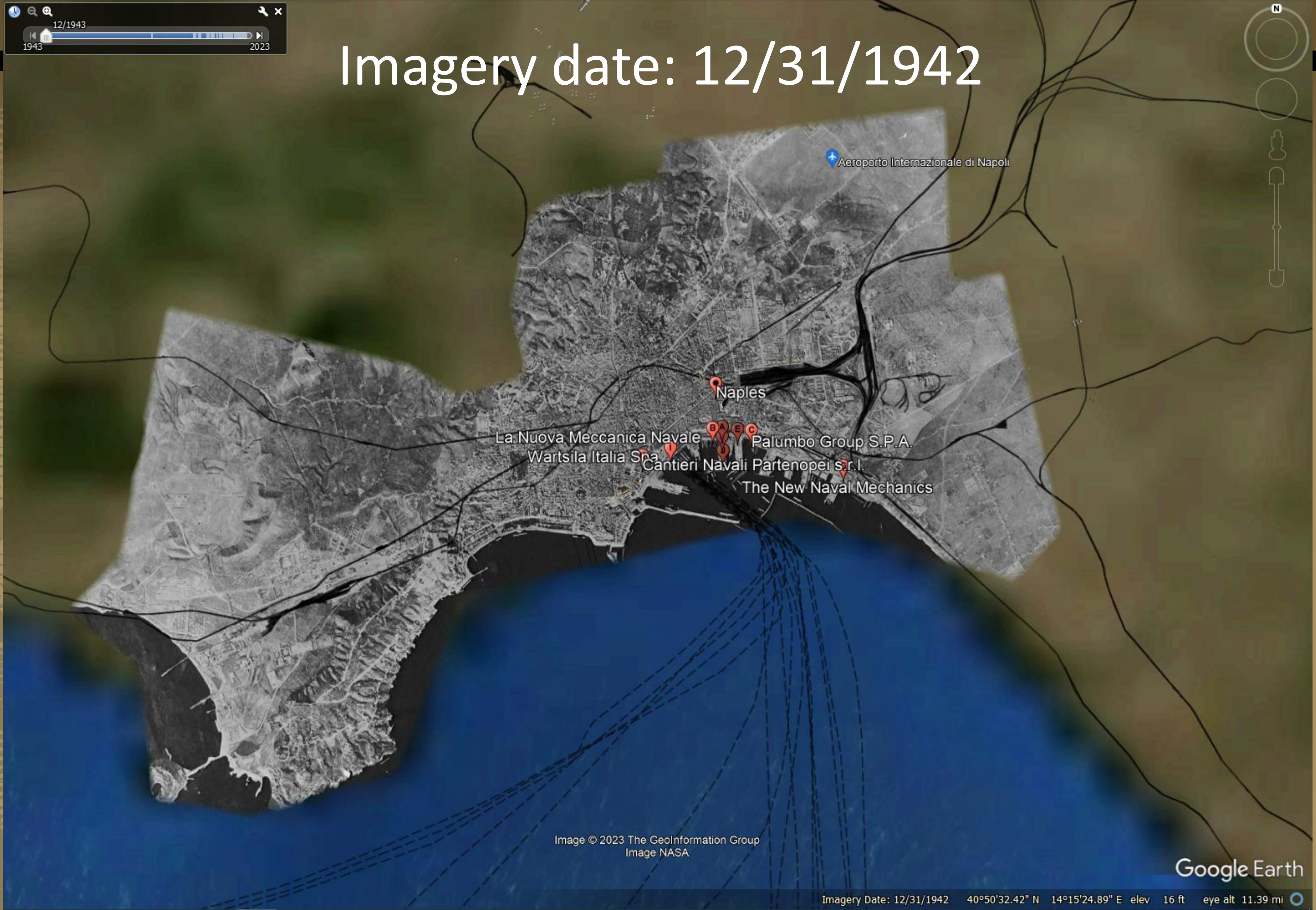
The Motivation for the Invention of Reticulated Micropile Groups.
The Genius of Dr. Fernando Lizzi.

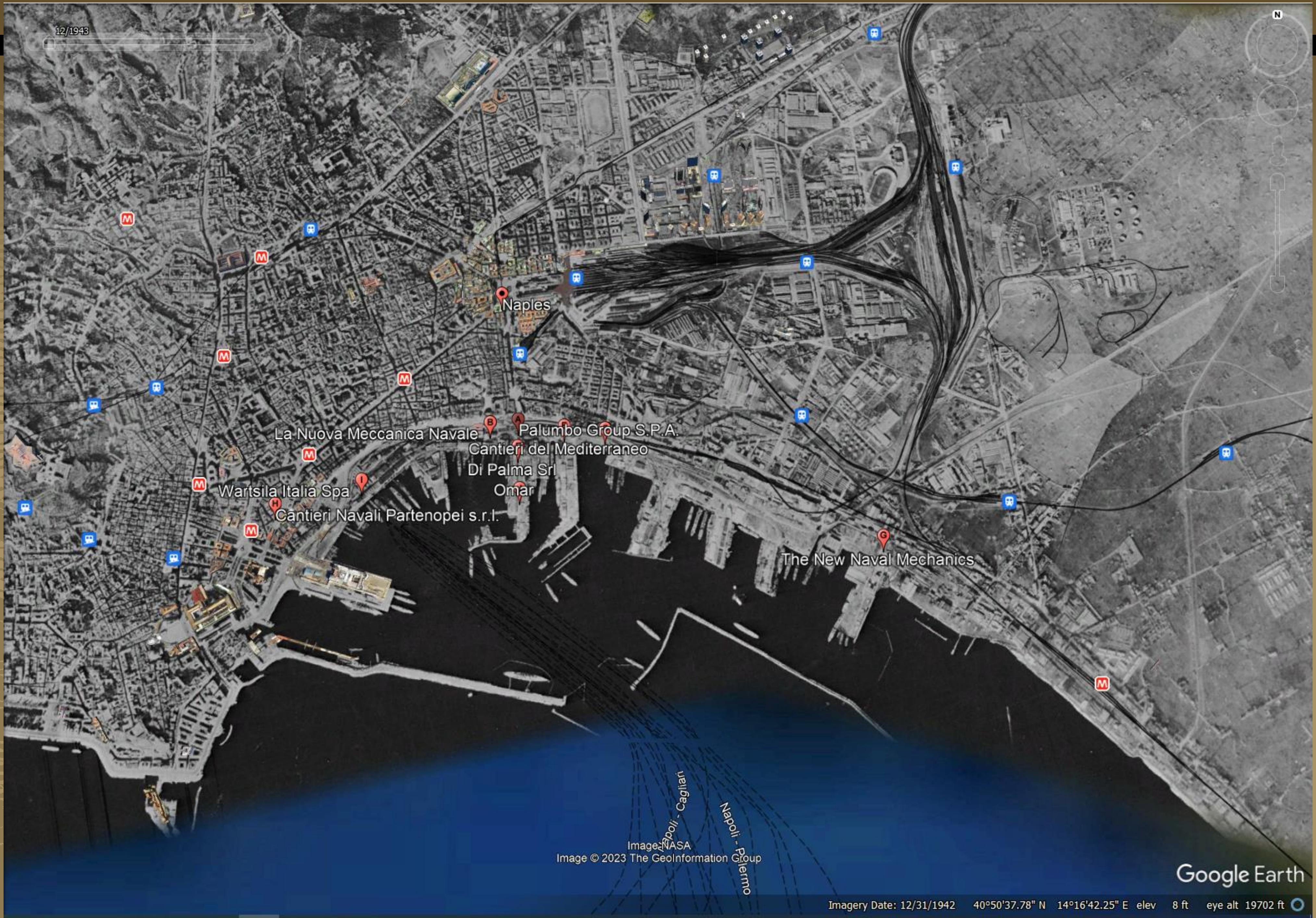
Naples, Italy. Immediately after the retreat by the Nazi Forces.

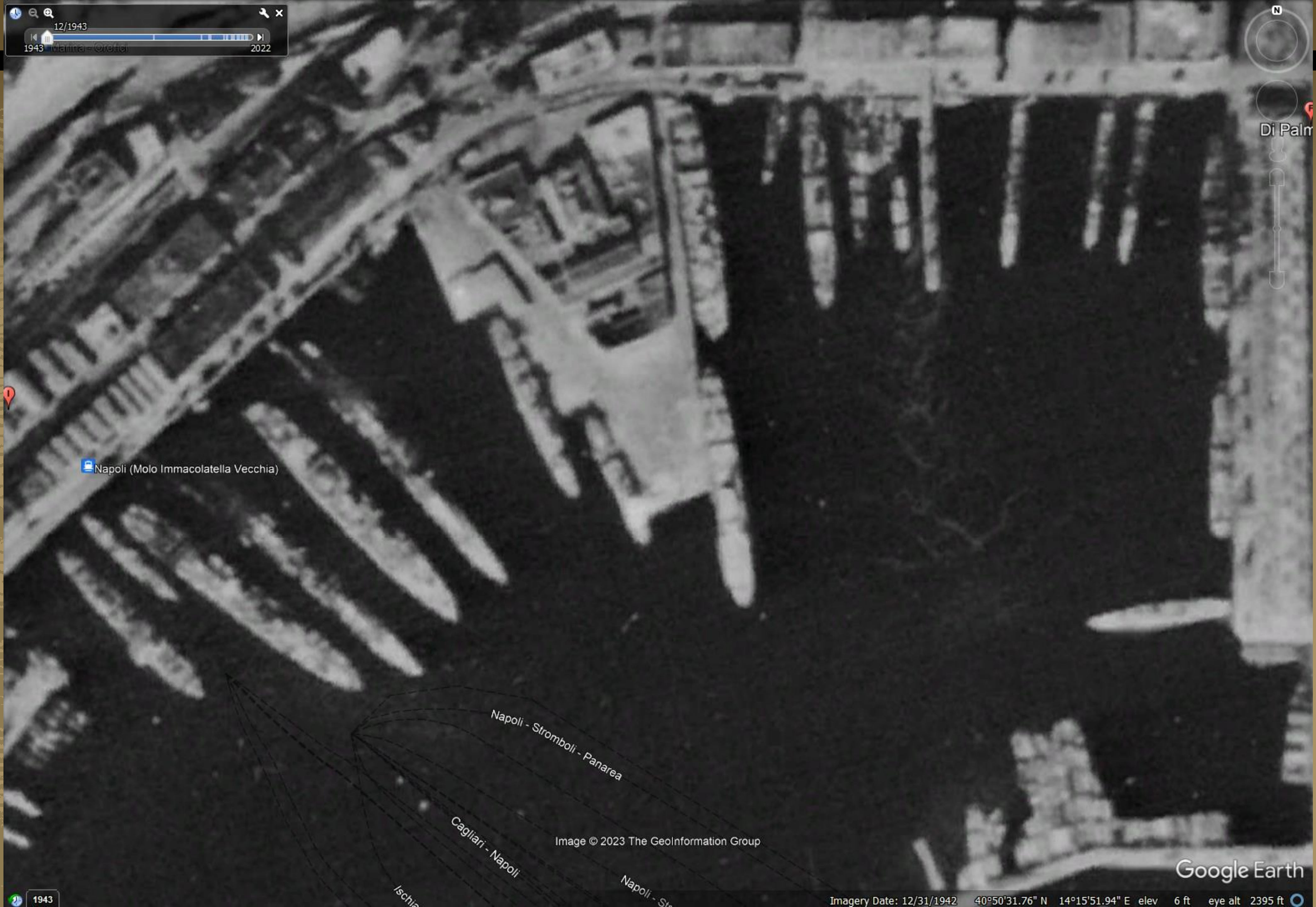
The Four Days of Naples (Italian: Quattro giornate di Napoli) was an uprising in Naples, Italy, against Nazi German occupation forces from September 27 to September 30, 1943, immediately prior to the arrival of Allied forces in Naples on October 1 during World War II.



Imagery date: 12/31/1942

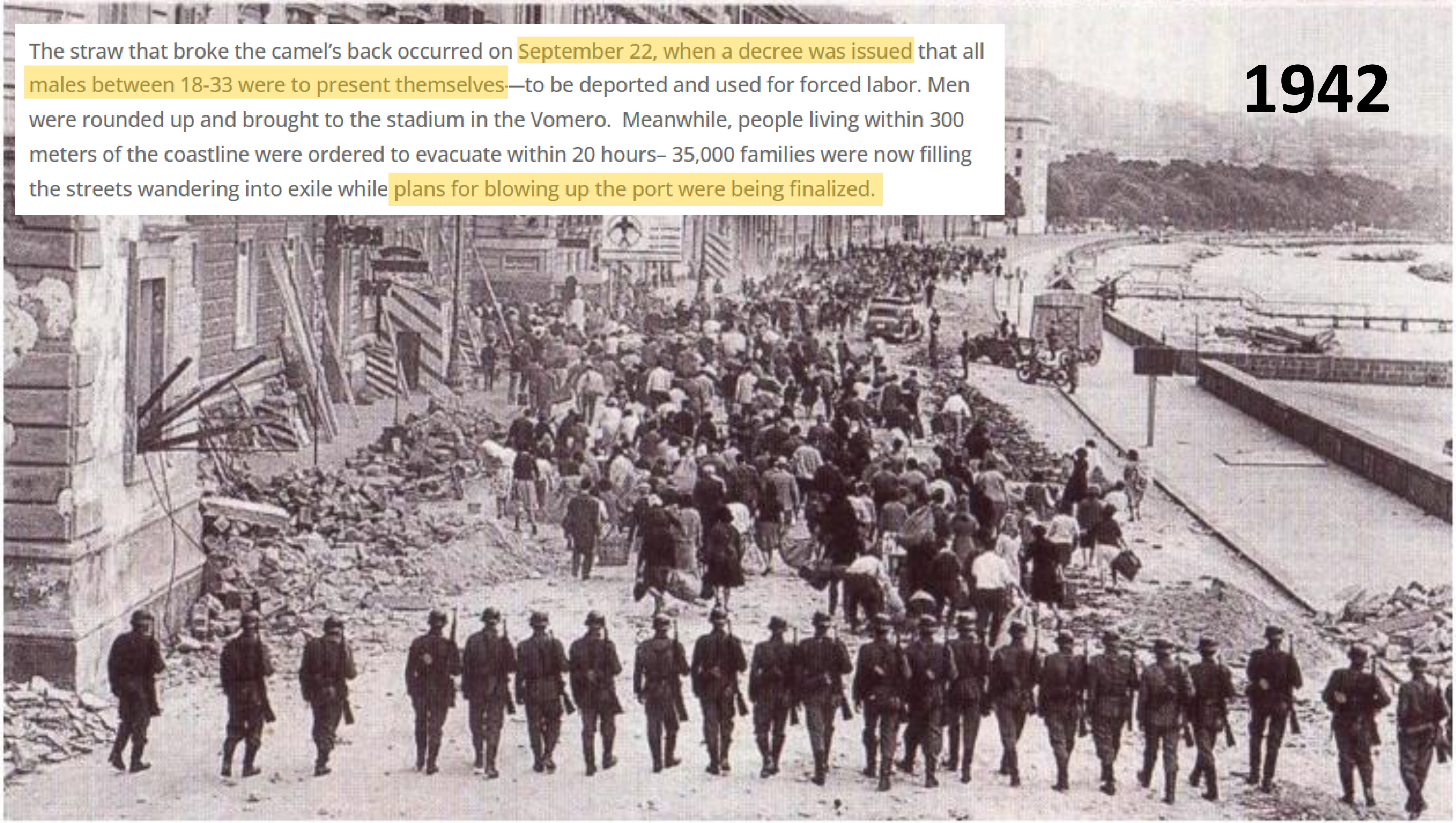



12/1943
Naples
La Nuova Meccanica Navale
Palumbo Group S.P.A.
Cantieri del Mediterraneo
Di Palma Srl
Omar
Wartsila Italia Spa
Cantieri Navali Partenopei s.r.l.
The New Naval Mechanics
Napoli - Cagliari
Napoli - Palermo
Image NASA
Image © 2023 The GeoInformation Group
Google Earth
Imagery Date: 12/31/1942 40°50'37.78" N 14°16'42.25" E elev 8 ft eye alt 19702 ft


12/1943
1943
2022
Di Palm
Napoli (Molo Immacolatella Vecchia)
Napoli - Stromboli - Panarea
Cagliari - Napoli
Image © 2023 The GeoInformation Group
Google Earth
1943
Imagery Date: 12/31/1942 40°50'31.76" N 14°15'51.94" E elev 6 ft eye alt 2395 ft

The straw that broke the camel's back occurred on September 22, when a decree was issued that all males between 18-33 were to present themselves—to be deported and used for forced labor. Men were rounded up and brought to the stadium in the Vomero. Meanwhile, people living within 300 meters of the coastline were ordered to evacuate within 20 hours– 35,000 families were now filling the streets wandering into exile while plans for blowing up the port were being finalized.

1942



On September 8, 1943 the Italians switched sides (Cassibile Armistice) leaving the Germans in an untenable position—having to change from allies to invaders in one day. Almost immediately they turned from stern occupiers to defeated warriors. By September 9 they had already received their orders, Napoli was to be reduced "to cinders and mud" so that the arriving Allied forces could not use the port city as a strategic base.

Patrioti e popolazione solidarizzano con i soldati nei giorni successivi all'insurrezione.

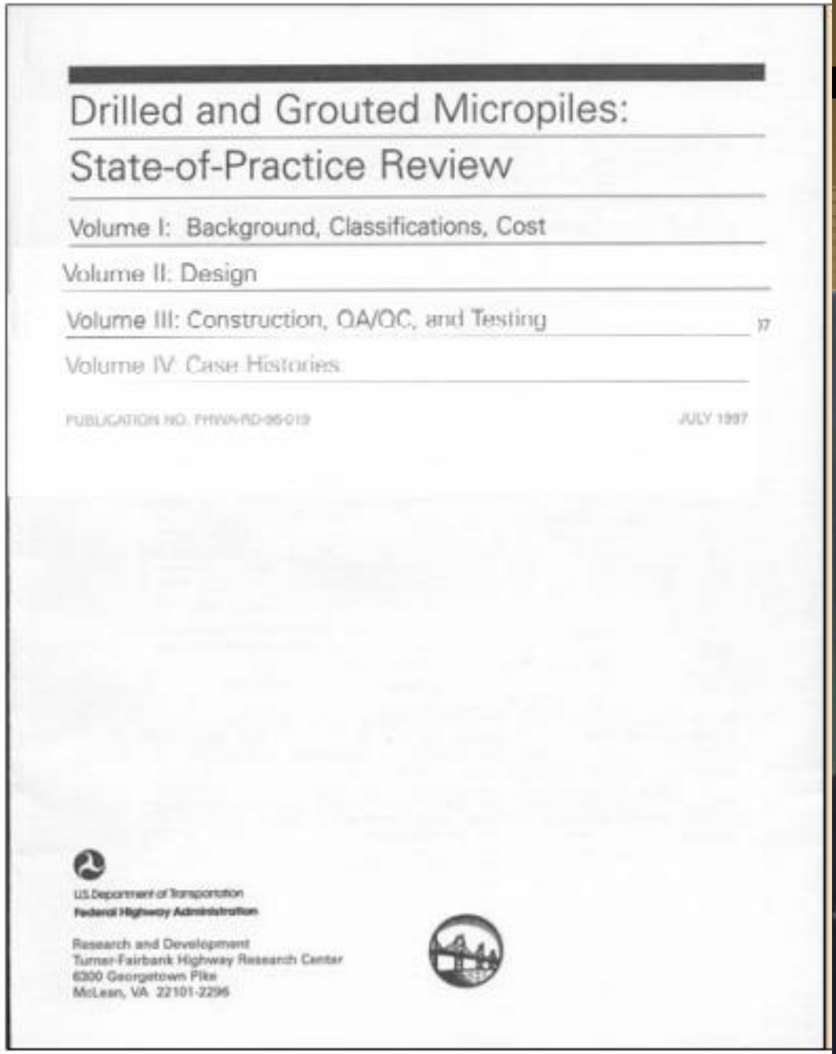
The **Four Days of Naples** (Italian: Quattro giornate di Napoli) was an uprising in Naples, Italy, against Nazi German occupation forces from **September 27 to September 30, 1943**, immediately prior to the **arrival of Allied forces in Naples on October 1** during World War II. The spontaneous uprising of Neapolitan and Italian Resistance against German occupying forces, despite limited armament, organization or planning, nevertheless successfully disrupted German plans to deport Neapolitans en masse, destroy the city and prevent Allied forces from gaining a strategic foothold.

On July 25, 1943, Mussolini was voted out of office.
On April 28, 1945, he was executed.

During World War II the Italian city of Naples suffered approximately 200 air raids by the Allies from 1940 to 1944; only Milan was attacked more frequently. Almost all of the attacks — a total of 181 — were launched in the first nine months of 1943 before the Four days of Naples and the Allied occupation of the city at the beginning of October. Estimates of civilian casualties vary between 20,000 and 25,000 killed.[1][2]


Destruction of Naples Harbor immediately after the retreat of the Nazi Submarine Navy


Oct. 4th, 1943. Enter the American Troops into Naples, Italy.



Drilled and Grouted Micropiles:
State-of-Practice Review

Volume I: Background, Classifications, Cost

Volume II: Design

Volume III: Construction, QA/QC, and Testing

Volume IV: Case Histories

PUBLICATION NO. FHWA-RD-96-019 JULY 1997

U.S. Department of Transportation
Federal Highway Administration

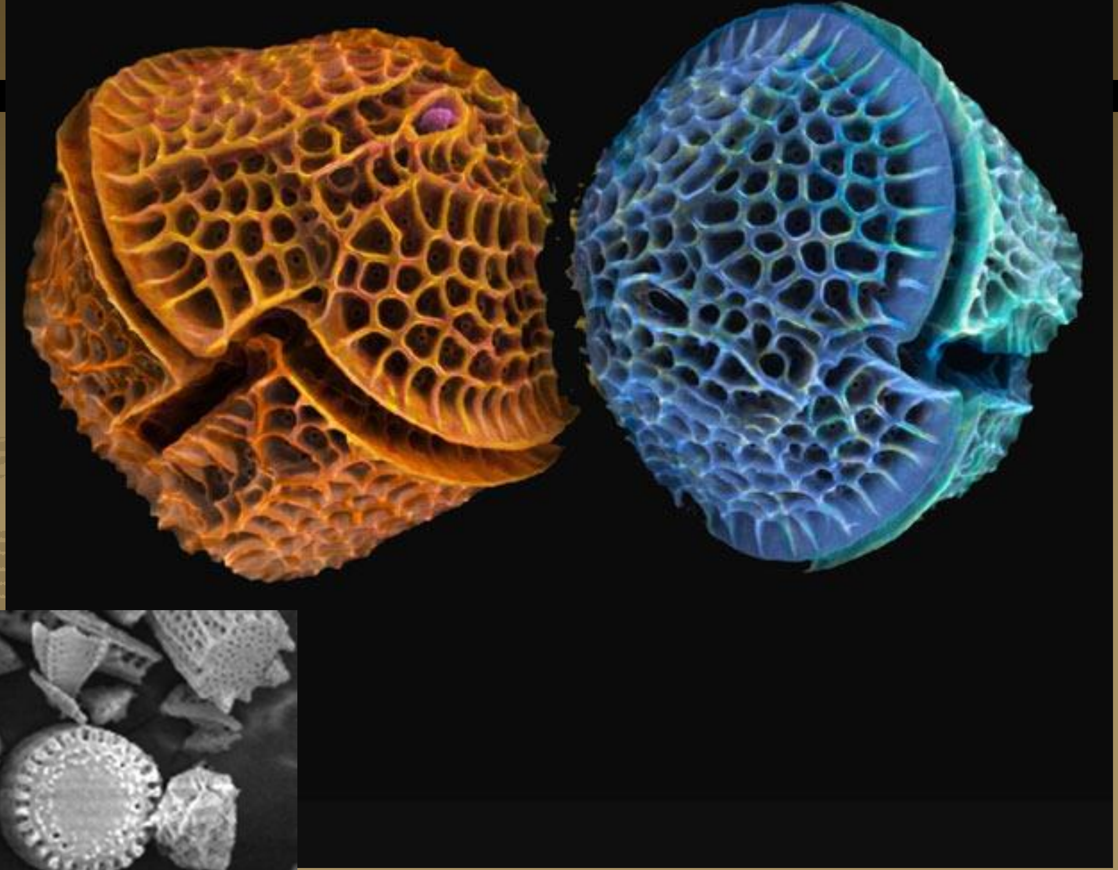
Research and Development
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, VA 22101-2296

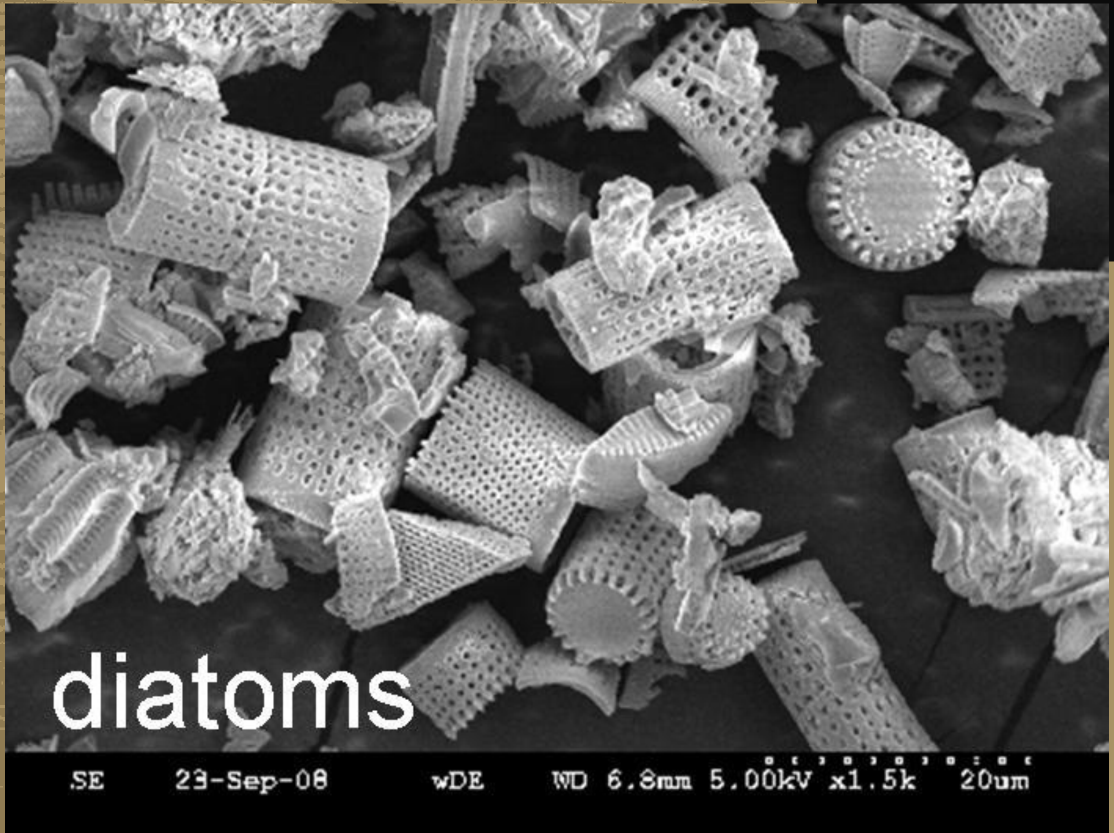
March 1994

Washington, DC. FHWA HQ. Some of the committee members who provided input and feedback to Dr. Donald Bruce for the writing of the "State-of-Practice Review".

Reticulation in Nature

Dr. Paul Hargreaves
and Faye Darling





Dr. Angel Palomino

Biomorphic Transformation


Reticulated Root Structure

The successful execution of the restoration works is based on 4 “Lizzi principles”:

- “Primum non nocere”(Latin). First, do no harm.
- Maintain the existing equilibrium.
- Reinforce both the soil and the existing structure.
- Strictly preserve the construction scheme and the original aesthetic designed by the original architect / engineer.

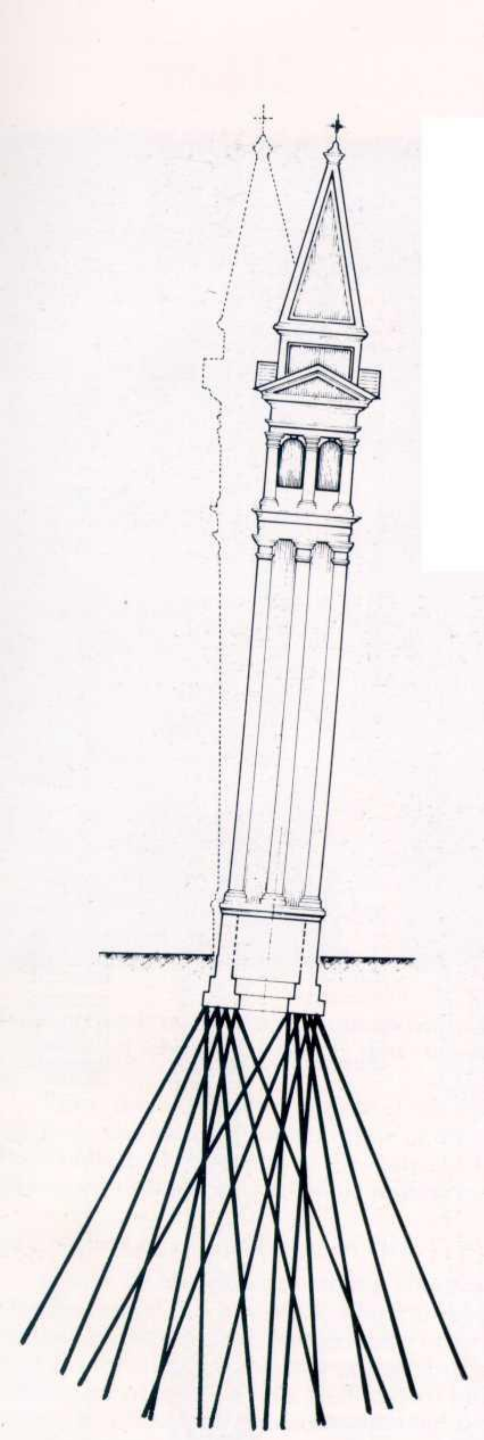
Lizzi's Reinforced Soils

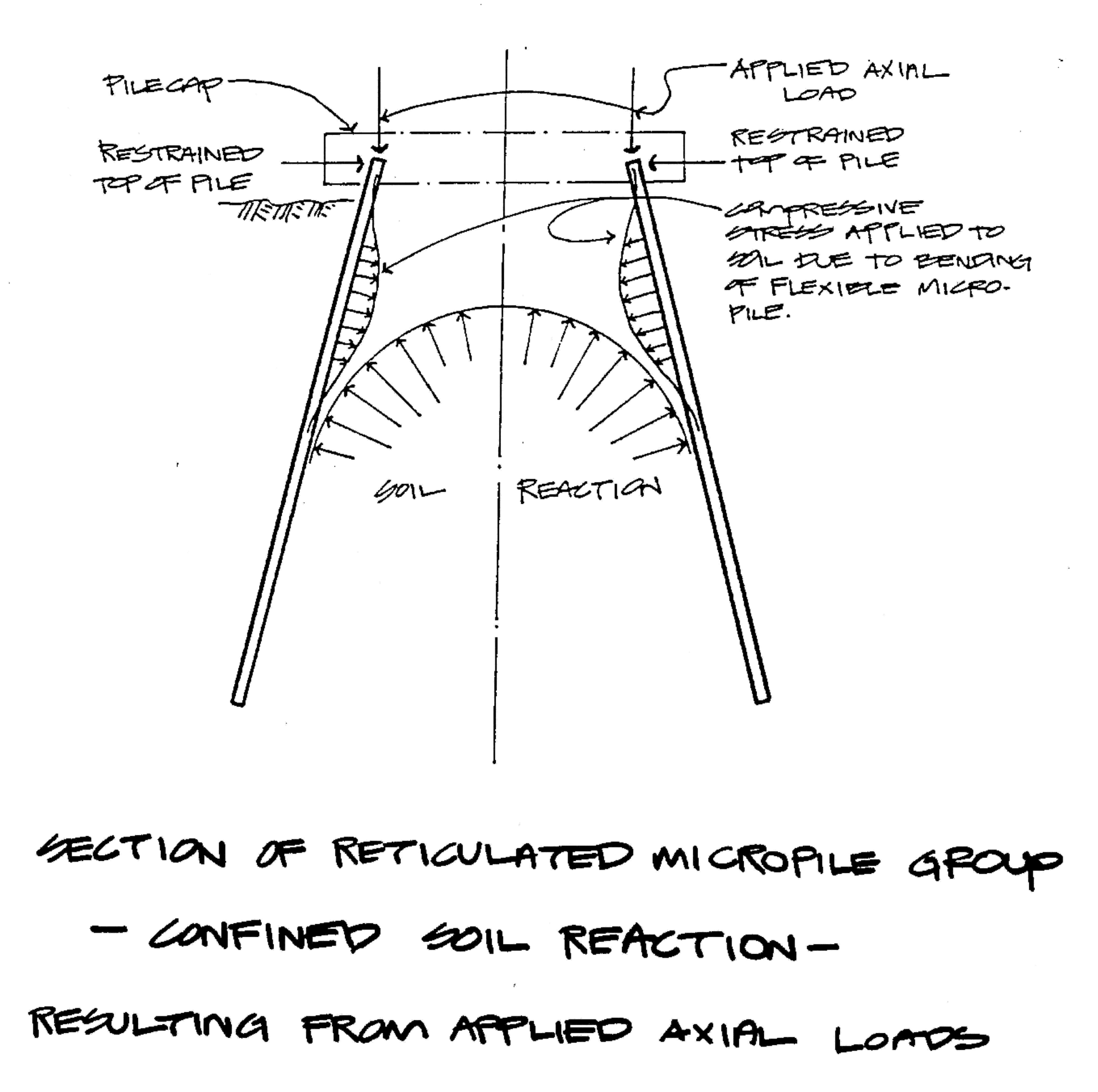
Improvement of Foundations of Historic Structures with Reticulated Micropiles.

JA Mason and FE Kulhawy

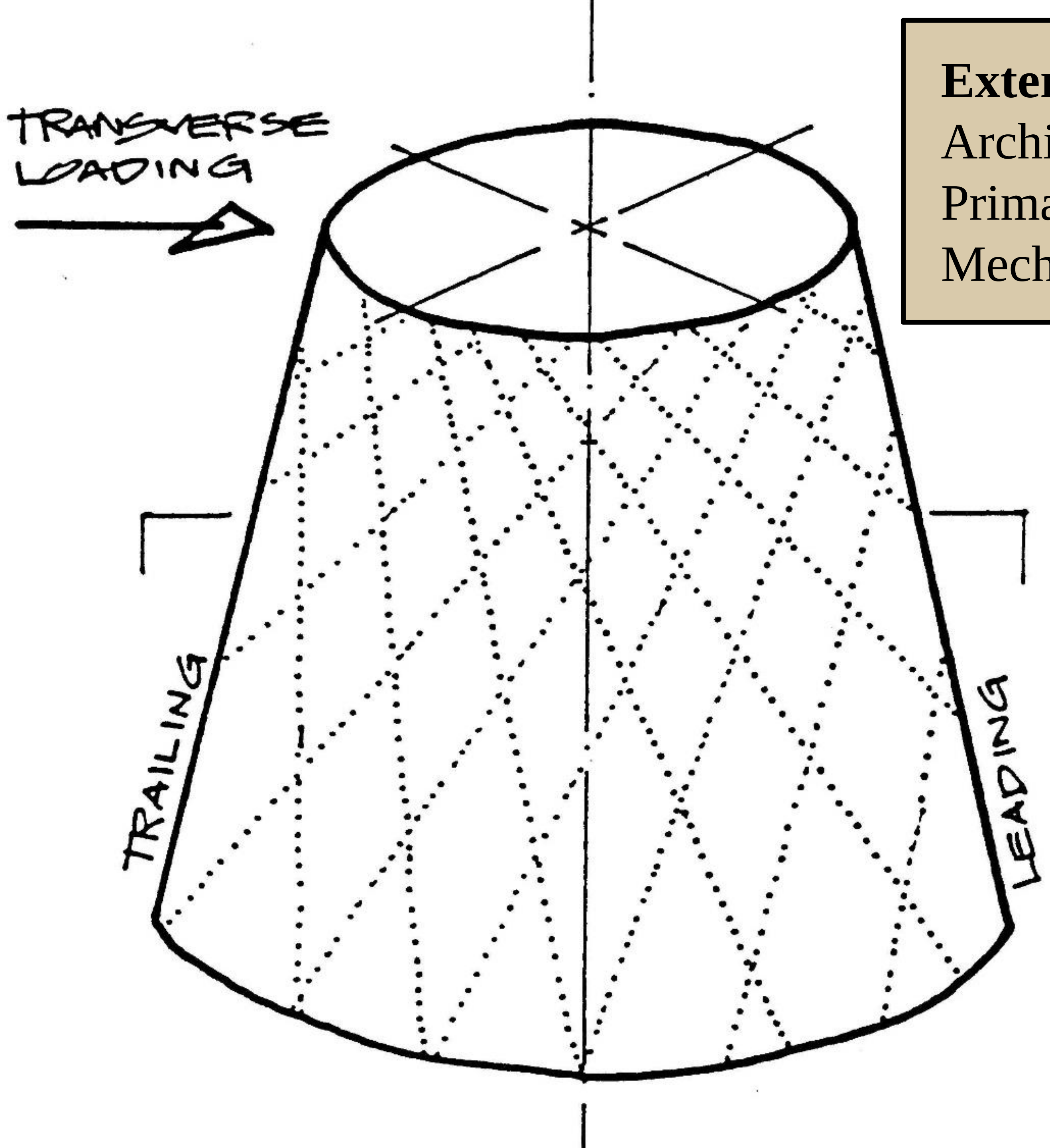
Basic Mechanics of RRP

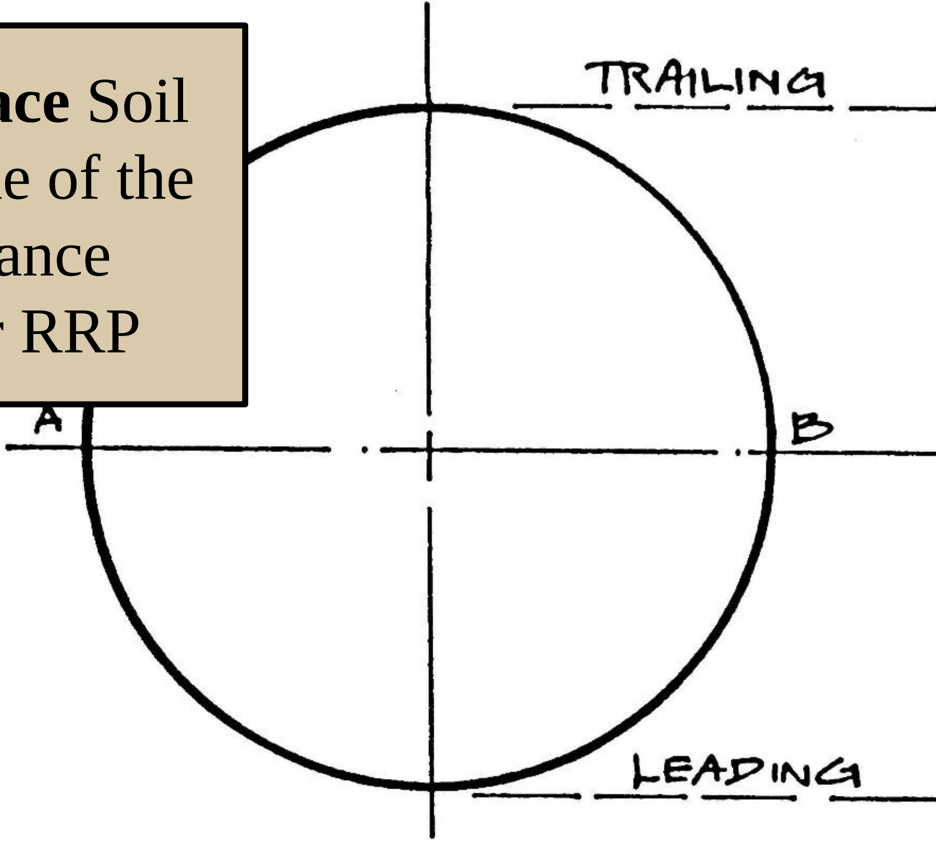
Burano Tower. Venetian Lagoon.

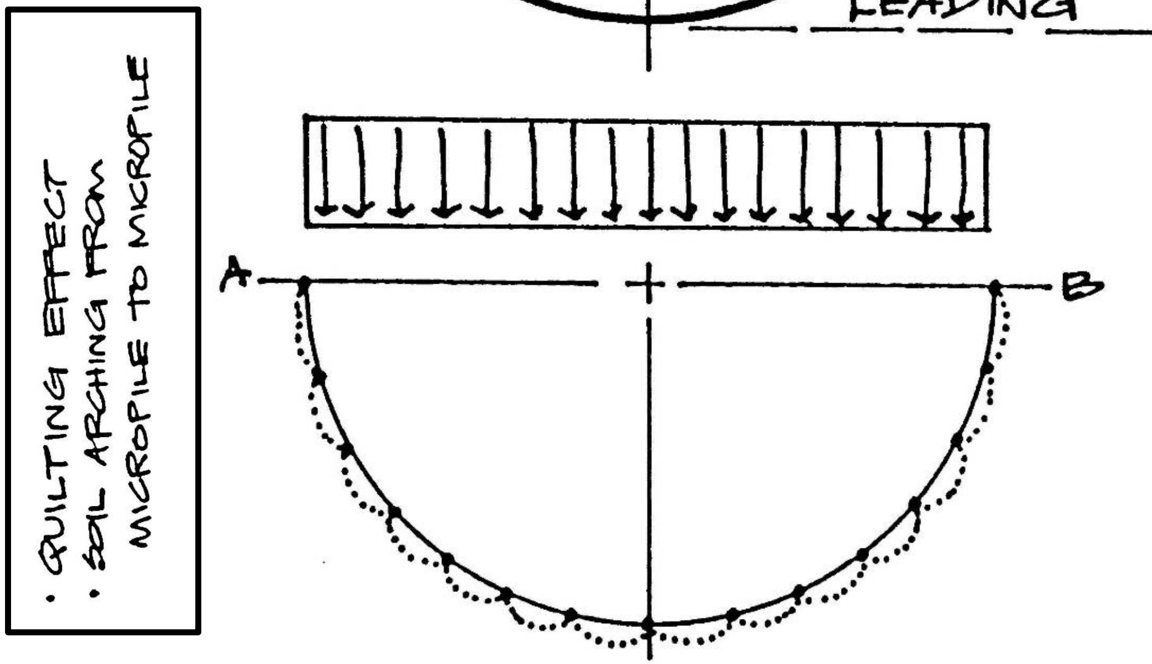




Exterior Surface Soil Arching As One of the Primary Resistance Mechanism for RRP



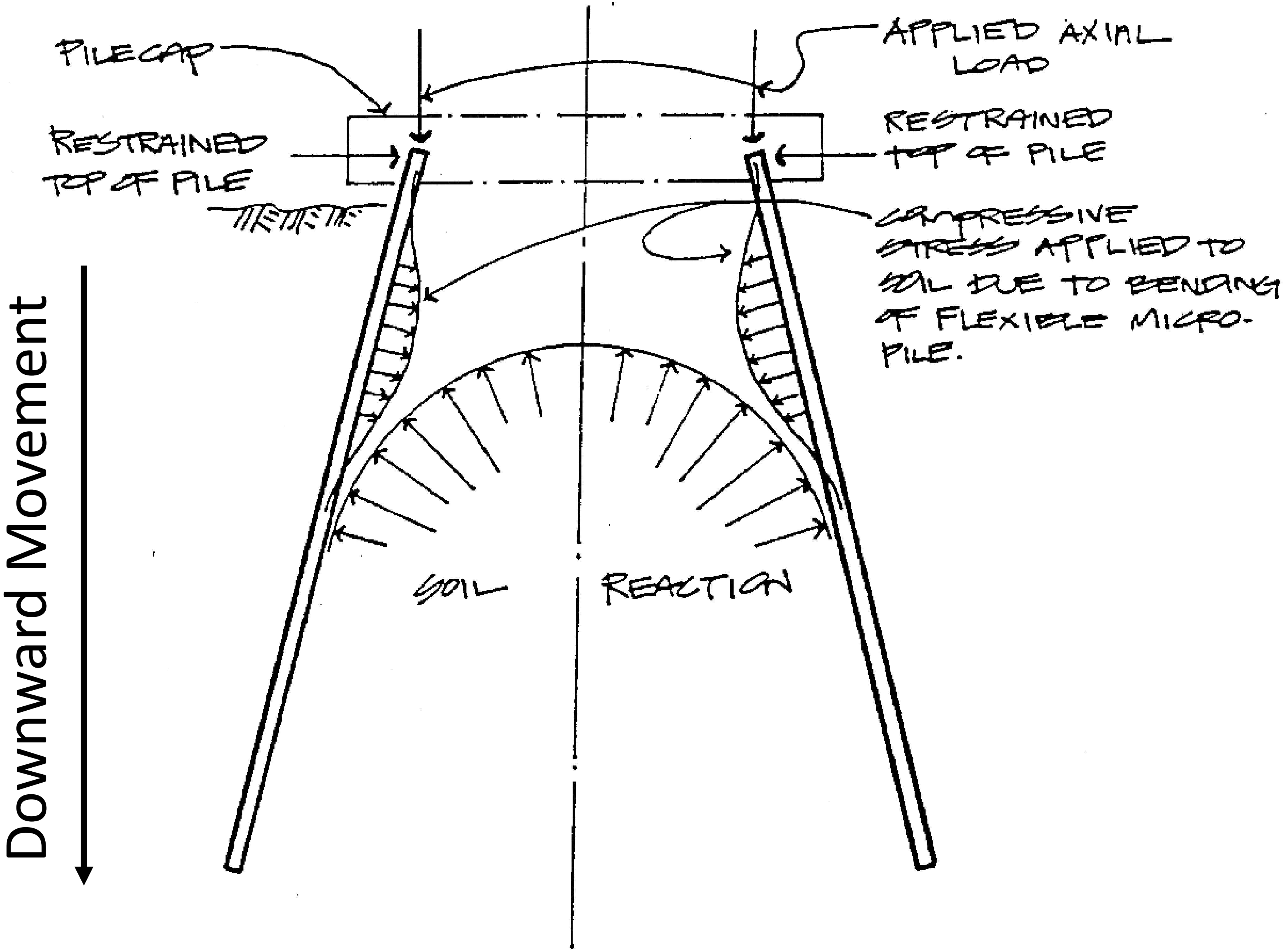




RECENT COMMENTS ABOUT NEW YORK CITY SINKING. NOTE HOW THE TRUNCATED CONE CONFIGURATION CONSTRAINS SUPPORTING SOILS.

Thus, downward movement densifies and strengthen the encased soil. With densification, i.e., a decrease in the soil voids, (further, yet smaller, downward vertical movement) the permeability is decreased.

Remember that the RRP geometrics allows the movement of ground water through the pile group.



The "Knotting Effect"

The ability of the soil-pile system to generate this "knot effect" is dependent on the density and arrangement of the system. When a reticulated micropile system is used to support excavations and slopes, the density and configuration of the piles should also be selected to minimize the possibility of plastic flow between the piles. The stability against plastic flow can be verified by comparing the horizontal pressure exerted by the soil mass to the limit resistance developed by the arching effect between two adjacent piles as analyzed by Ito and Matsui, (1975). A preliminary configuration of 6 to 7 piles per linear meter is recommended for reticulated micropile walls (Figure 5) to allow for the generation of the "knot effect."

Failure Surface: The failure surface in

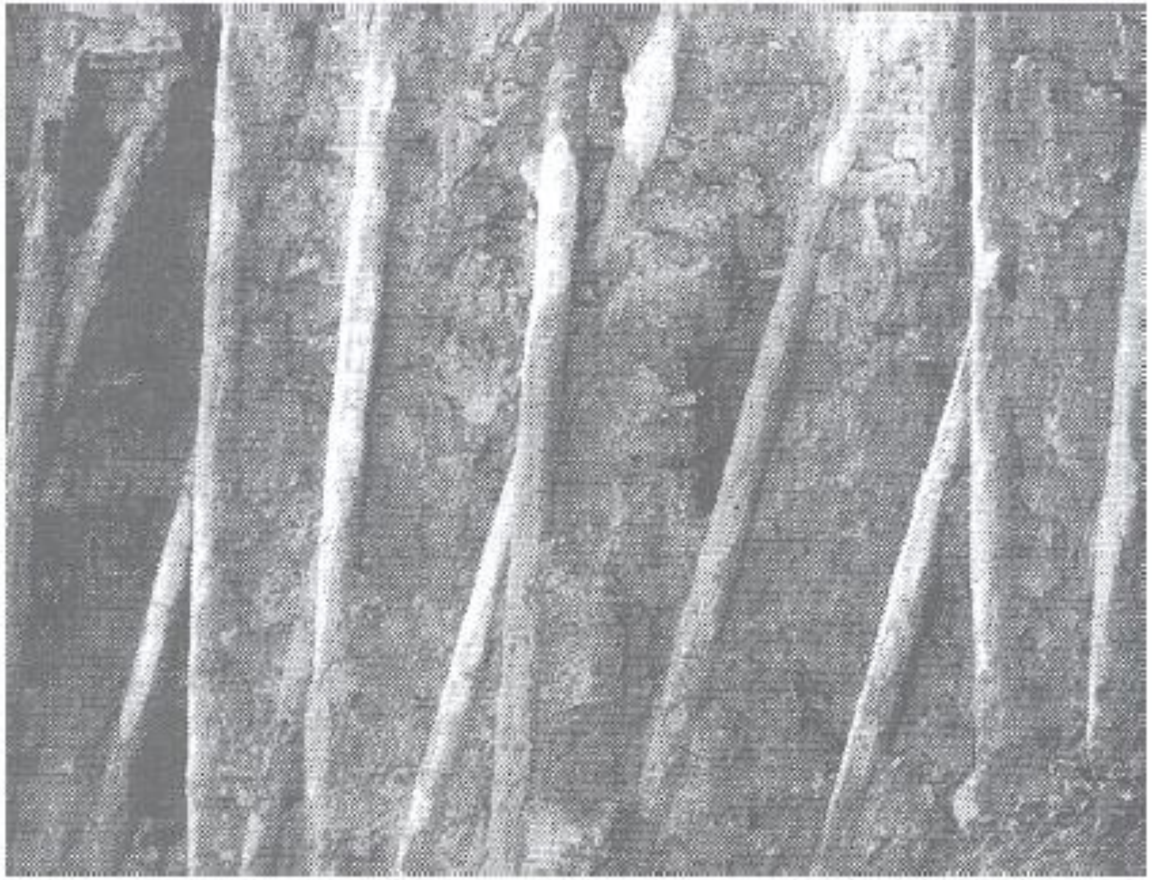


Figure 5 : Knot Effect in a Reticulated Micropile System

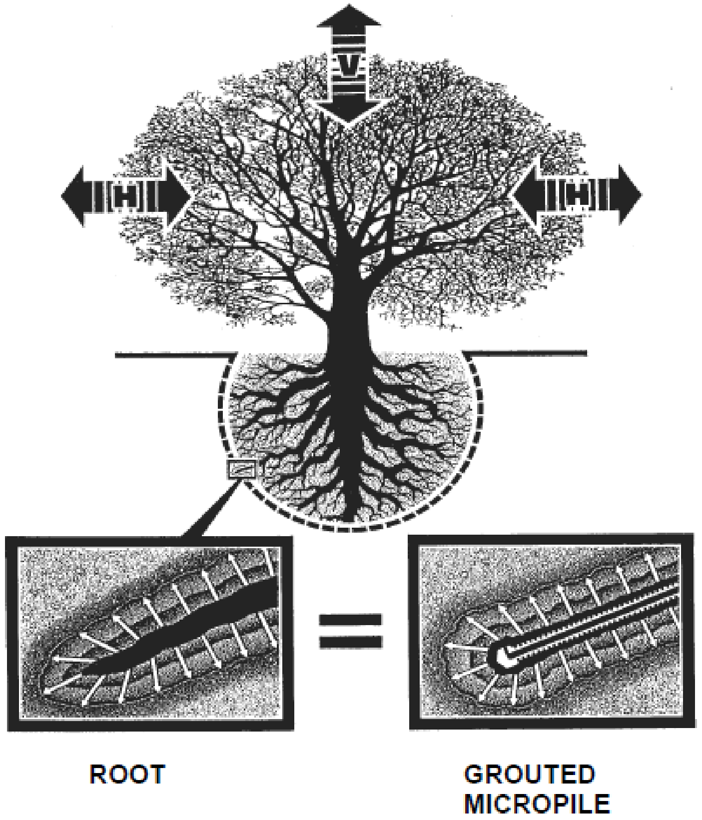
Ref: *Ground Improvement Engineering. Issues and Selection*. George Munfakh and Duncan Wylie

THE DESIGN AND EXECUTION OF DRILLED AND FLUSH-GROUTED TITAN MICROPILES IS GOVERNED IN EUROPEAN UNION (EU) BY NATIONAL TECHNICAL APPROVAL Z-34.14-209 (DIBT)

Dipl.-Ing. Ernst F. Ischebeck <Ischebeck@ischebeck.de>

1. FROM LIZZI'S PIONEERING VISION OF "PALI RADICE" TO - TYPE 1 AND TYPE 2 MICROPILES ACCORDING TO EN 14199 "MICROPILES" AND NATIONAL TECHNICAL APPROVAL FOR TITAN DRILLED MICROPILES.

Lizzi's Vision of "Pali Radice" - Micropiles Type 1 and Type 2 includes 4 fundamental experiences: (1)



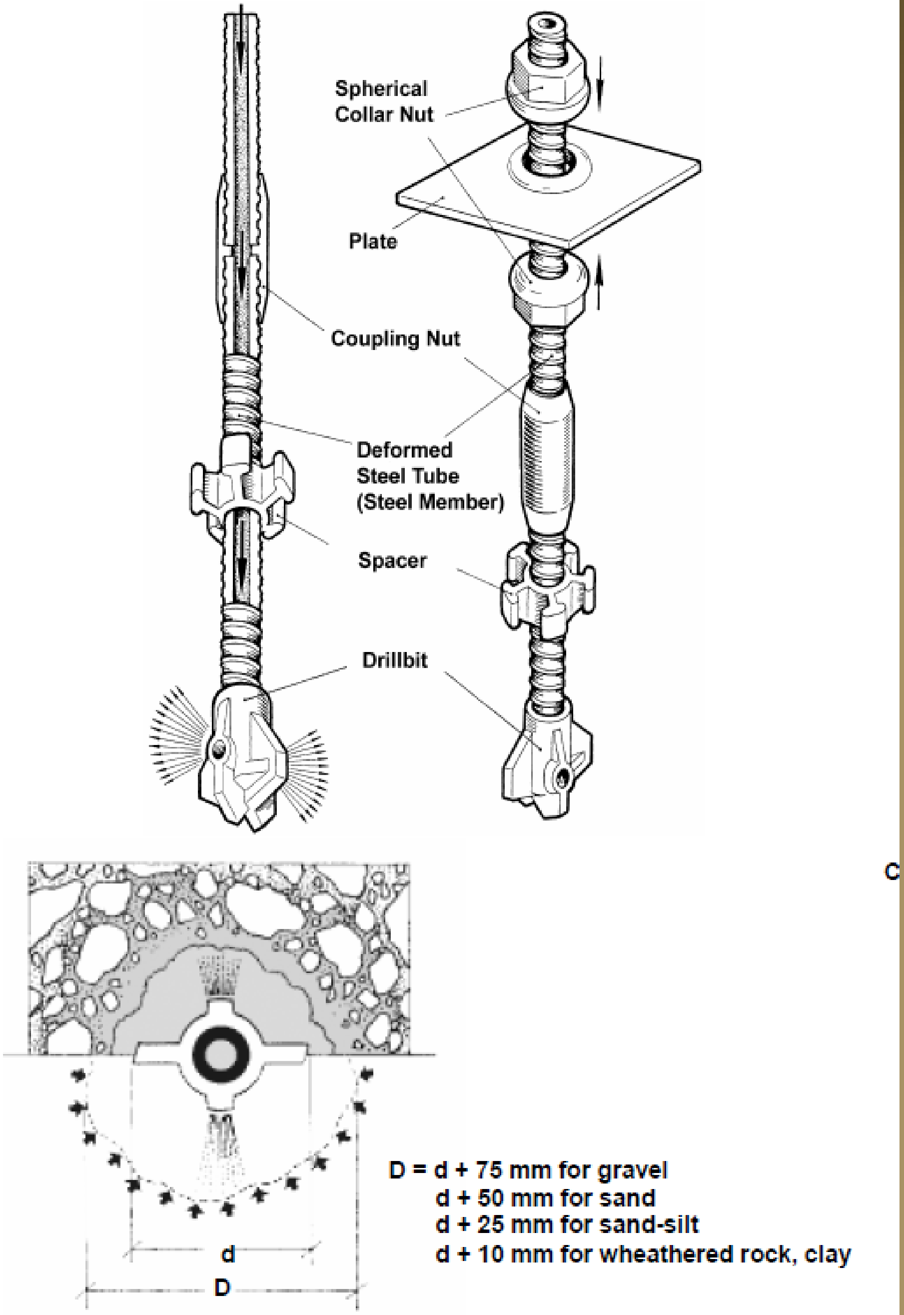


Figure 3: Micropile TITAN Main Components

- Both Roots and Micropiles can transfer tension or compression loads to the ground.
- Roots and Micropiles increase the cohesion of the ground and form a monolithic, composite foundation material.
- The increased volume of roots through growth or the pressure grouting of micropiles both create confinement of the soil. As a result there is an improvement in shear bond values and smaller displacements of the roots and micropiles.
- A network of roots form splayed Micropiles, which work like rebar in reinforced concrete or glasfibre – used in reinforced plastic (GRP).

THE DESIGN AND EXECUTION OF DRILLED AND FLUSH-GROUTED TITAN MICROPILES IS GOVERNED IN EUROPEAN UNION (EU) BY NATIONAL TECHNICAL APPROVAL Z-34.14-209 (DIBT)

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Example of Lizzi's Method of Modeling and Calculation Sequence

Ref. Thorburn and Hutchinson

Underpinning (1986)

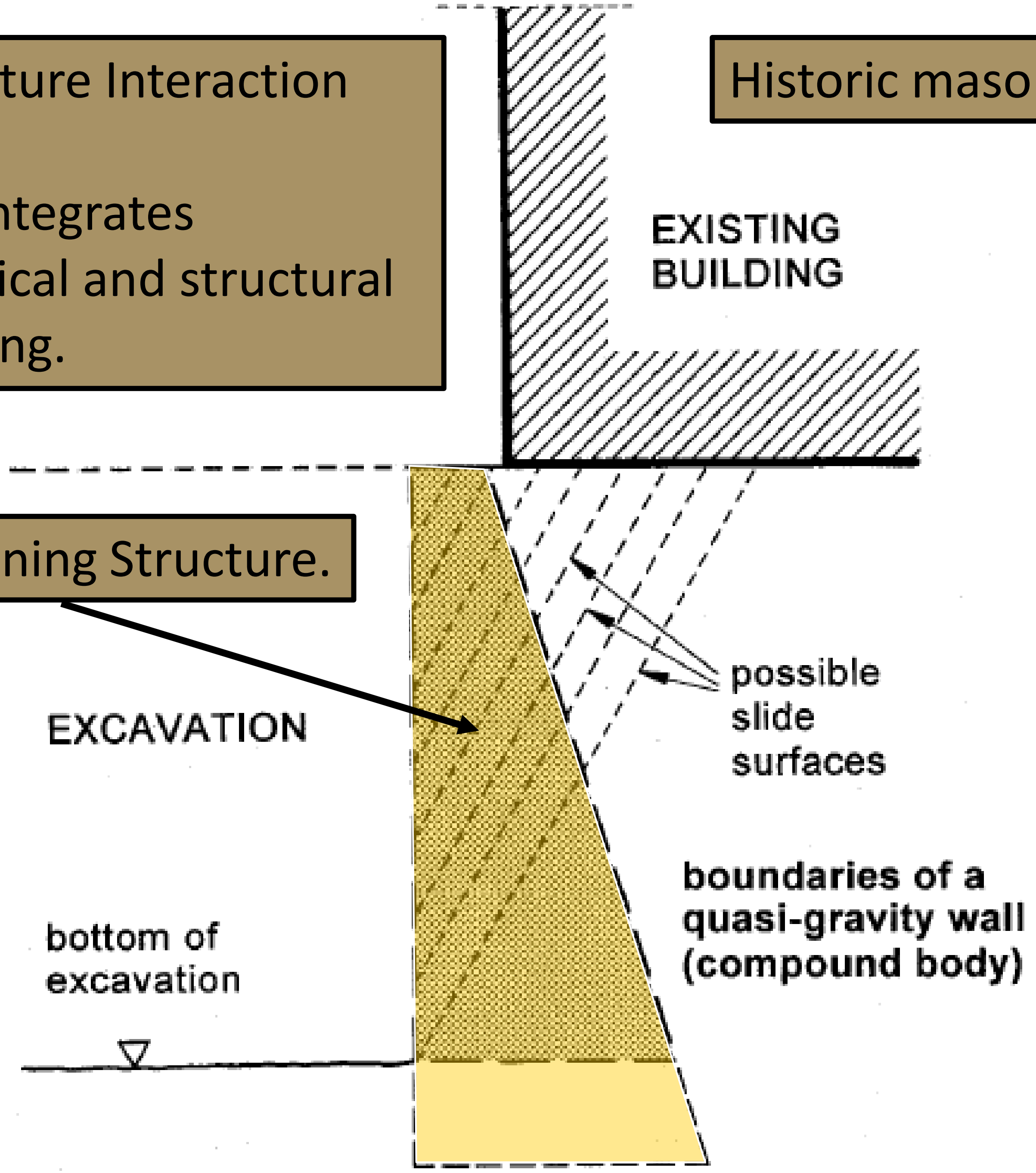
Surrey University Press

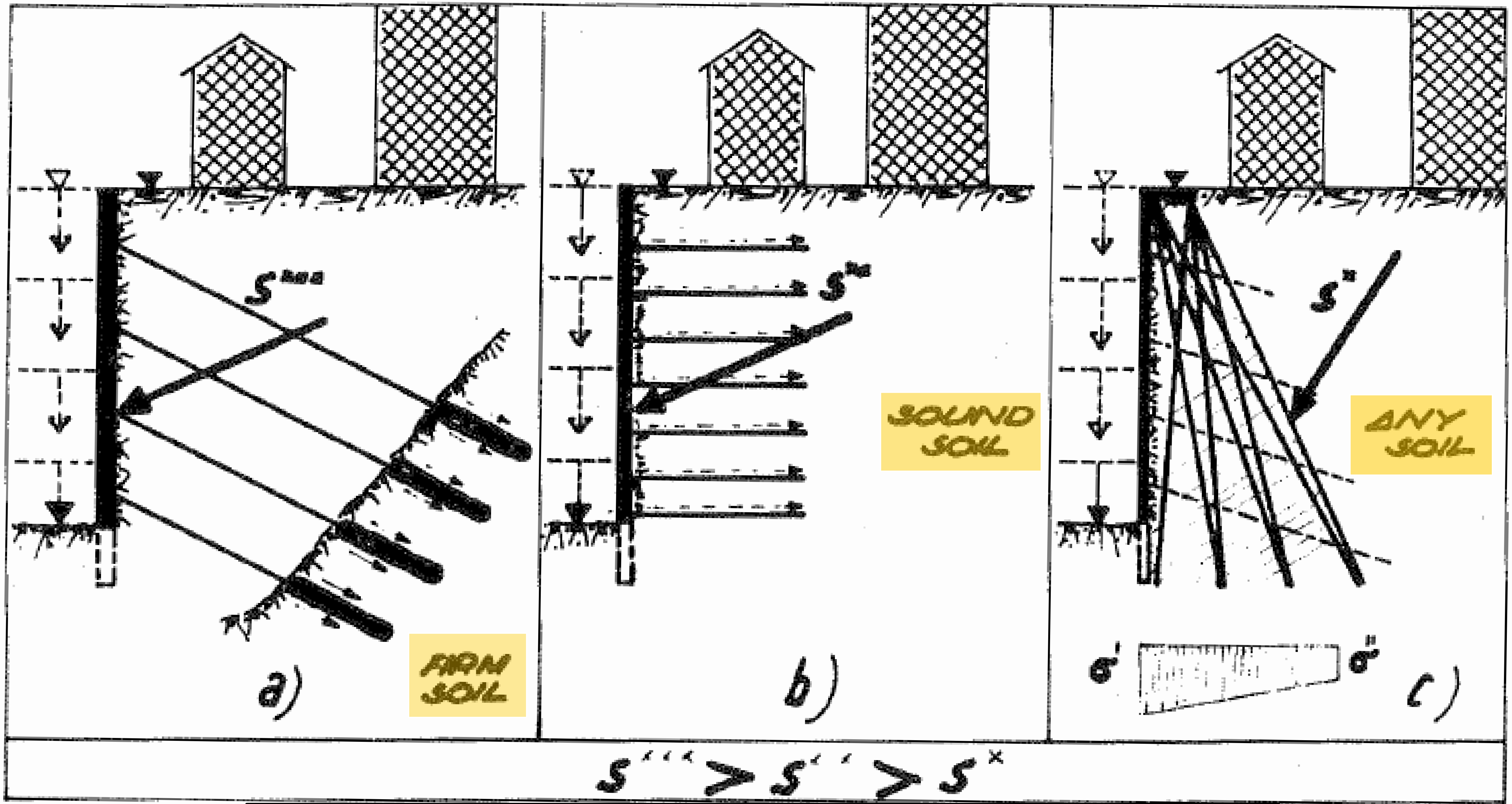
Calculations pgs. 122-126

Soil-Structure Interaction Problem.
Directly integrates geotechnical and structural engineering.

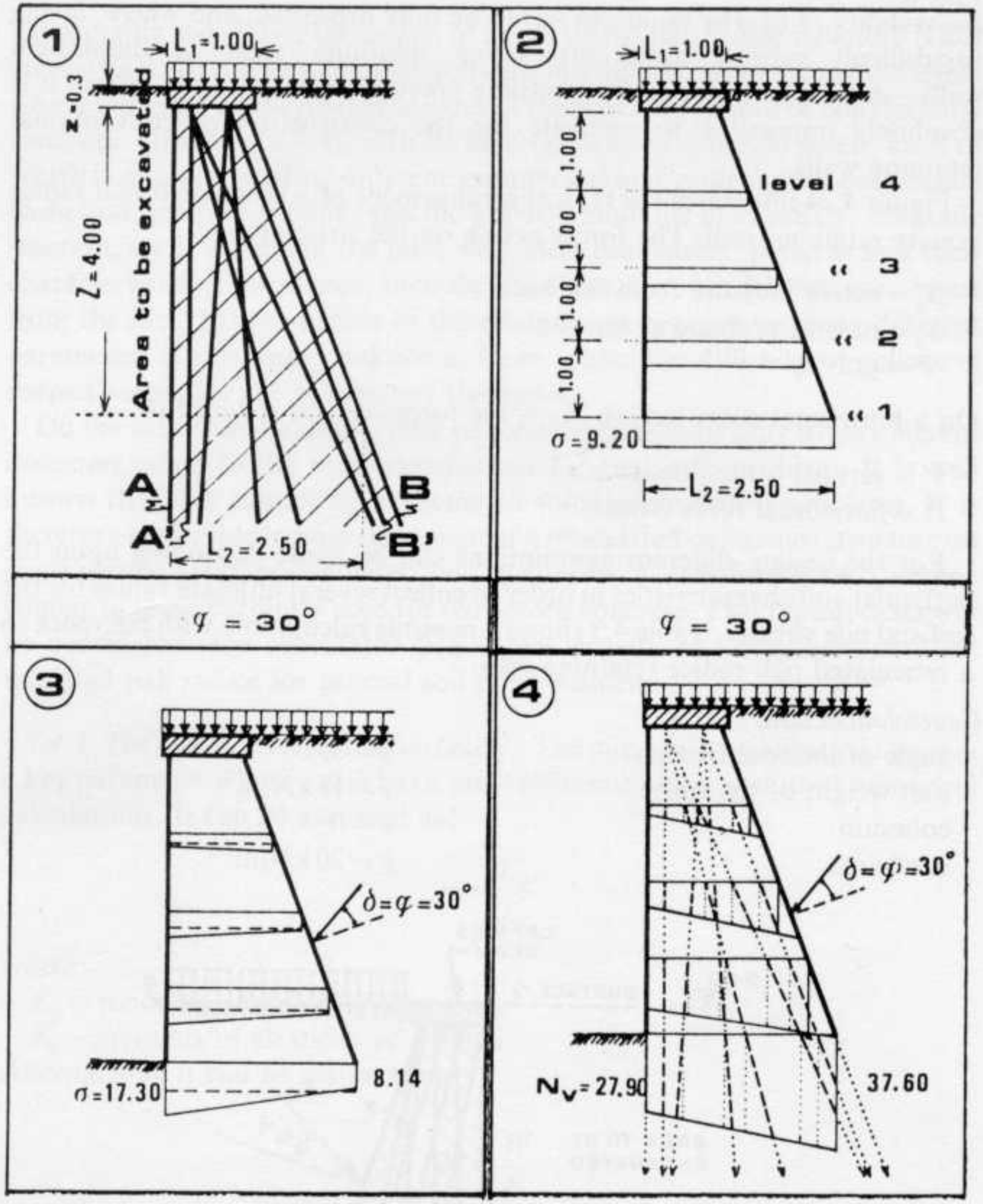
Historic masonry structure.

RRP Retaining Structure.

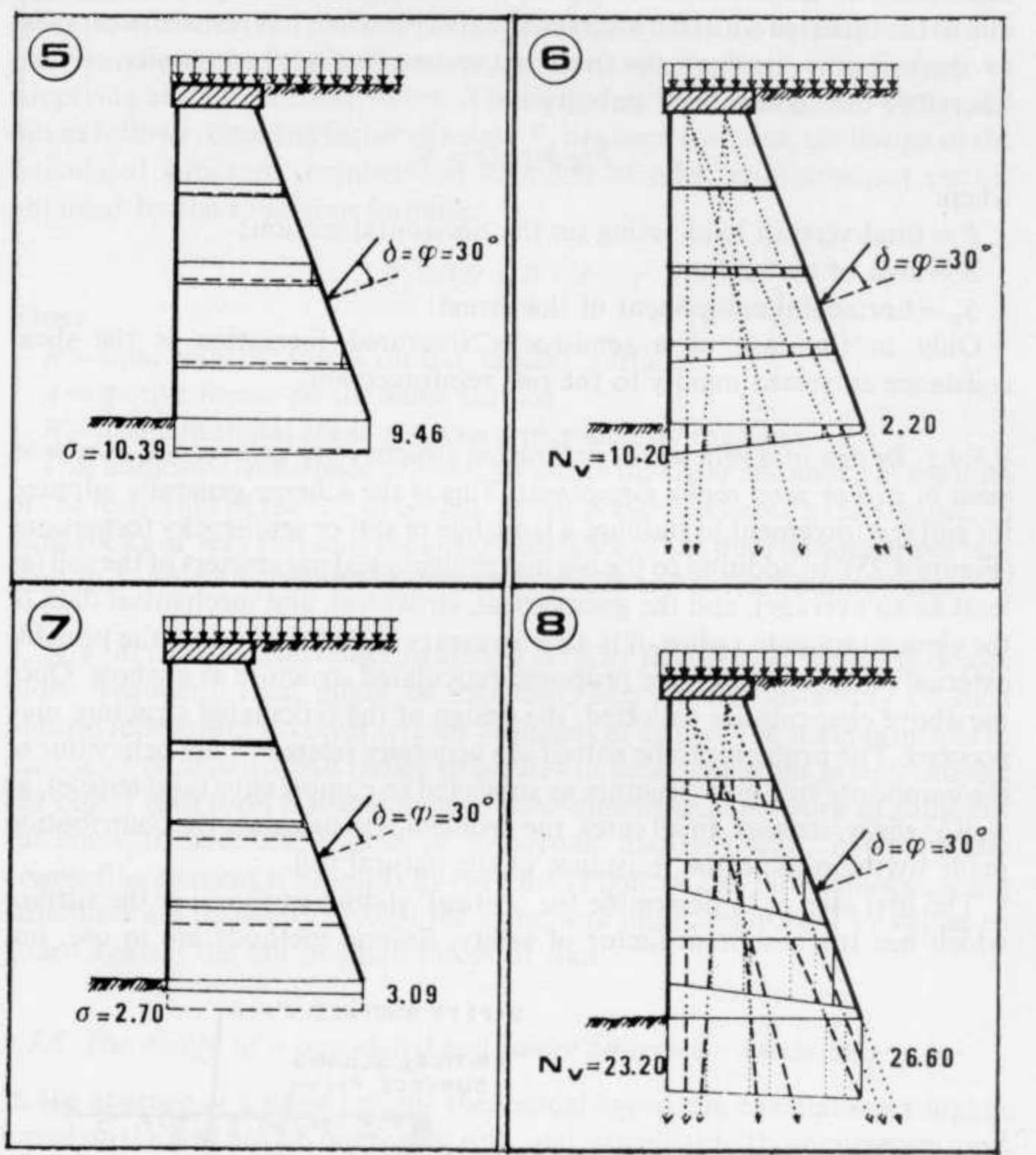




Lateral Load onto Retaining Wall



1. Scheme of the Reticulated Micropile layout before excavation.
2. Gravity stresses in the soil before excavation.
3. The Vertical load in addition with the forces introduced be the active soil pressure, after excavation, for the case where the complete system is supported by the encased soil.
4. The same case as #3, but where the loading is supported by the micropiles.



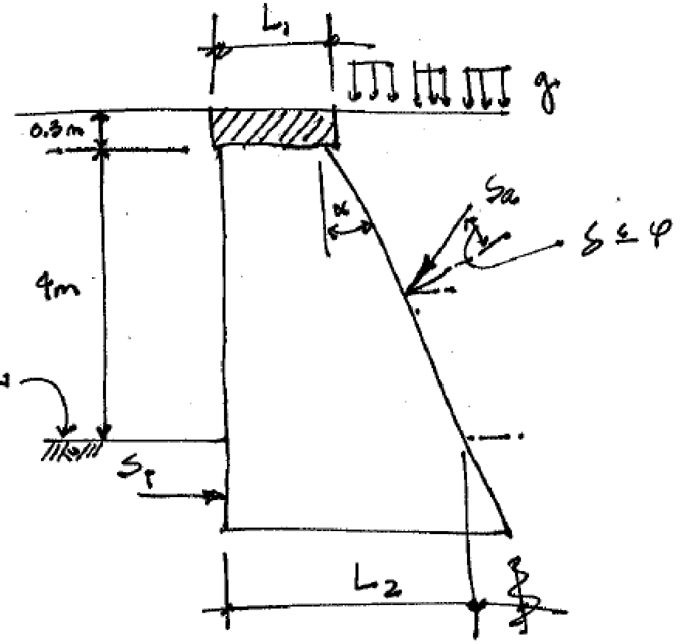
5 + 6. The forces introduced by the excavation are assumed to be supported by the soil (5) combined action of soil and piles (6) according to the pile-stiffness factor ‘m”. Transformed section analysis.

7 + 8. All forces, including the loading from “dead load”, after excavation, are supported by the soil (7) and combined soil-pile action (8).

REF: THORBURN / HUTCHISON
UNDERPINNING, (1985)
SURREY UNIVERSITY PRESS
PG. 122 – 126

THE DESIGN OF A RETICULATED PALI RADICE STRUCTURE.

1. STRUCTURE TYPE: RRP GRAVITY RETAINING WALL.



$L_1 = 1.00m$

$L_2 = 2.50m$

$\alpha = \tan^{-1}\left(\frac{1.5}{4}\right) = 20.6°$

2. DATA / DEFINITIONS

1. PILE-SOIL AMPLIFICATION FACTOR

$m = \frac{E_p}{E_s}$, E_p = MODULUS OF ELASTICITY OF PILE
E_s = MODULUS OF ELASTICITY OF SOIL

2. TERMS.

1. S_a = ACTIVE PRESSURE OF SOIL FROM BACK
2. S_p = PASSIVE PRESSURE OF SOIL AT FOOT
3. P = GRAVITY MASS
4. V = VERTICAL FORCE (LOAD)
5. H = HORIZONTAL FORCE (SHEAR).

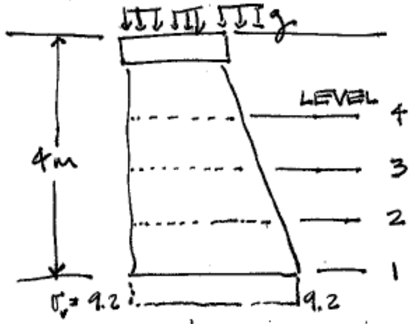
3. GEOTECHNICAL DATA.

1. ANGLE OF INTERNAL FRICTION: $\phi = 30°$
2. UNIT WT. OF SOIL: $\gamma = 18\ kN/m^3$
3. COHESION: $c = 0$
4. SURCHARGE: $q = 20\ kN/m^2$

4. PALI RADICE DATA.

1. DIAMETER: $b = 150\ mm$
2. STEEL REINF. (ONE BAR) DIAMETER: $d = 18\ mm$
3. NUMBER OF PILES / L.M. OF WALL: $n = 10$
4. PILE-SOIL AMPLIFICATION FACTOR: $m = 40$
5. VERTICAL STRESS ON SOIL: σ (N/cm^2)
6. LOAD ON PILES (VERTICAL COMPONENT): N_v (kN)

3. FIGURE (2): GRAVIMETRIC STRESSES BEFORE EXCAVATION.



1. $\sigma_v = \gamma_T h + q$

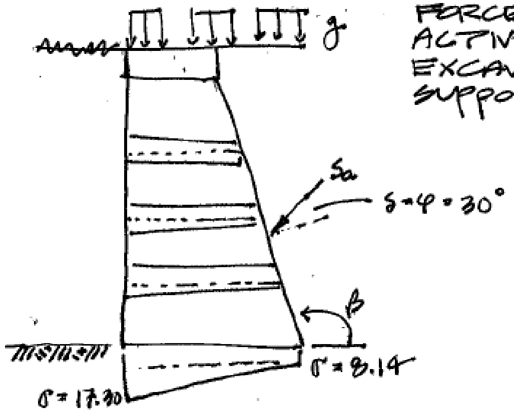
$= \left(18 \frac{kN}{m^3}\right)(4\ m) + \left(20 \frac{kN}{m^2}\right)$

$= 72\ kN/m^2 + 20\ kN/m^2$

$= \left(92 \frac{kN}{m^2}\right)\left(\frac{1000\ N}{kN}\right)\left(\frac{m}{100\ cm}\right)^2$

$\sigma_v = 9.2 \frac{N}{cm^2}$

4. FIGURE (3)



- VERTICAL LOAD AS WELL AS FORCES INTRODUCED BY ACTIVE PRESSURE, AFTER EXCAVATION. LOADS SUPPORTED BY SOIL ONLY.

, $S_a = P_a$, $q = q_s$

REF. LAMBE & WHITMAN SOIL MECHANICS EQN. 13.7 p. 173, 13.12 p. 178

1. $P_a = \frac{1}{2}\gamma H^2 K_a + q_s H K_a$, EQN. 13.7 p. 173

   1. $K_a = \left[\frac{\csc\beta \sin(\beta-\phi)}{\sqrt{\sin(\beta+\phi_w)} + \sqrt{\frac{\sin(\phi+\phi_w)\sin(\phi-i)}{\sin(\beta-i)}}}\right]^2$

      1. $\csc\beta = \frac{1}{\sin\beta}$, $\beta = 90° + 20.6° = 110.6°$

         $= 1.0683$

      2. $\sin(\beta-\phi) = \sin(110.6° - 30°) = 0.9866$

      3. $\sin(\beta+\phi_w) = \sin(110.6 + 30) = 0.6347$

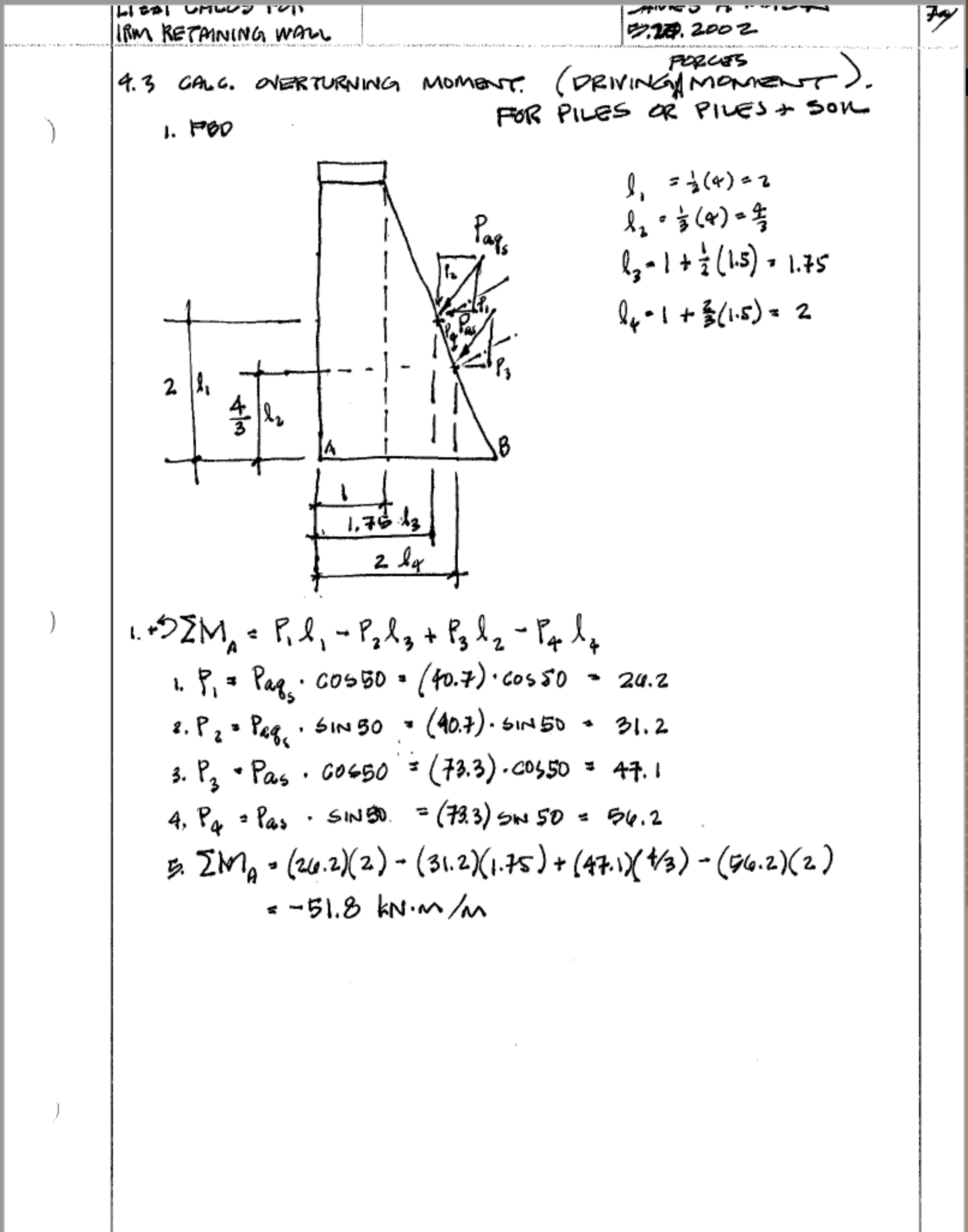
         $\Rightarrow \sqrt{\sin(\ )} = 0.7967$

      4. $\sin(\phi+\phi_w) = \sin(30 + 30) = 0.8660$

      5. $\sin(\phi - i) = \sin(30 - 0) = 0.5$

      6. $\sin(\beta - i) = \sin(110.6 - 0) = 0.9361$

The Unit Cell.



IRM RETAINING WALL

5.28.2002

4.3 CALC. OVERTURNING MOMENT (DRIVING FORCES MOMENT). FOR PILES OR PILES + SOIL

1. FBD

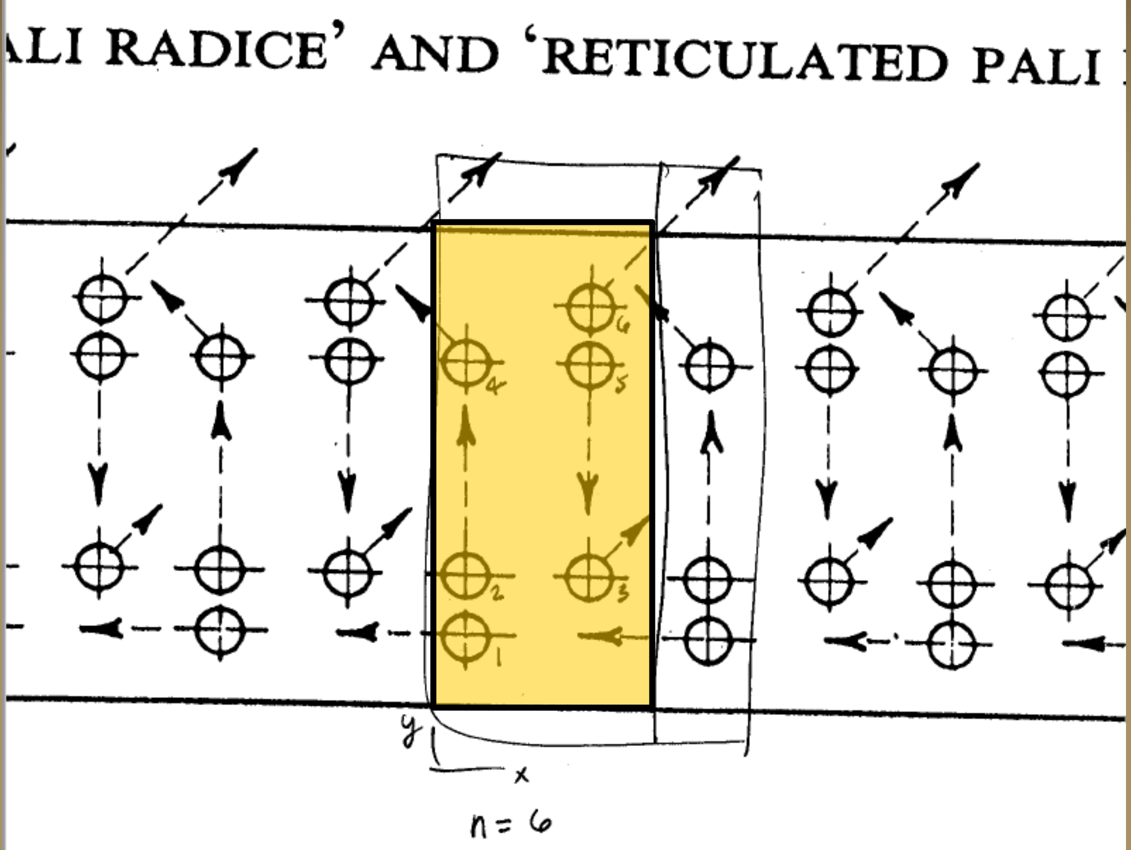
$l_1 = \frac{1}{2}(4) = 2$

$l_2 = \frac{1}{3}(4) = \frac{4}{3}$

$l_3 = 1 + \frac{1}{2}(1.5) = 1.75$

$l_4 = 1 + \frac{2}{3}(1.5) = 2$

1. $\circlearrowleft \Sigma M_A = P_1 l_1 - P_2 l_3 + P_3 l_2 - P_4 l_4$
   1. $P_1 = P_{aq_s} \cdot \cos 50 = (40.7) \cdot \cos 50 = 26.2$
   2. $P_2 = P_{aq_s} \cdot \sin 50 = (40.7) \cdot \sin 50 = 31.2$
   3. $P_3 = P_{as} \cdot \cos 50 = (73.3) \cdot \cos 50 = 47.1$
   4. $P_4 = P_{as} \cdot \sin 50 = (73.3) \sin 50 = 56.2$
   5. $\Sigma M_A = (26.2)(2) - (31.2)(1.75) + (47.1)(4/3) - (56.2)(2) = -51.8$ kN·m/m



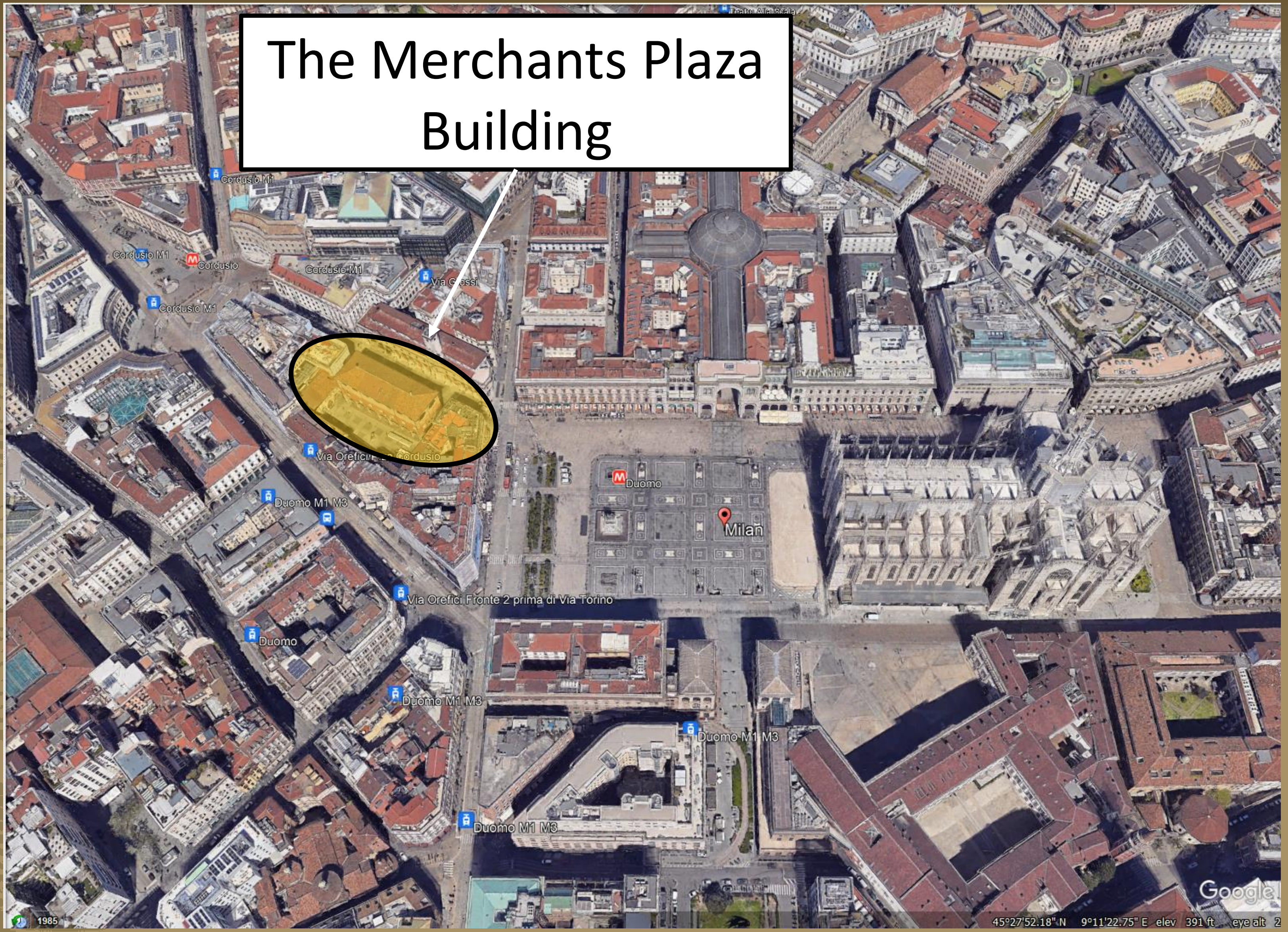
1. $\Sigma F_x = (-P_1) + (P_3)(\cos 45) + (-P_4)(\cos 45) + (P_6)(\cos 45)$

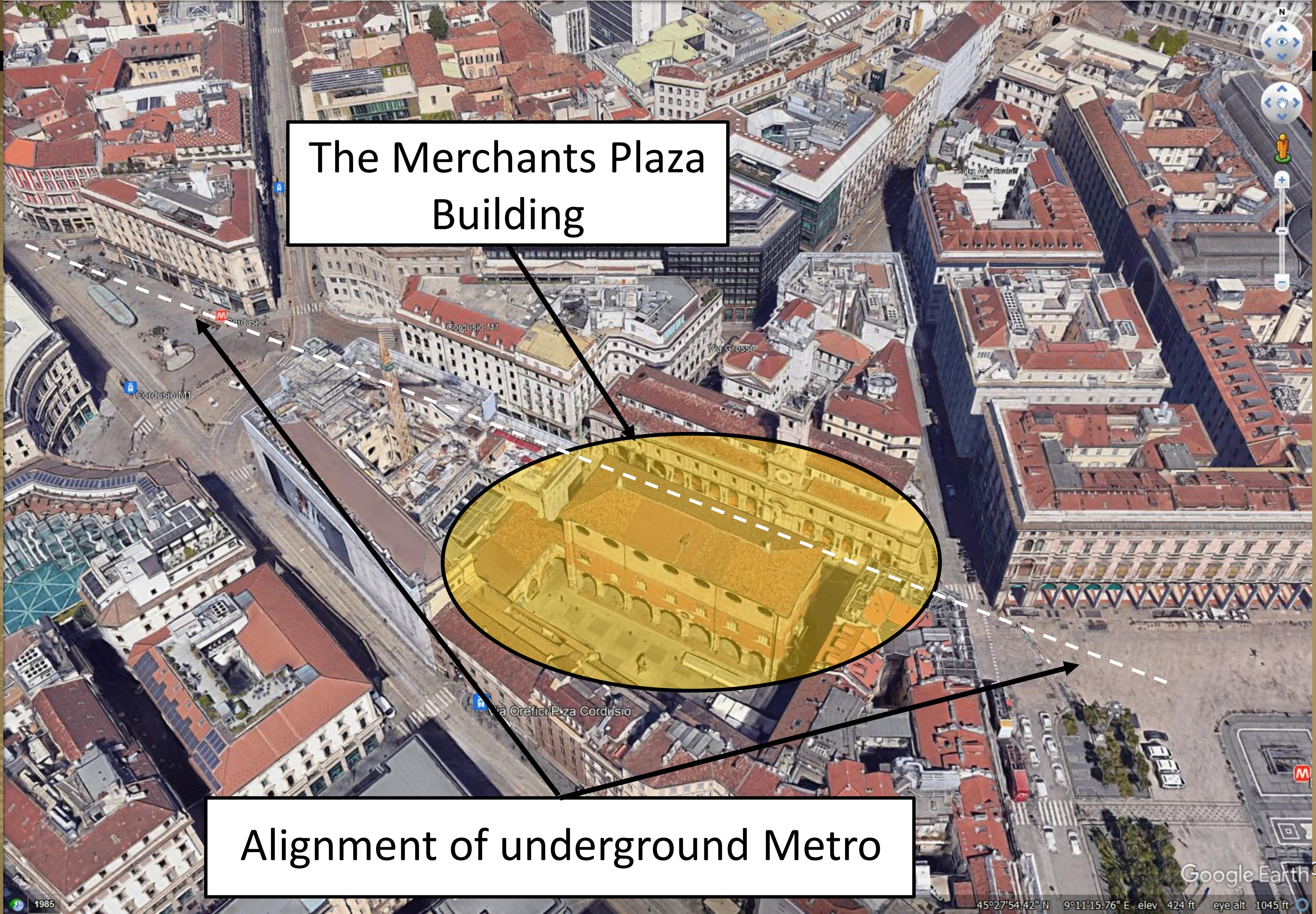
   $= -P_1 \cos 45$

2. $\Sigma F_y = (+P_2) + (P_3)(\sin 45) + (P_4)(\sin 45) + (-P_5) + (P_6)(\sin 45)$

   $= +3P \sin 45$

Lizzi used similar hand calculations for a historic building within a meter of the Milan Underground. The tunnel was constructed via a cut-construct-cover process with the reticulated micropile retaining wall being constructed in-situ before and excavation. Lizzi noted that the lateral movement at the backwall was just several millimeters.





The Merchants Plaza Building
Alignment of underground Metro
Cordusio M1
Cordusio M1
Via Grossi
Via Orefici/P.za Cordusio
Google Earth
1985
45°27'54.42" N 9°11'15.76" E elev 424 ft eye alt 1045 ft

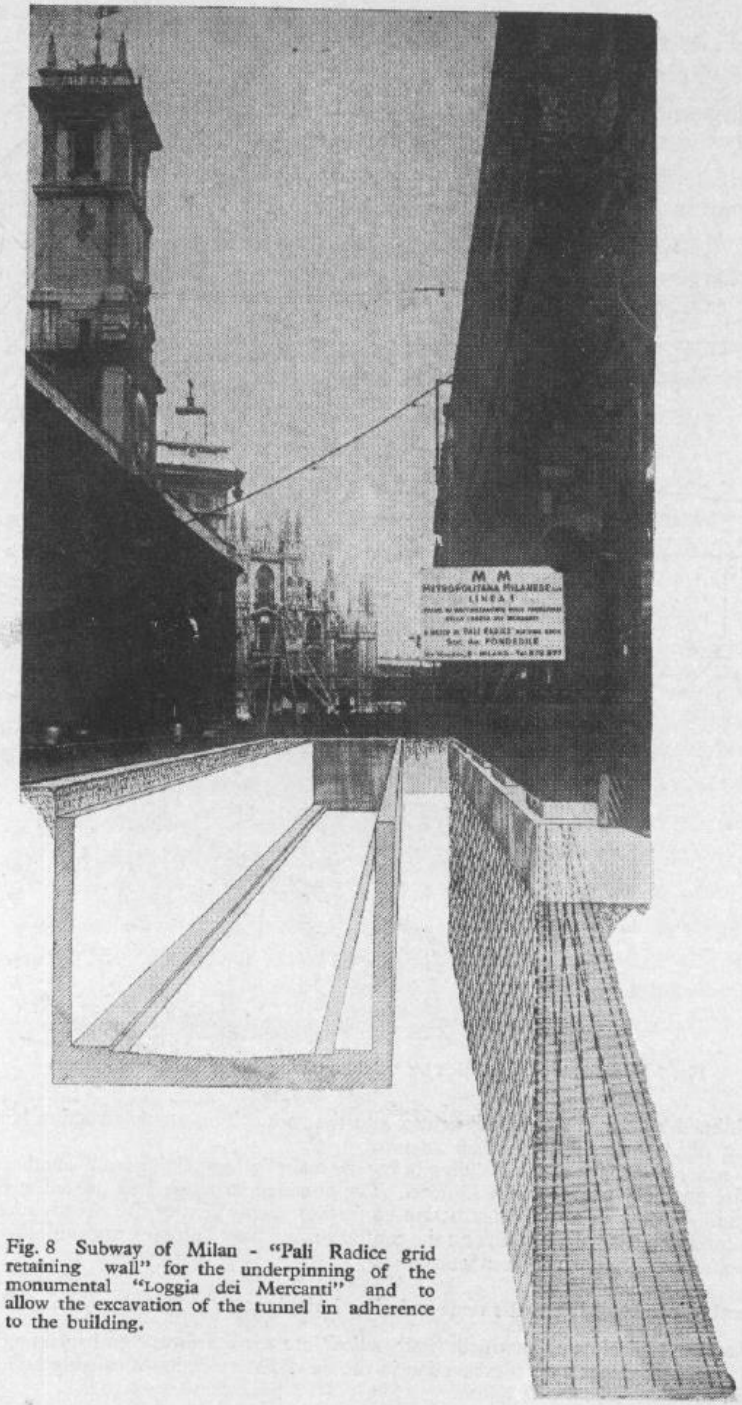


Fig. 8 Subway of Milan - "Pali Radice grid retaining wall" for the underpinning of the monumental "Loggia dei Mercanti" and to allow the excavation of the tunnel in adherence to the building.

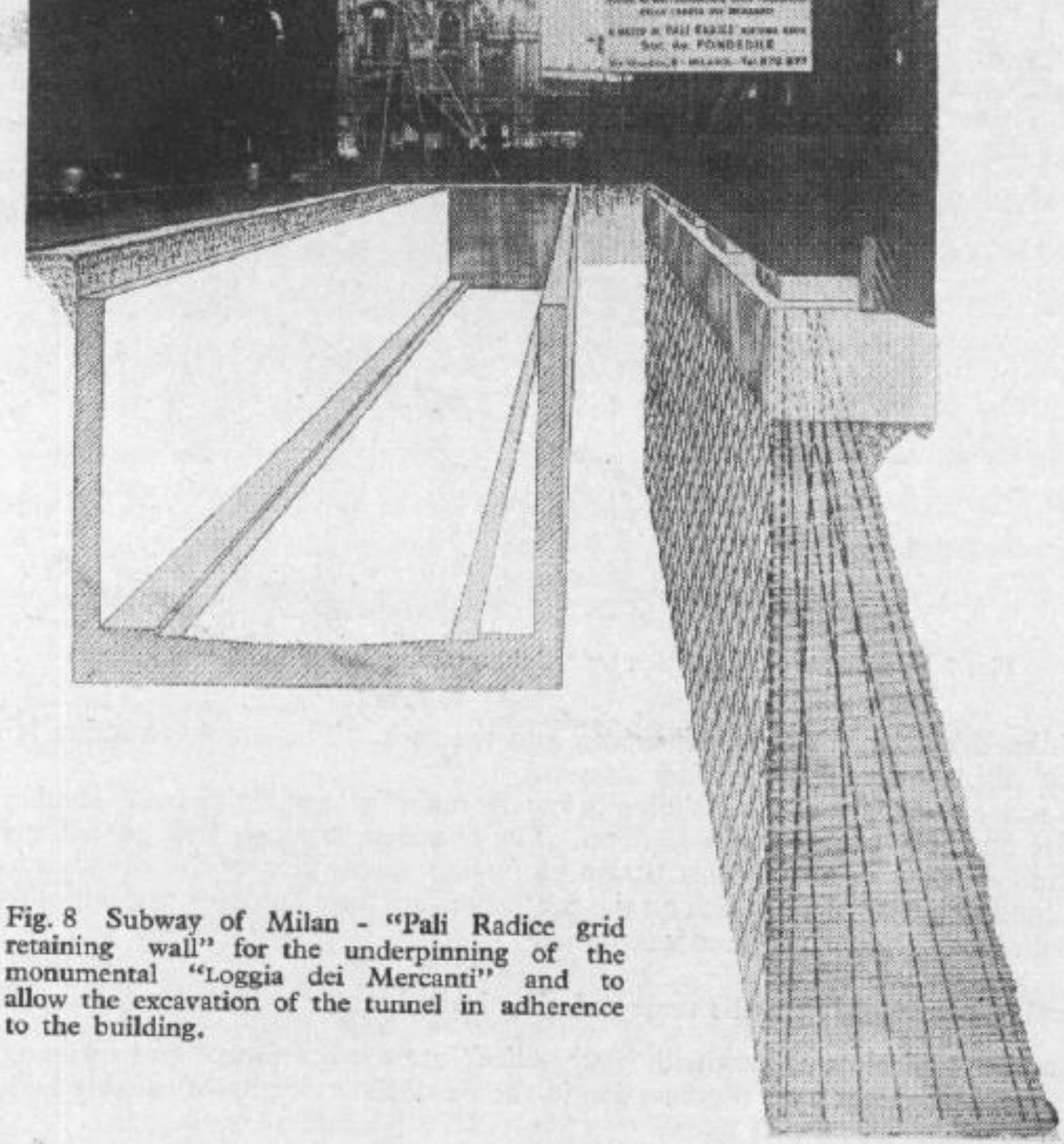
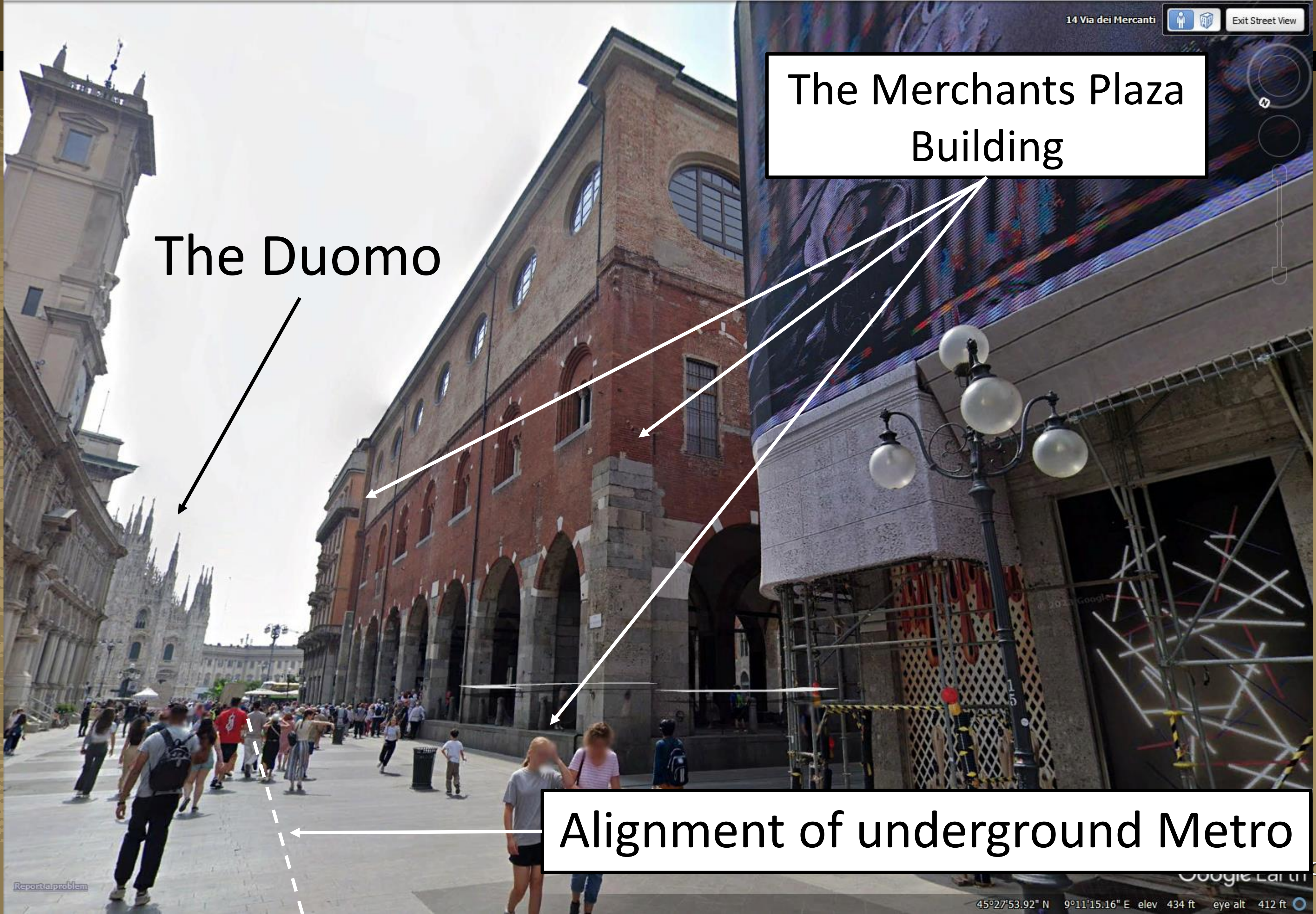


Fig. 8 Subway of Milan - "Pali Radice grid retaining wall" for the underpinning of the monumental "Loggia dei Mercanti" and to allow the excavation of the tunnel in adherence to the building.


14 Via dei Mercanti
Exit Street View
The Merchants Plaza Building
The Duomo
Alignment of underground Metro
Report a problem
45°27'53.92" N 9°11'15.16" E elev 434 ft eye alt 412 ft

The loading of the RRP retaining wall converts lateral earth pressure on the micropile backwall into bending stress, which is subsequently converted into axial stresses within the micropile group, i.e., a moment couple. The backwall being in tension and the front wall (the excavation side) is loaded in compression. The 3-D soil arching provides the restraining surface onto which the earth pushes against. The flexural displacement, inward towards the interior constrained soil mass, provides a clamping pressure on the core. So, the front and back RRP walls provide the constraint for the lateral earth pressure. The induced bending stress, which could easily use 50 to 60% of the available strength of the micropile steel, is converted into axial stress in the low range of 10 to 20% of the axial strength of the micropile, shown with FEA. Also, the front wall with composite micropiles has both the grout and steel in compression. Lizzi considered the crushing strength of the grout as the limiting capacity of the micropile in compression. It must be remembered that Lizzi designed and successfully constructed micropiles by drilling a 4" diameter hole, inserting a 1" diameter steel rebar, and finishing by grouting the void with a neat cement grout.

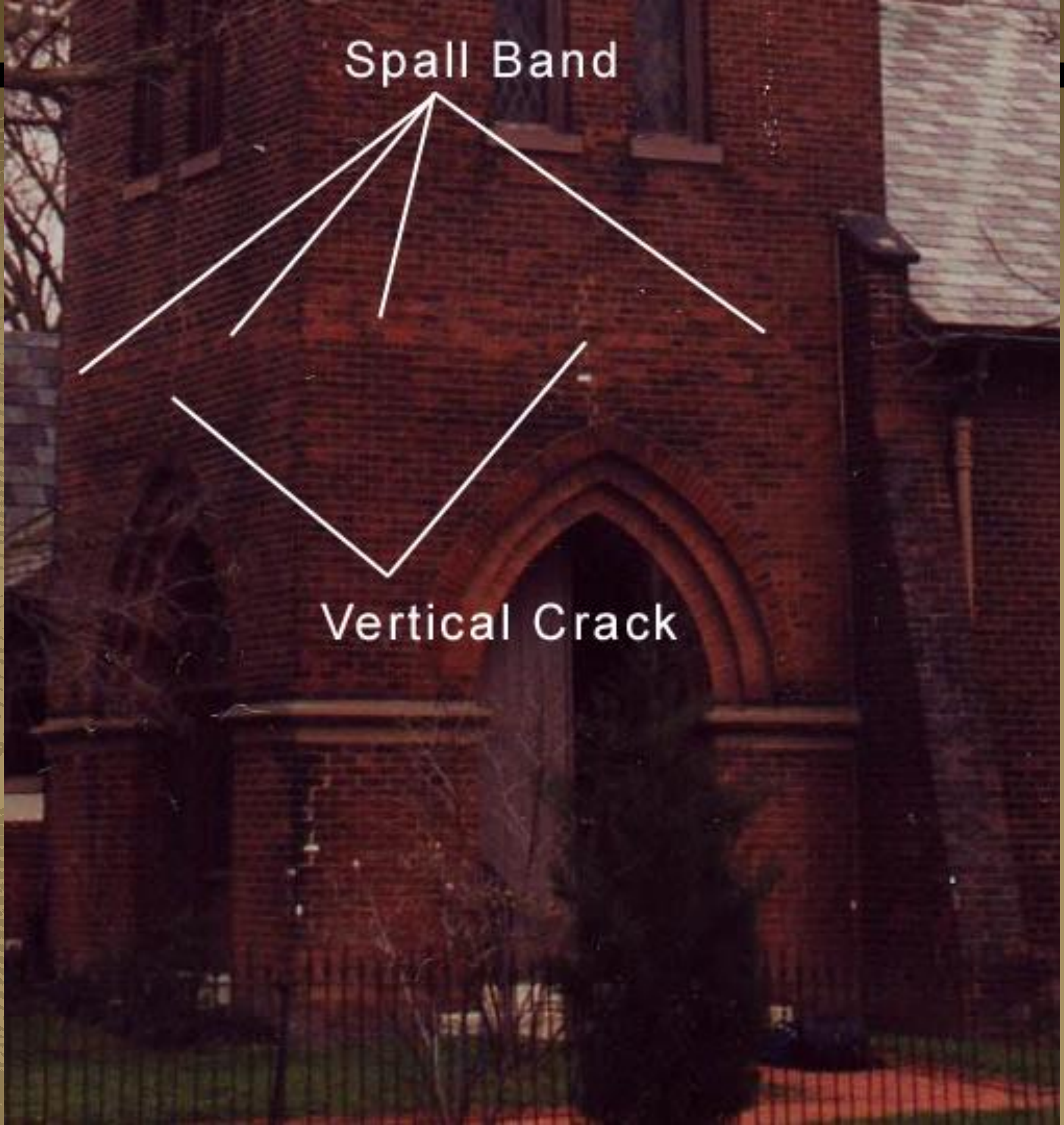
Retrofitting and Strengthening Of a Civil War Era Historic Church Tower In Paducah, Kentucky.

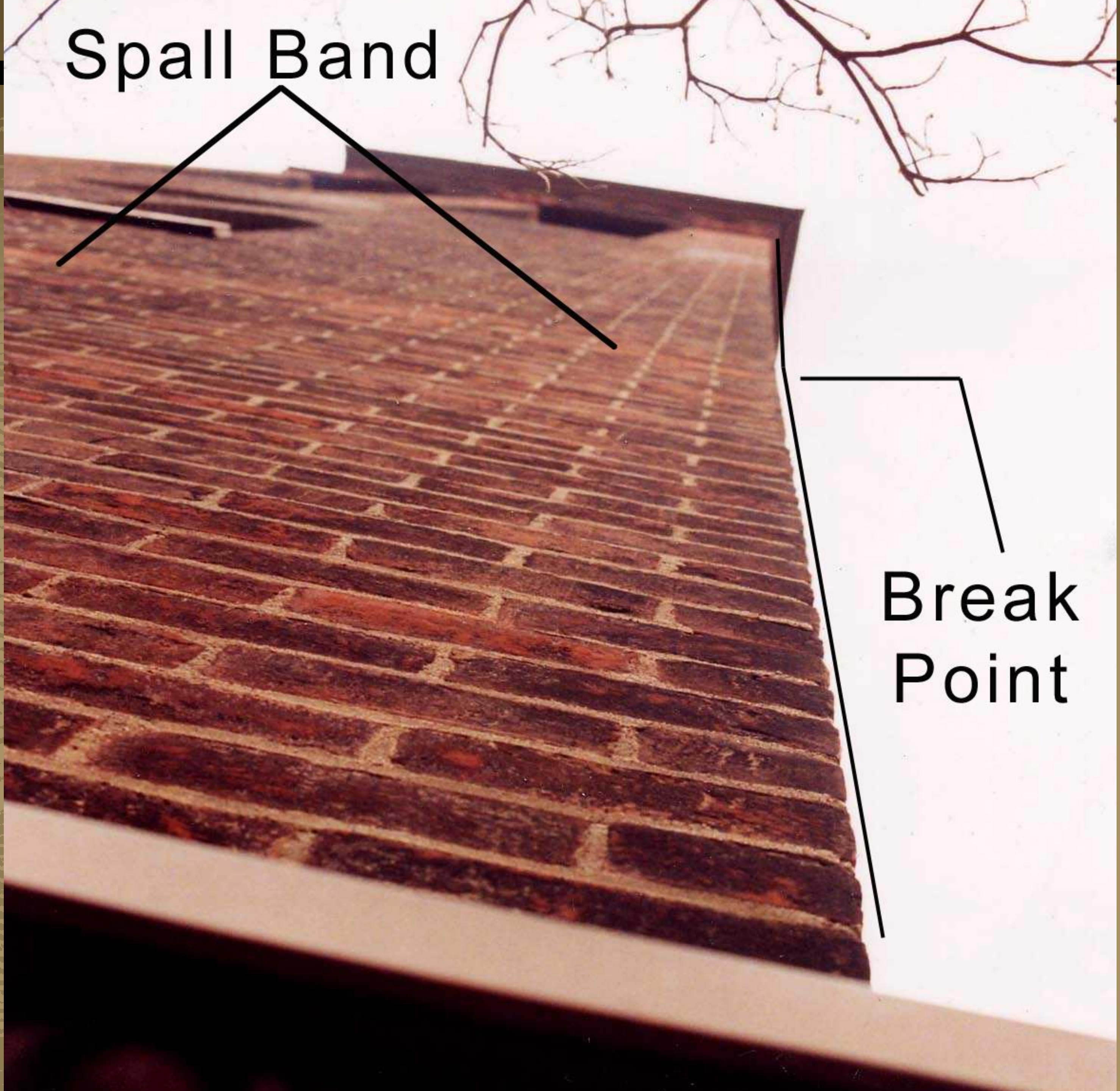
The Grace Episcopal Church Tower. Paducah, KY
DESIGN ARCHITECT, GENERAL CONSTRUCTION MATERIALS and METHODS

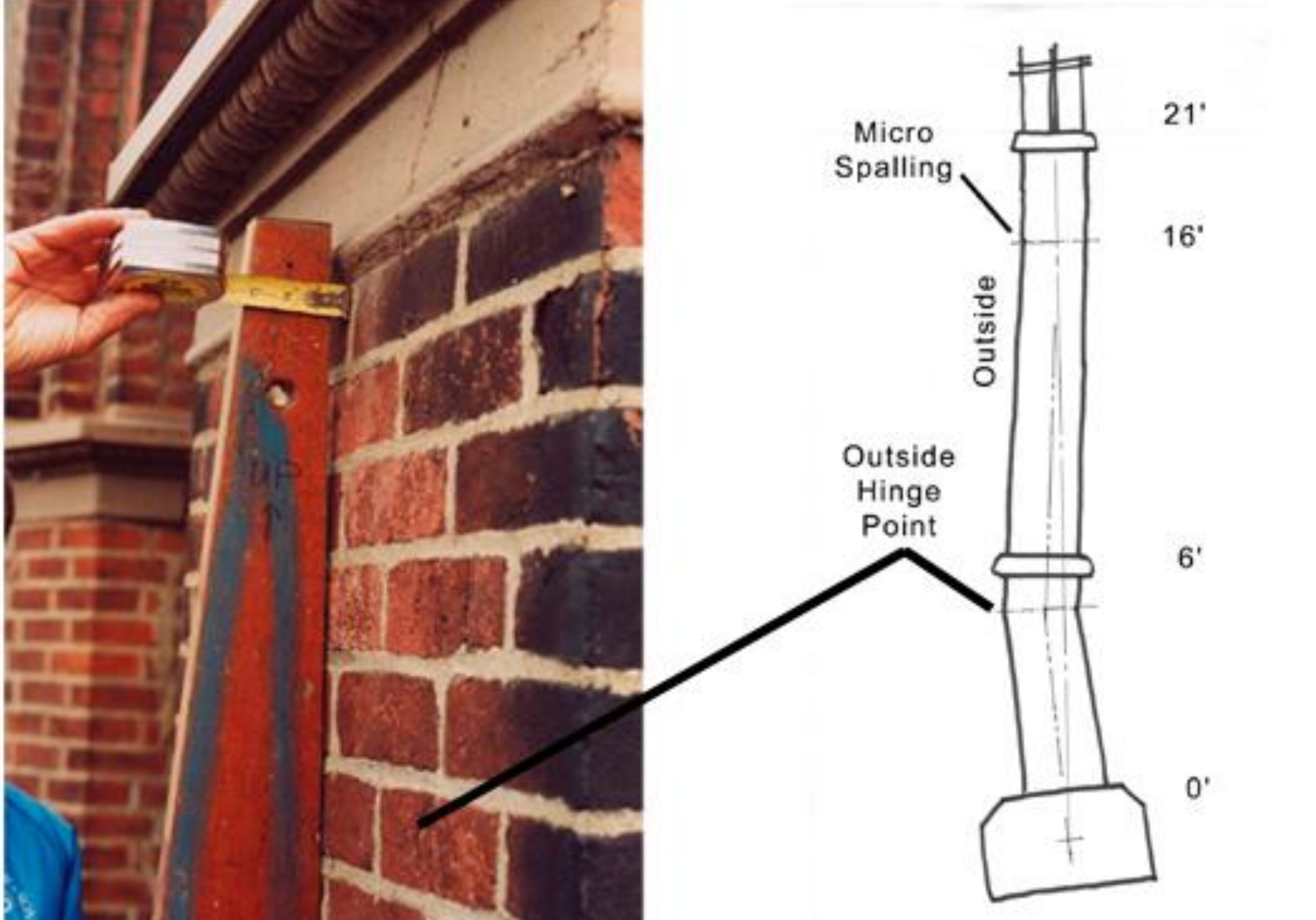
- Henry M. Condon 1834 – 1922.
- Graduate of Columbia.
- Member of the Ecclesiastical Architectural Movement.

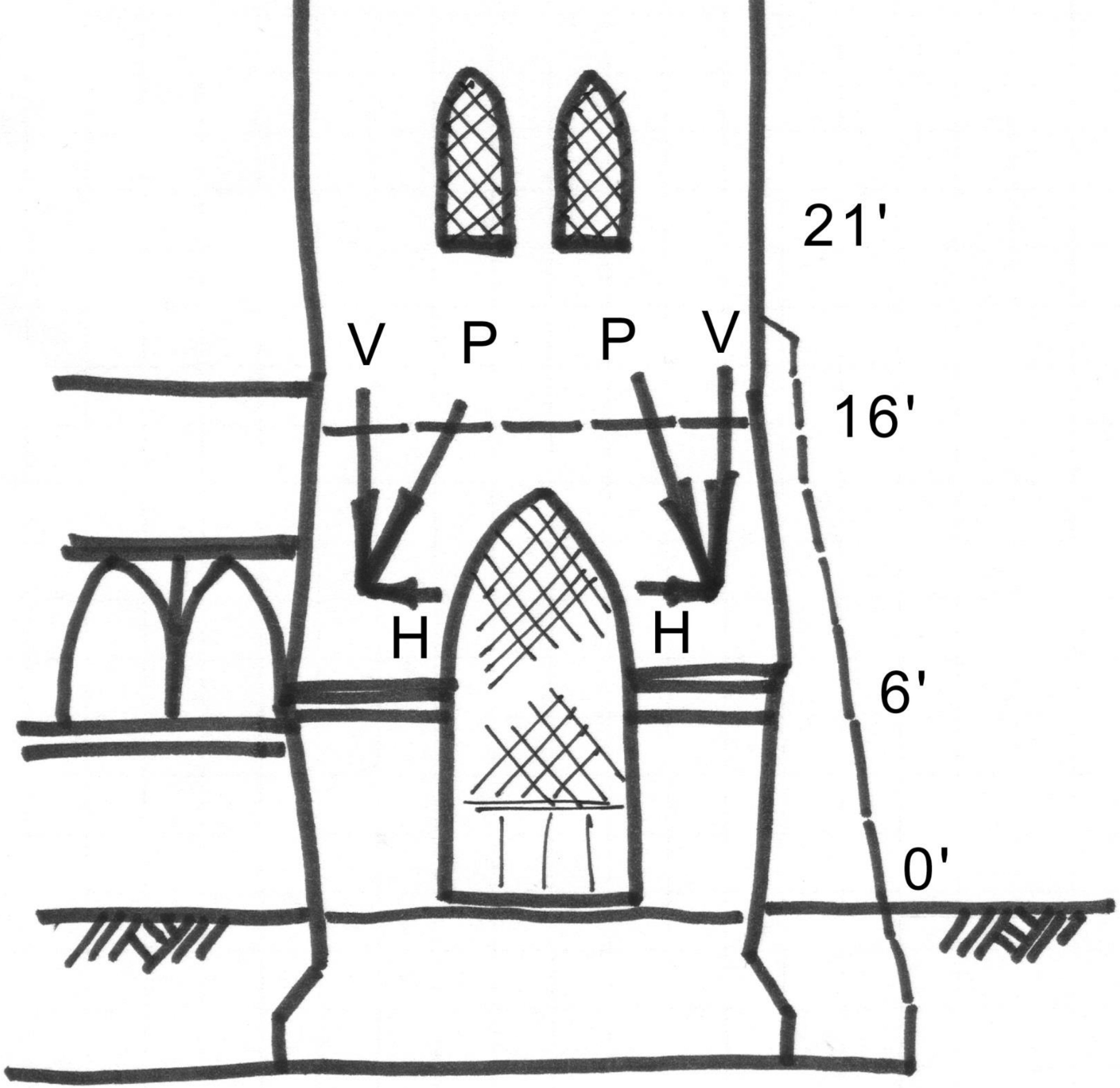
27 ft.

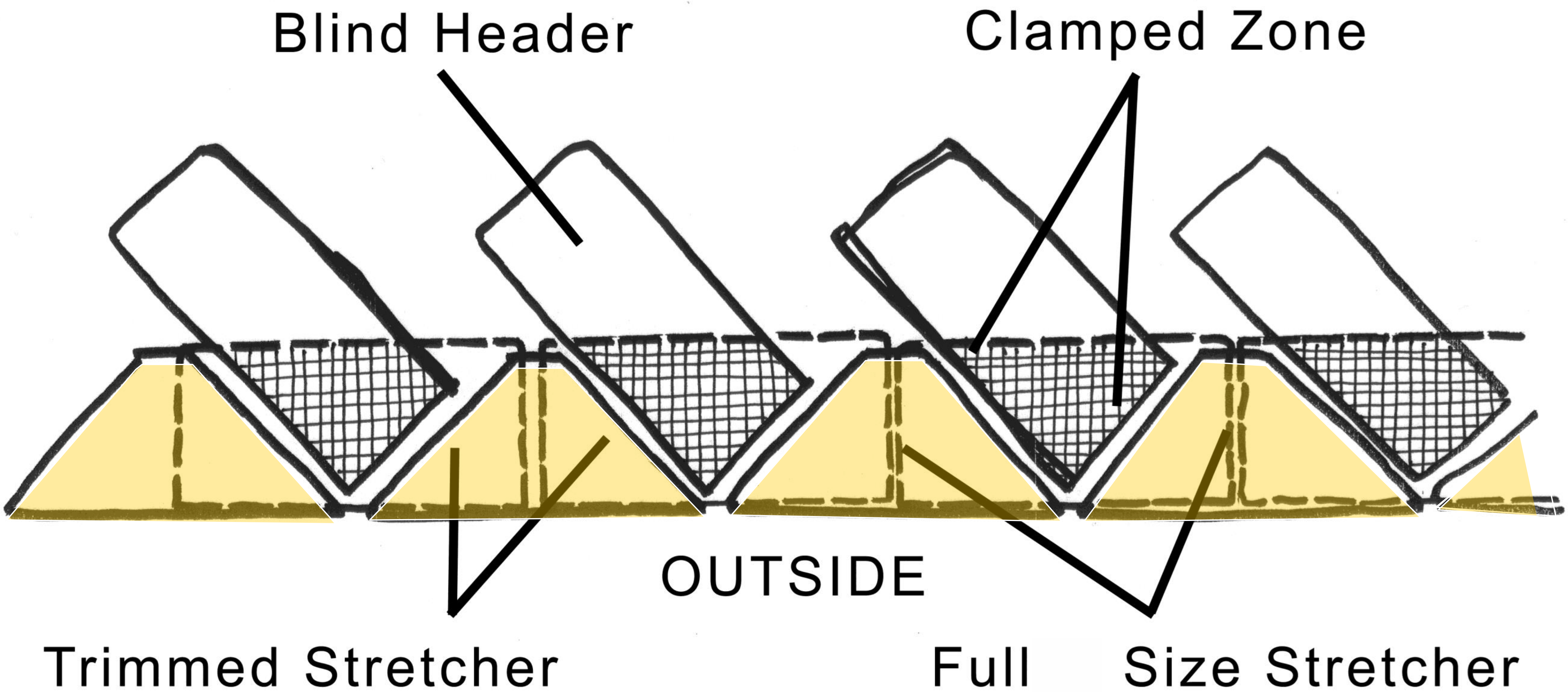
80 ft.

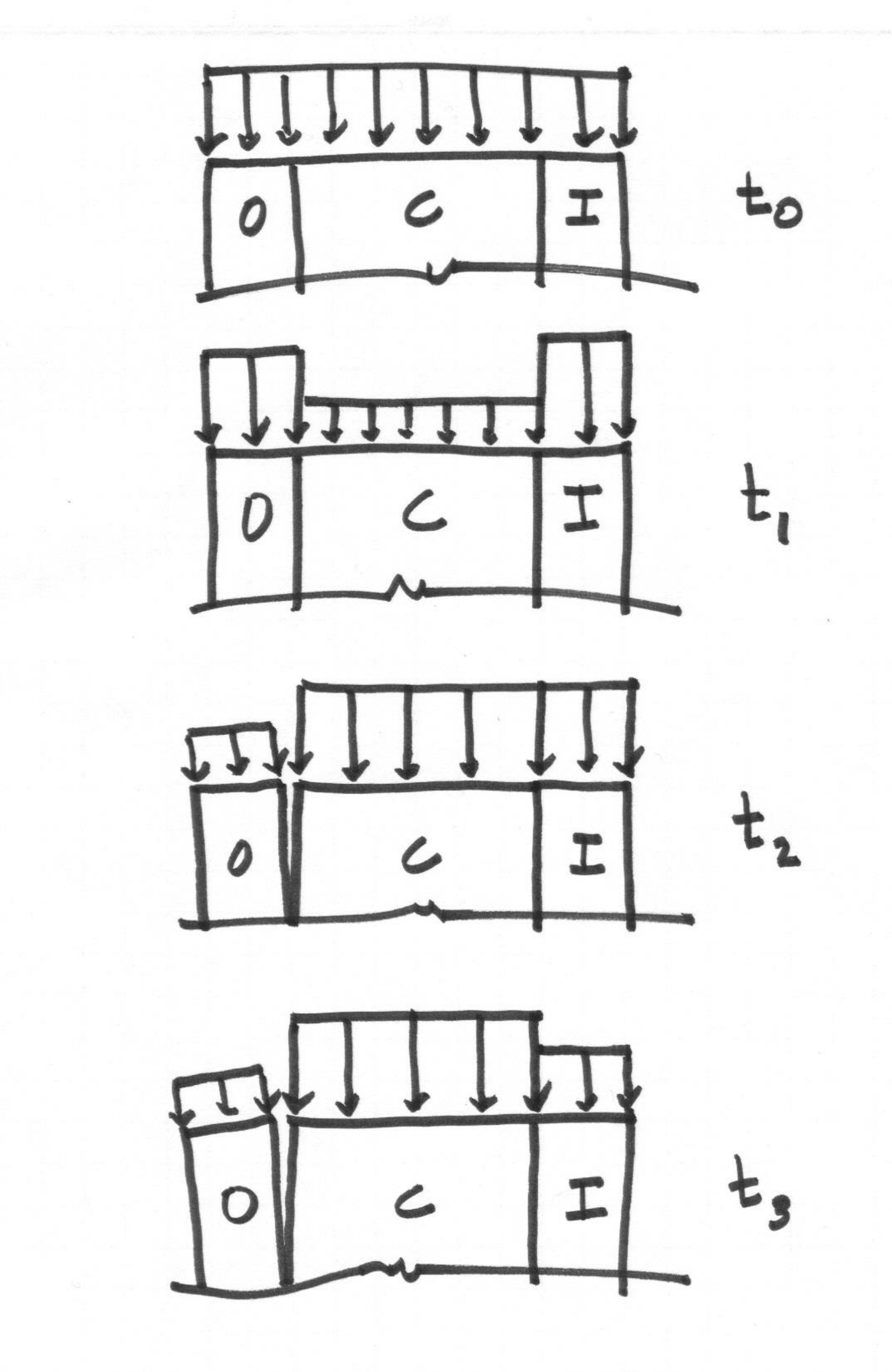

Spall Band
Vertical Crack


Spall Band
Break
Point


Micro Spalling
21'
16'
Outside
Outside Hinge Point
6'
0'


21'
V
P
P
V
16'
H
H
6'
0'


Blind Header
Clamped Zone
OUTSIDE
Trimmed Stretcher
Full
Size Stretcher

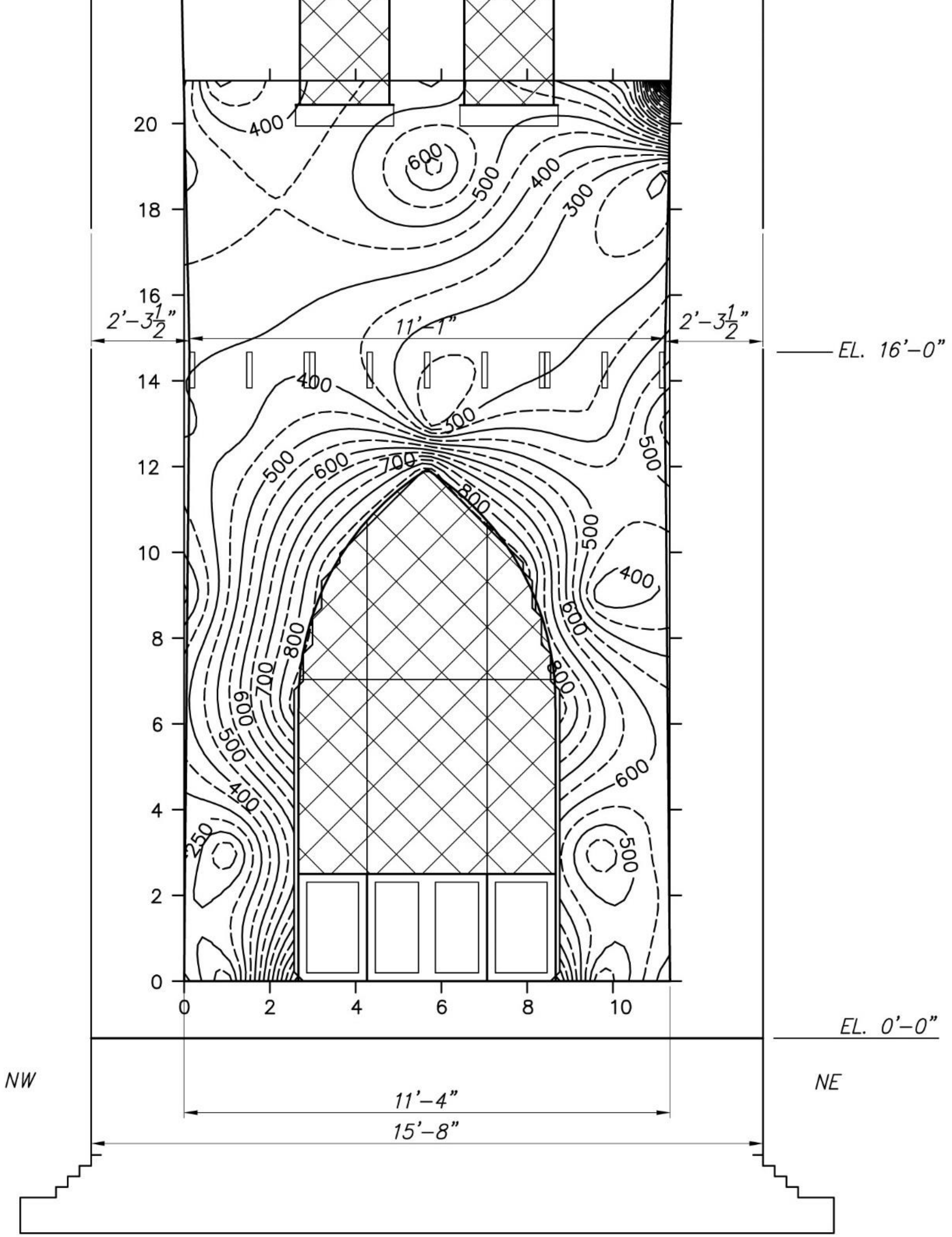


Initial Construction

Deteriorated Core

Outer Wythe Buckling

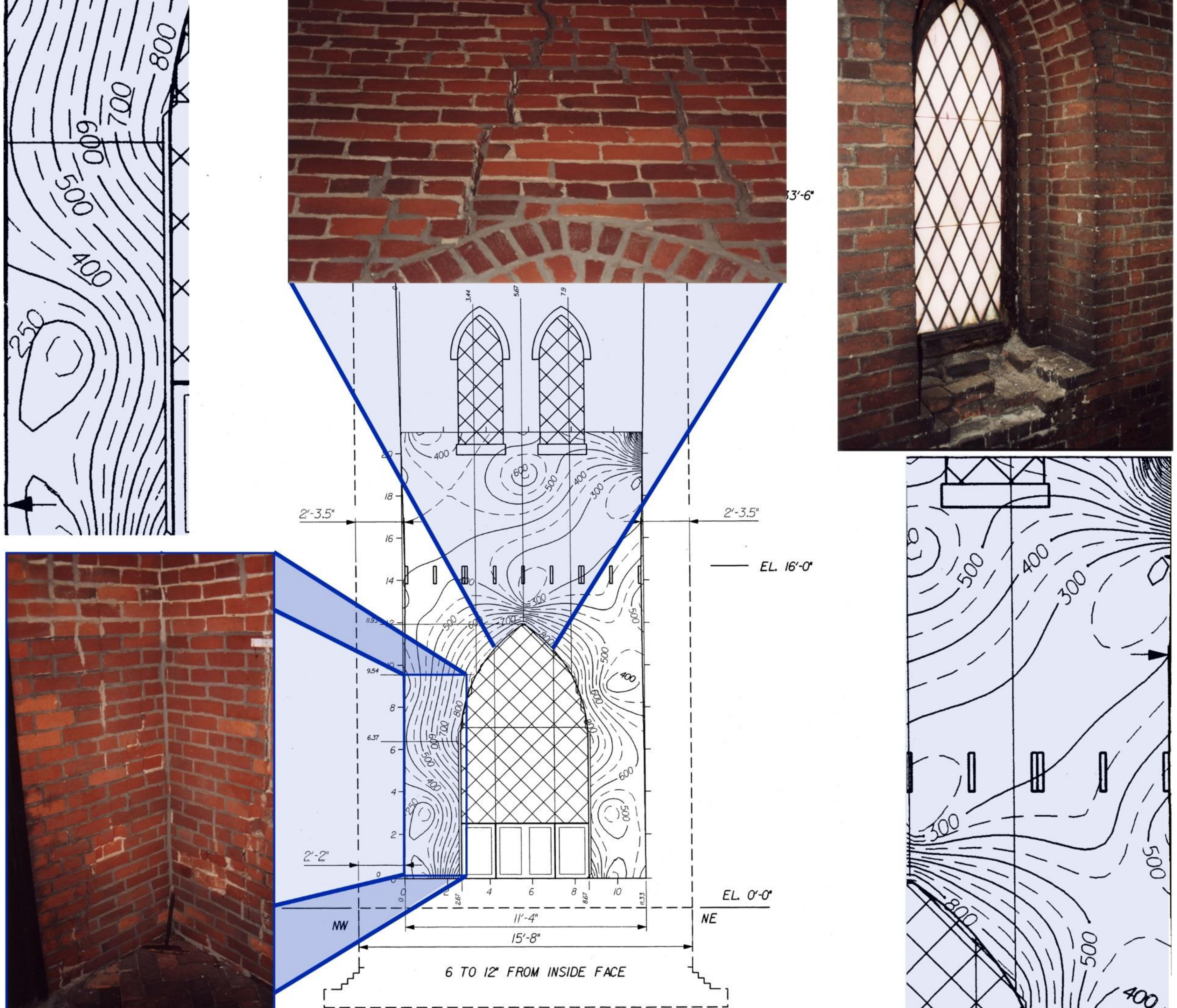
Load Redistribution
to Core



Iso-Modulus Plot (ksi)

Krieging Analysis

$f'_c = 550\ E_m$ (psi)


2'-3.5"
2'-3.5"
EL. 16'-0"
2'-2"
EL. 0'-0"
NW
NE
11'-4"
15'-8"
6 TO 12" FROM INSIDE FACE
33'-6"

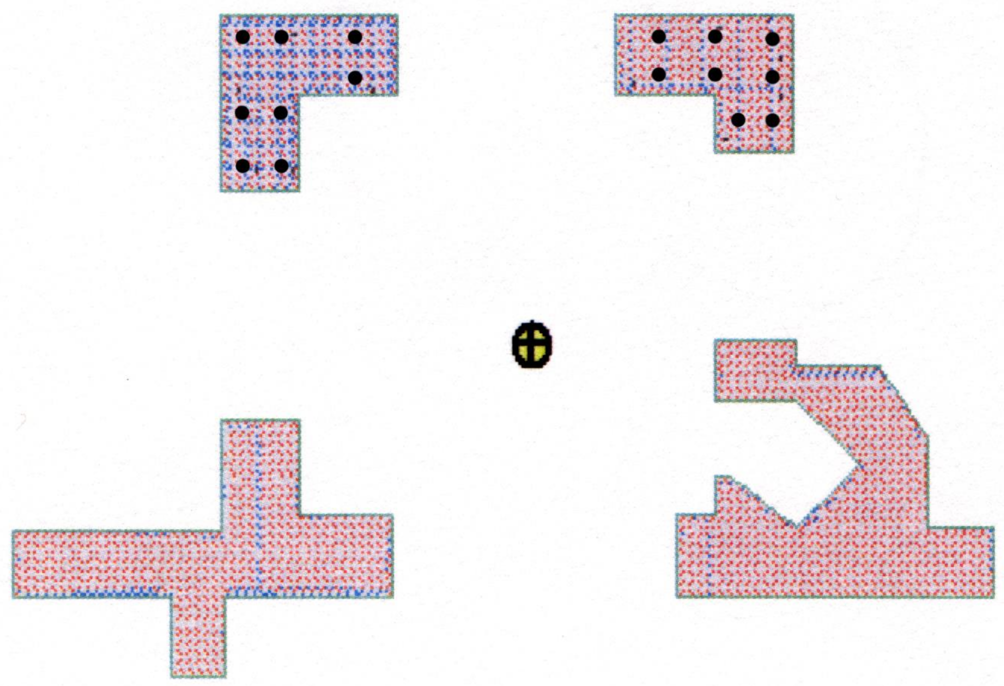
Section Details:

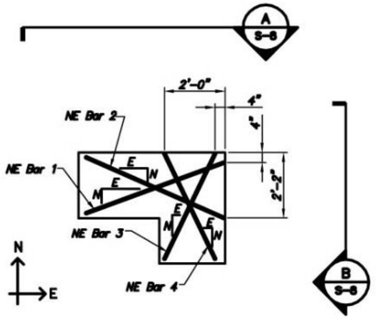
X Centroid:	8.411 in
Y Centroid:	-12.29 in
Section Area:	13.28E+3 in^2
I gross about X:	7.07E+7 in^4
I gross about Y:	1.20E+8 in^4
Reinforcing Bar Area:	2.454 in^2
Percent Longitudinal Steel:	18.48E-3 %
Overall Width:	323.0 in
Overall Height:	214.0 in
Number of Fibers:	2824
Number of Bars:	16
Number of Materials:	2

Material Types and Names:

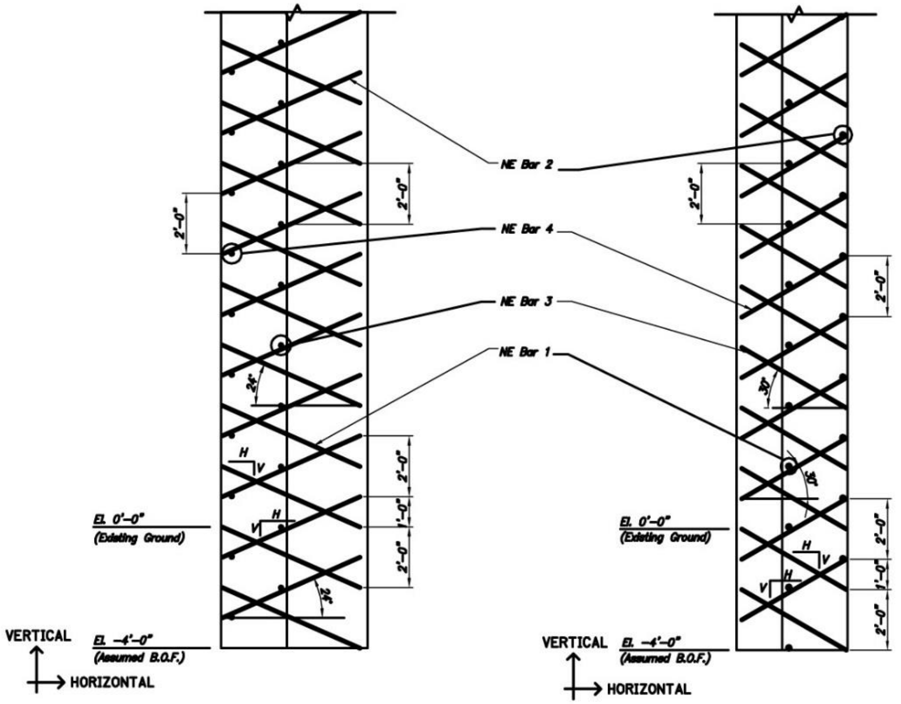
User Defined:	URM fm = 600 psi
Strain Hardening Steel:	Steel 40

FIBER ANALYSIS



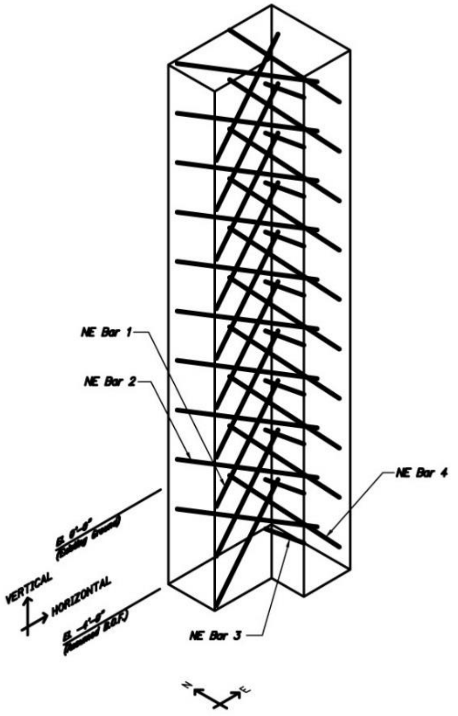


1 PLAN
1/8" = 1-0"

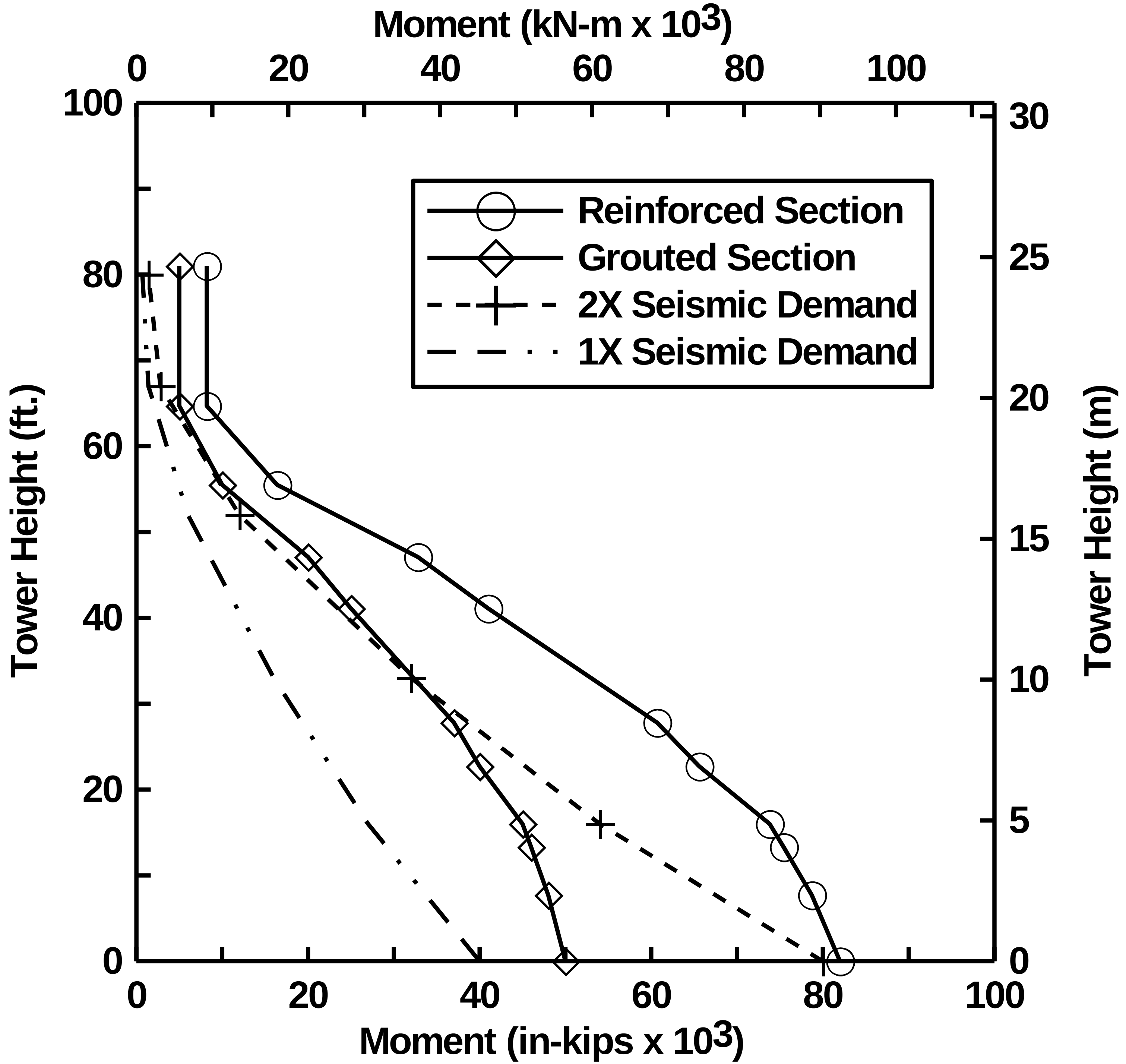


A NORTH ELEVATION
1/8" = 1 0"

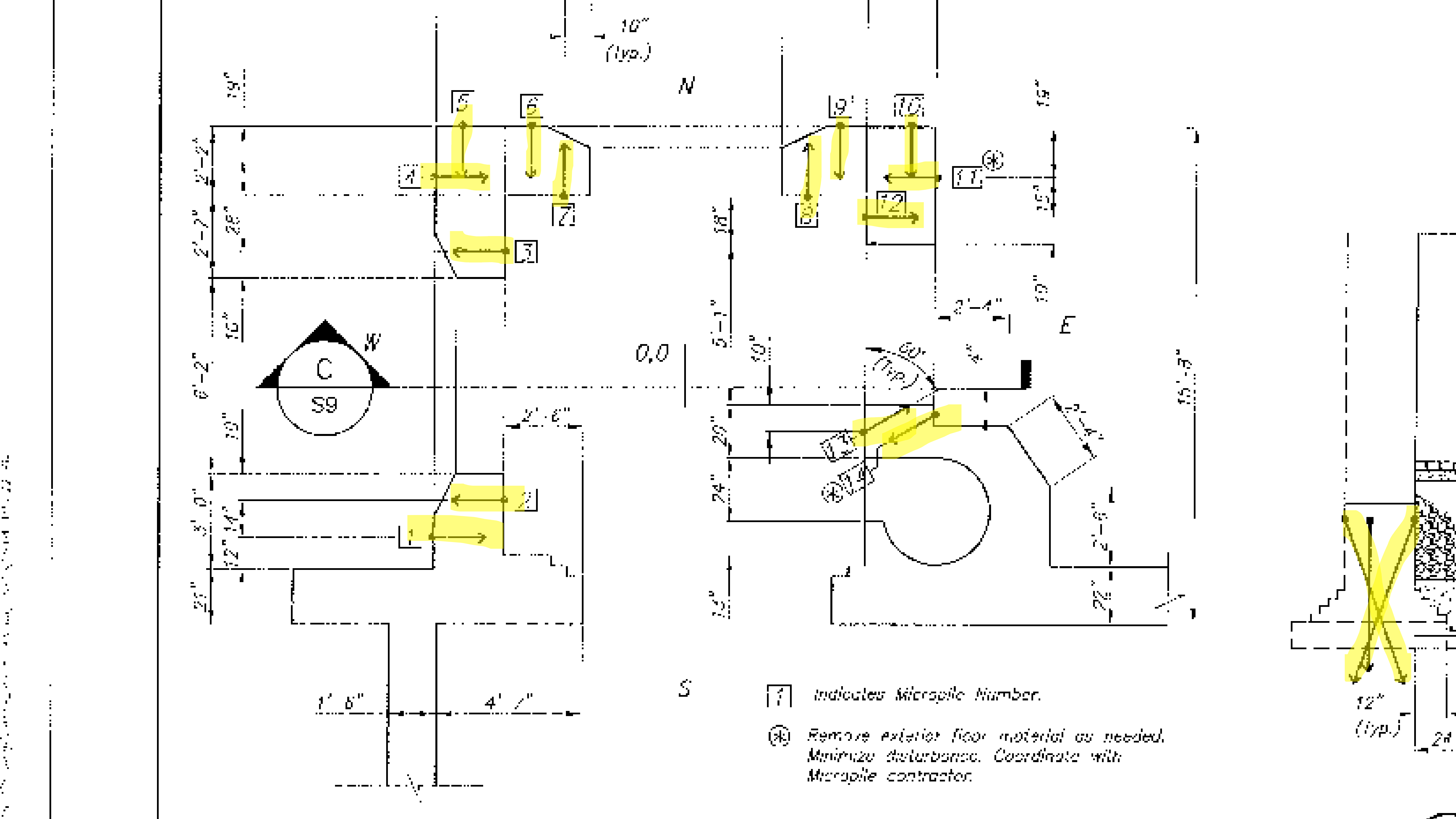
B EAST ELEVATION
1/8" = 1 0"



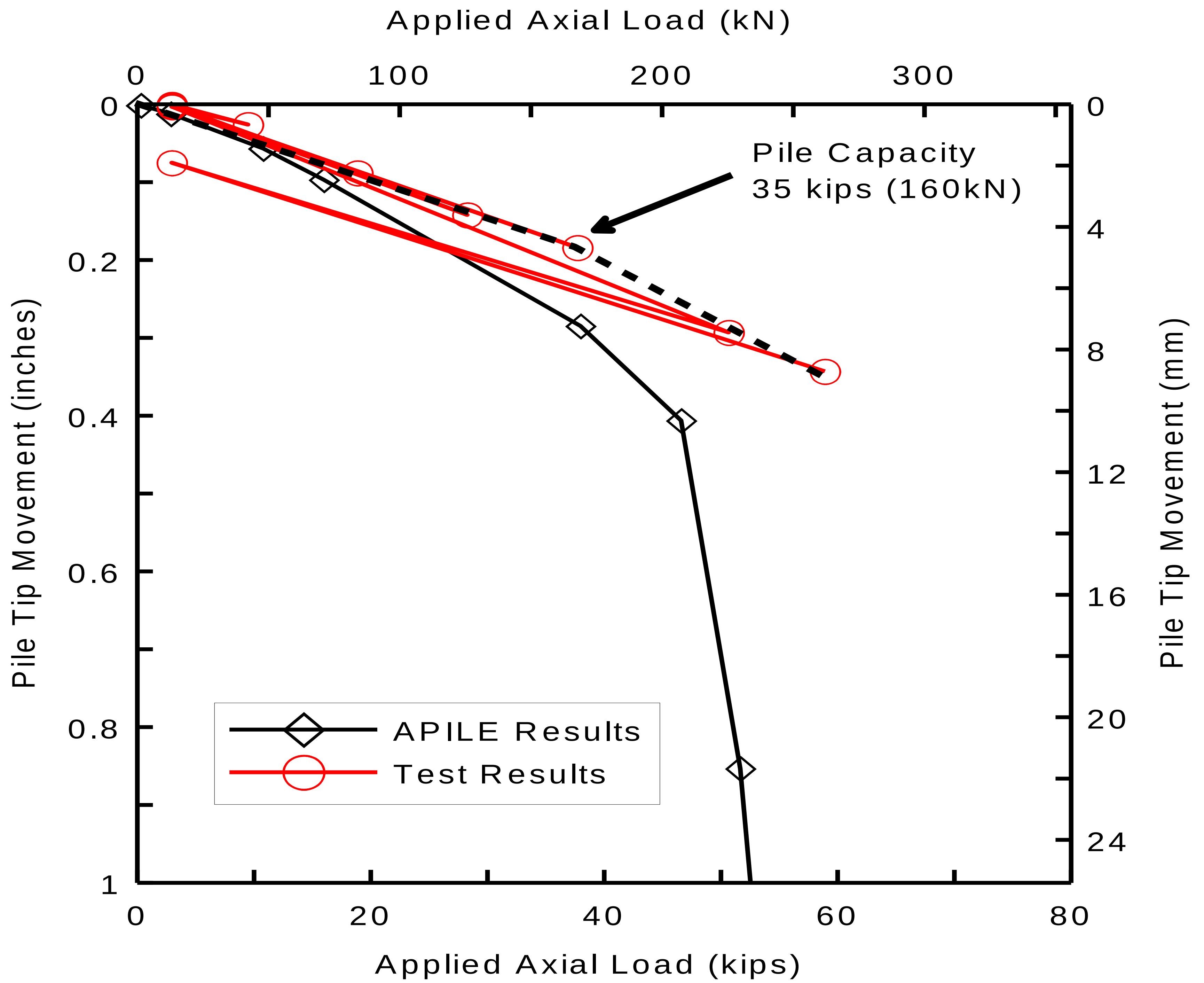
2 ORTHOGONAL WIREFRAME VIEW
1/8" = 1-0"



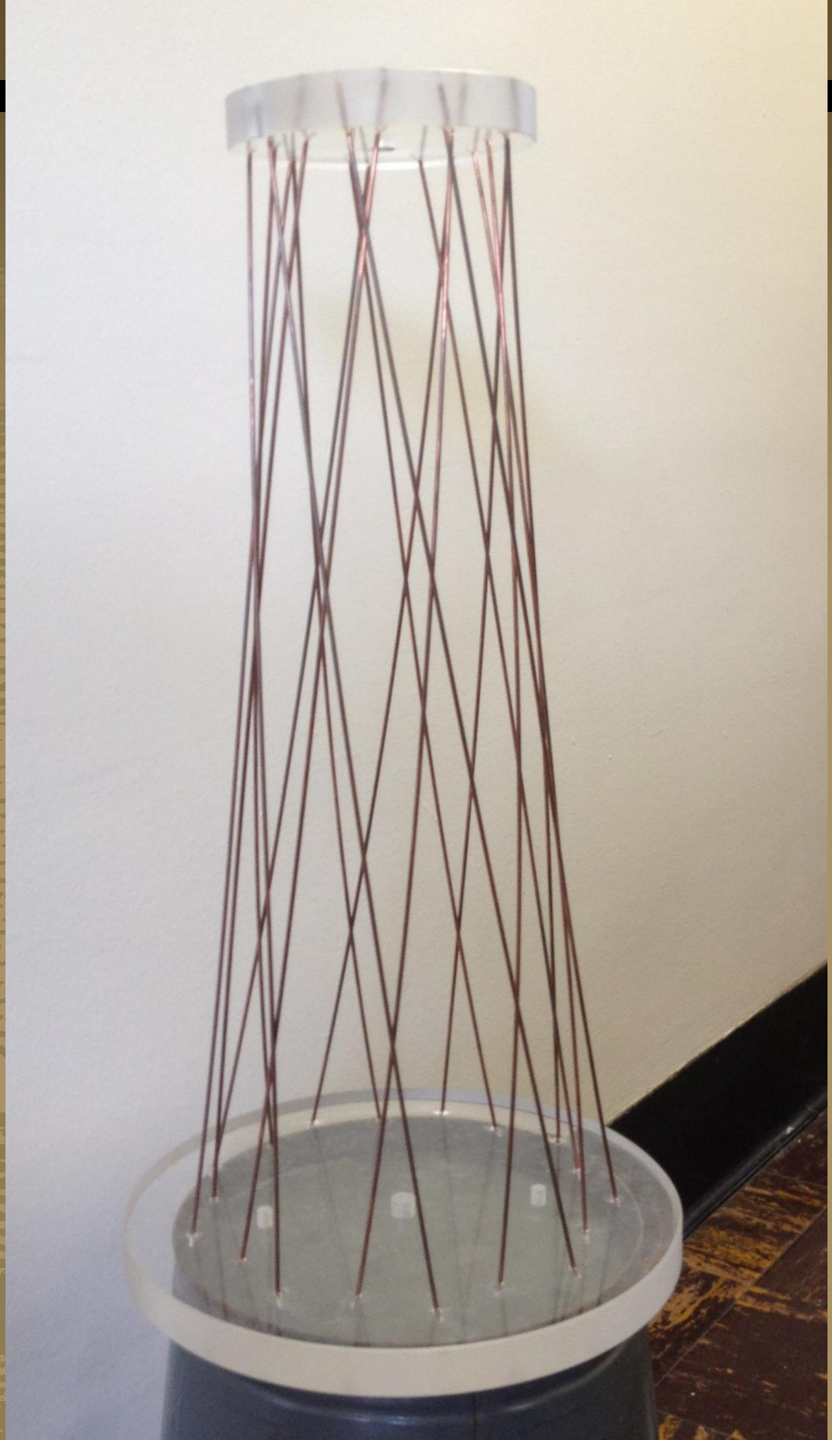
Moment (kN-m x 10³)
0
20
40
60
80
100
Reinforced Section
Grouted Section
2X Seismic Demand
1X Seismic Demand
Tower Height (ft.)
100
80
60
40
20
0
Tower Height (m)
30
25
20
15
10
5
0
0
20
40
60
80
100
Moment (in-kips x 10³)

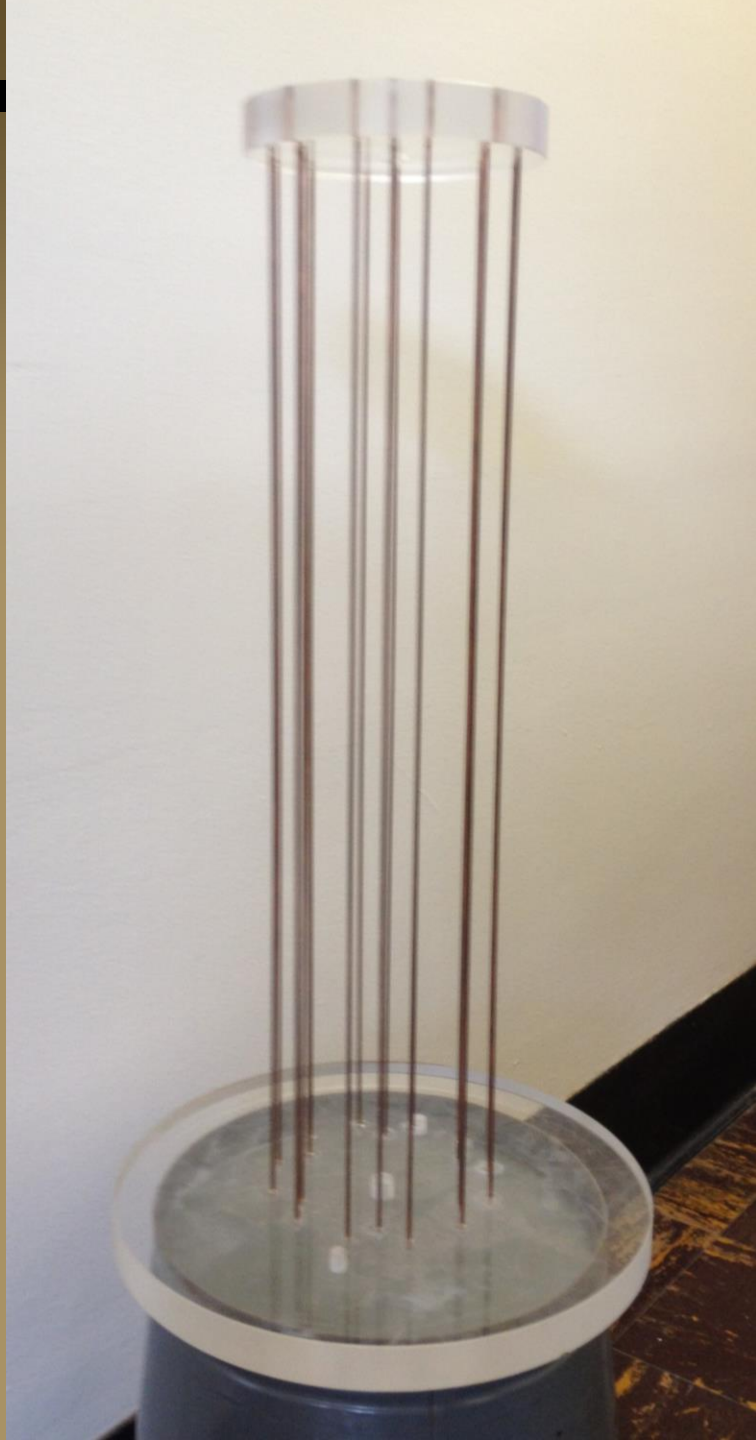


10" (typ.)
N
E
S
W
0,0
C
S9
1
2
3
4
5
6
7
8
9
10
11
12
13
14
19"
2'-2"
2'-7"
28"
16"
6'-2"
10"
3'-0"
14"
12"
21"
2'-6"
1'-6"
4'-7"
18"
5'-1"
15"
2'-4"
60° (typ.)
4"
20"
24"
2'-6"
22"
15'-3"
12" (typ.)
1 Indicates Micropile Number.
✱ Remove exterior floor material as needed. Minimize disturbance. Coordinate with Micropile contractor.

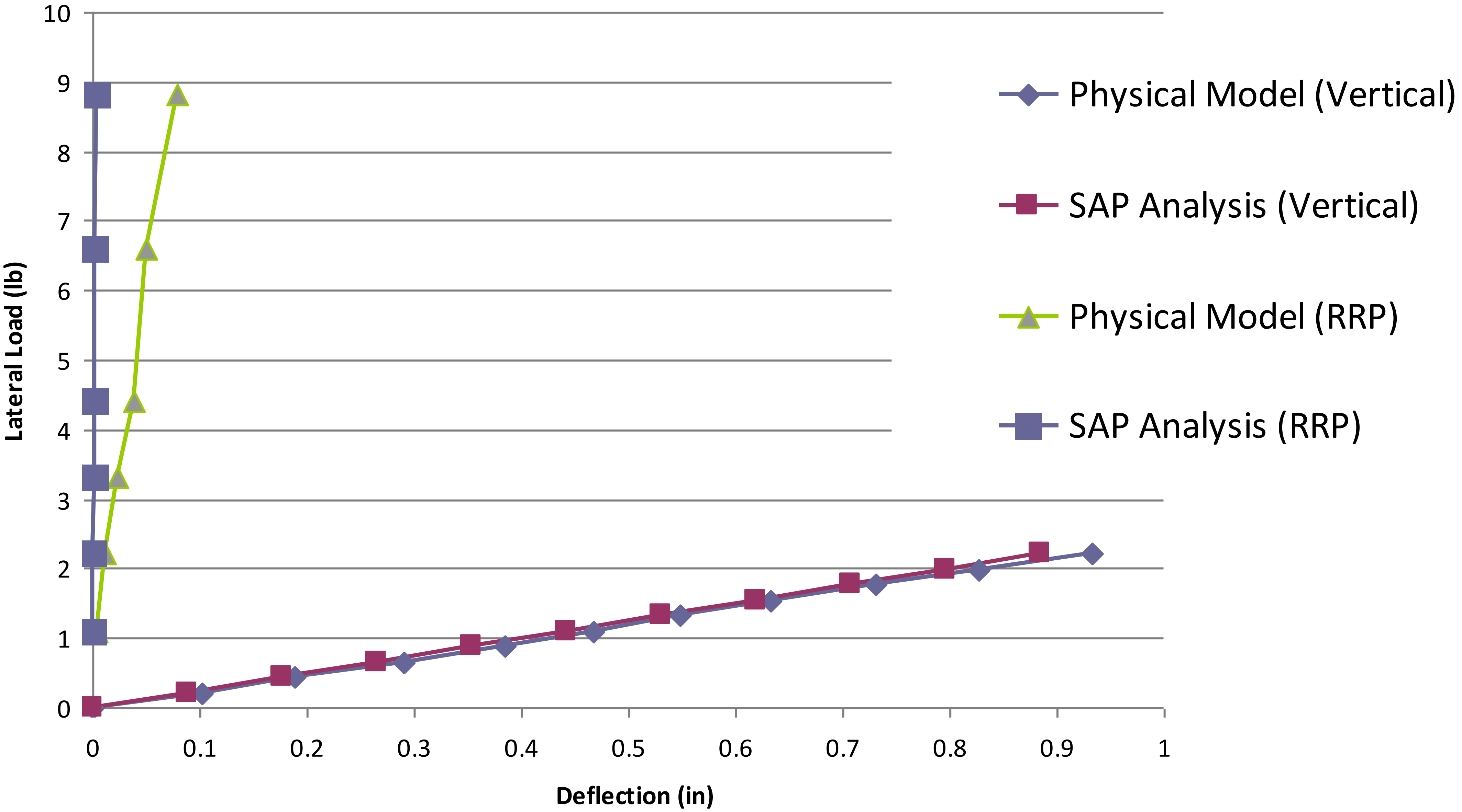

Applied Axial Load (kN)
0
100
200
300
0
0.2
0.4
0.6
0.8
1
0
4
8
12
16
20
24
Pile Capacity
35 kips (160kN)
Pile Tip Movement (inches)
Pile Tip Movement (mm)
APILE Results
Test Results
0
20
40
60
80
Applied Axial Load (kips)

The Potential Performance of RRP Groups during Earthquake induced Liquefaction



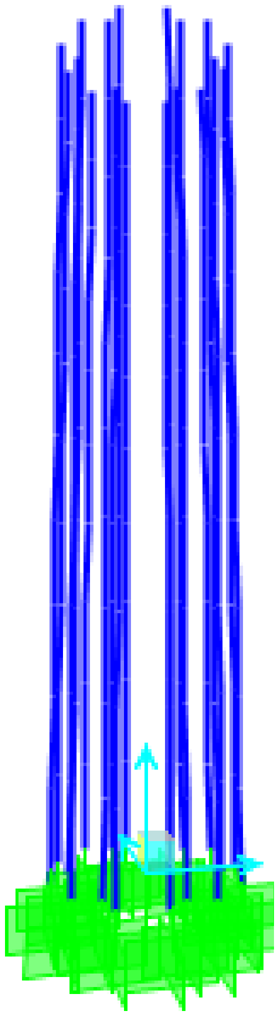


Load vs Deflection



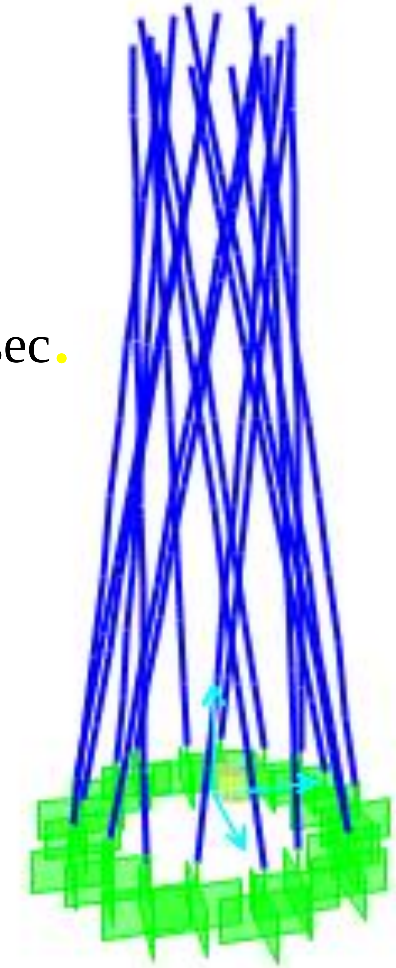
SAP Modeling: Steven Beaton, UTK

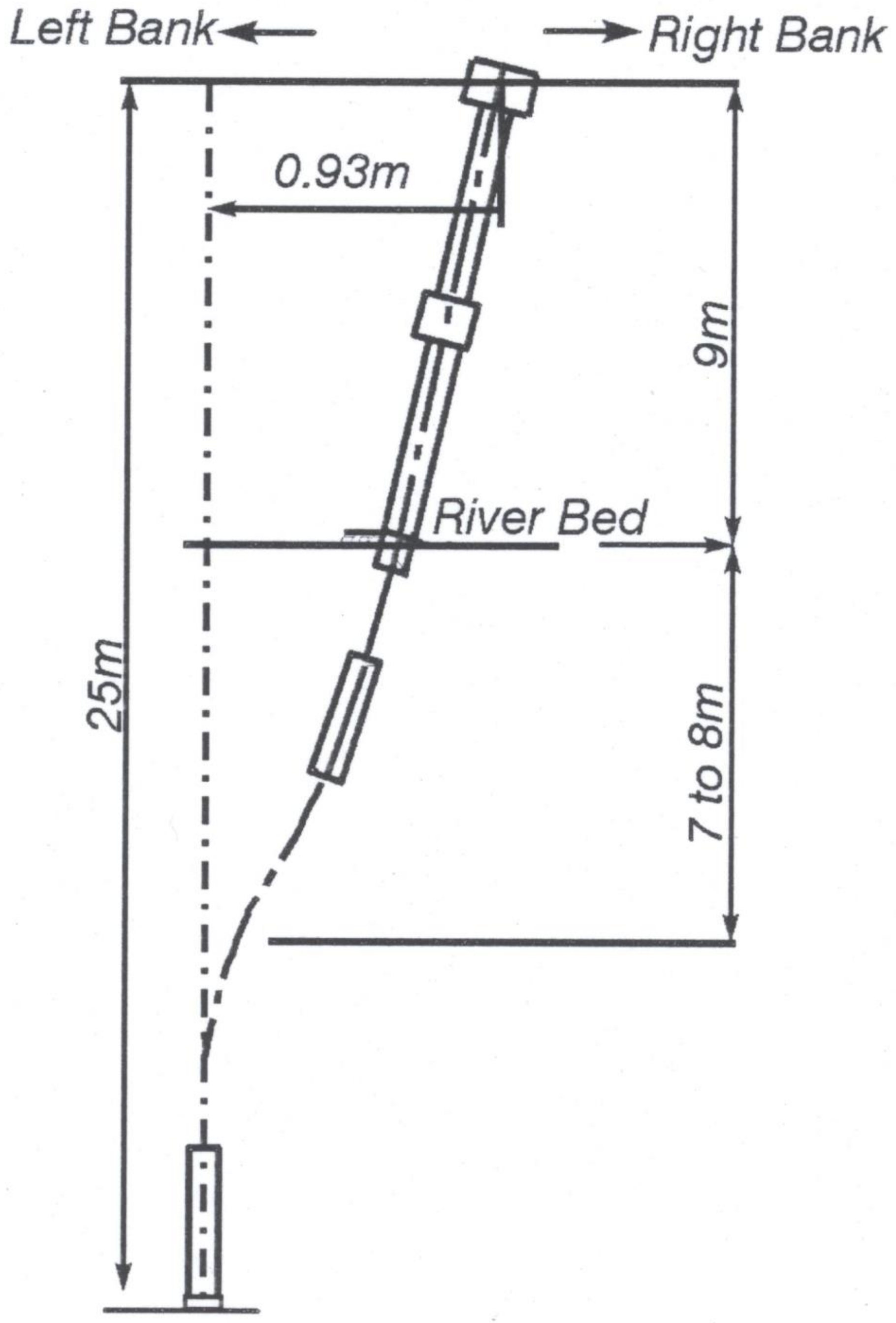
Modal Responses



First Mode Period
18 piles. PP7.00x0.408 23 ft. Long
Vertical Pile Group: 0.42 sec.

Reticulated Micropile Group: 0.052 sec.





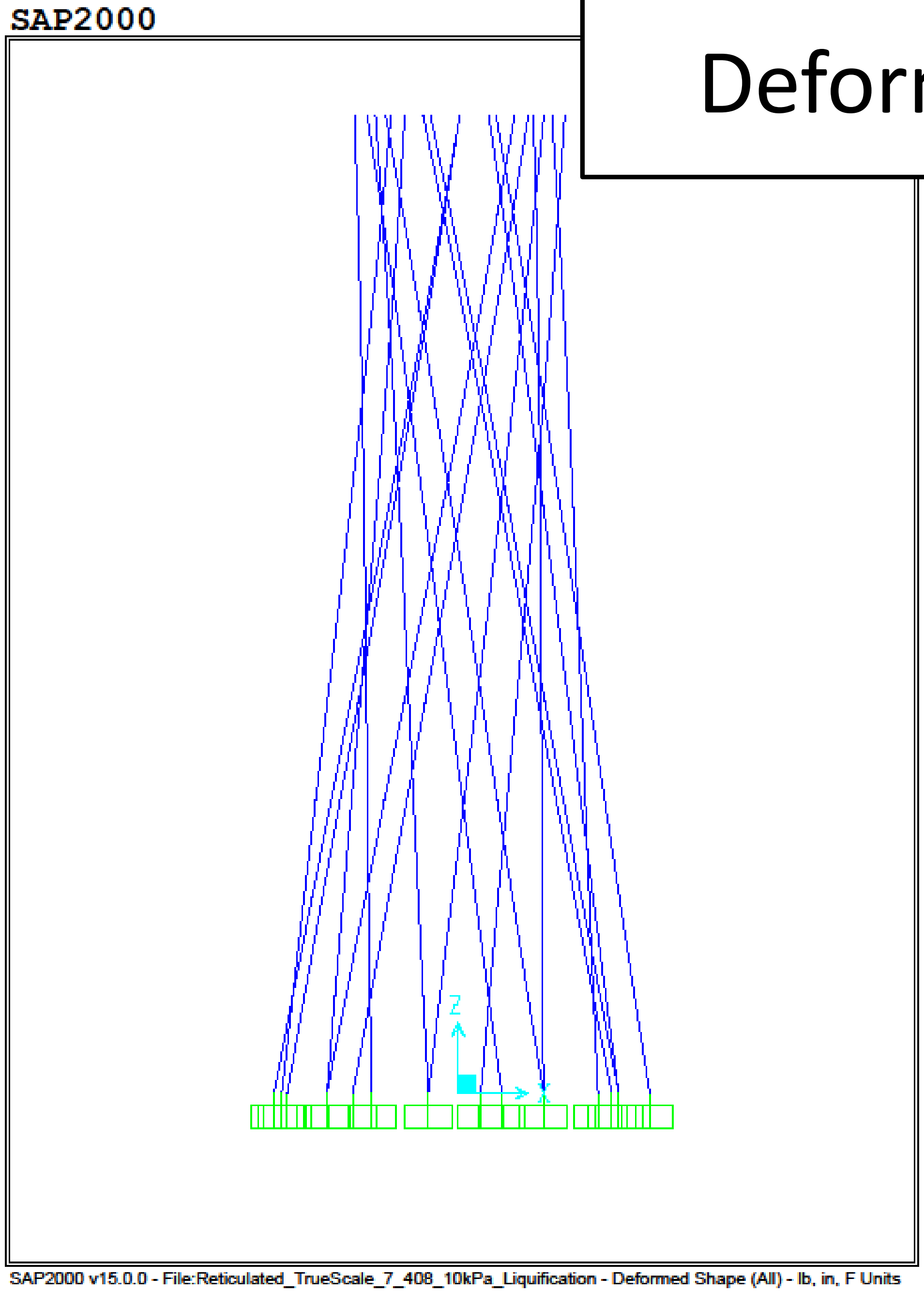
Showa Bridge, Niigata, 1964

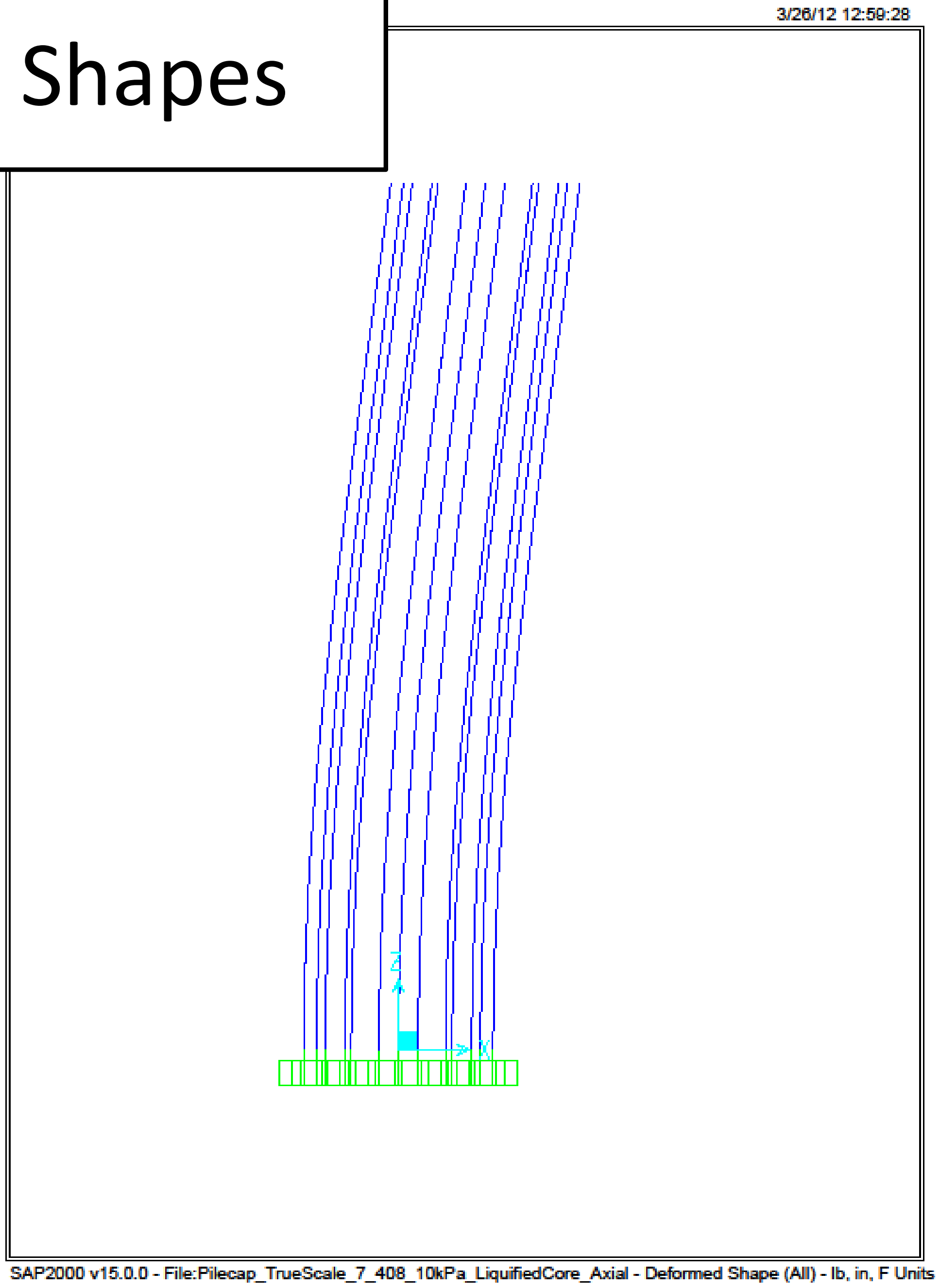
Liquefied Soil "Fluid Pressure" 10 to 30kPa = 1.5 to 4.5psi

"Liquefaction and Piled Foundations: Some Issues"
J. Berrill and S. Yasuda
Journal of Earthquake Engineering
Vol. 1 Special Issue 1 (2002)

Liquefaction Response Comparison. RRP and Vertical Pile Groups

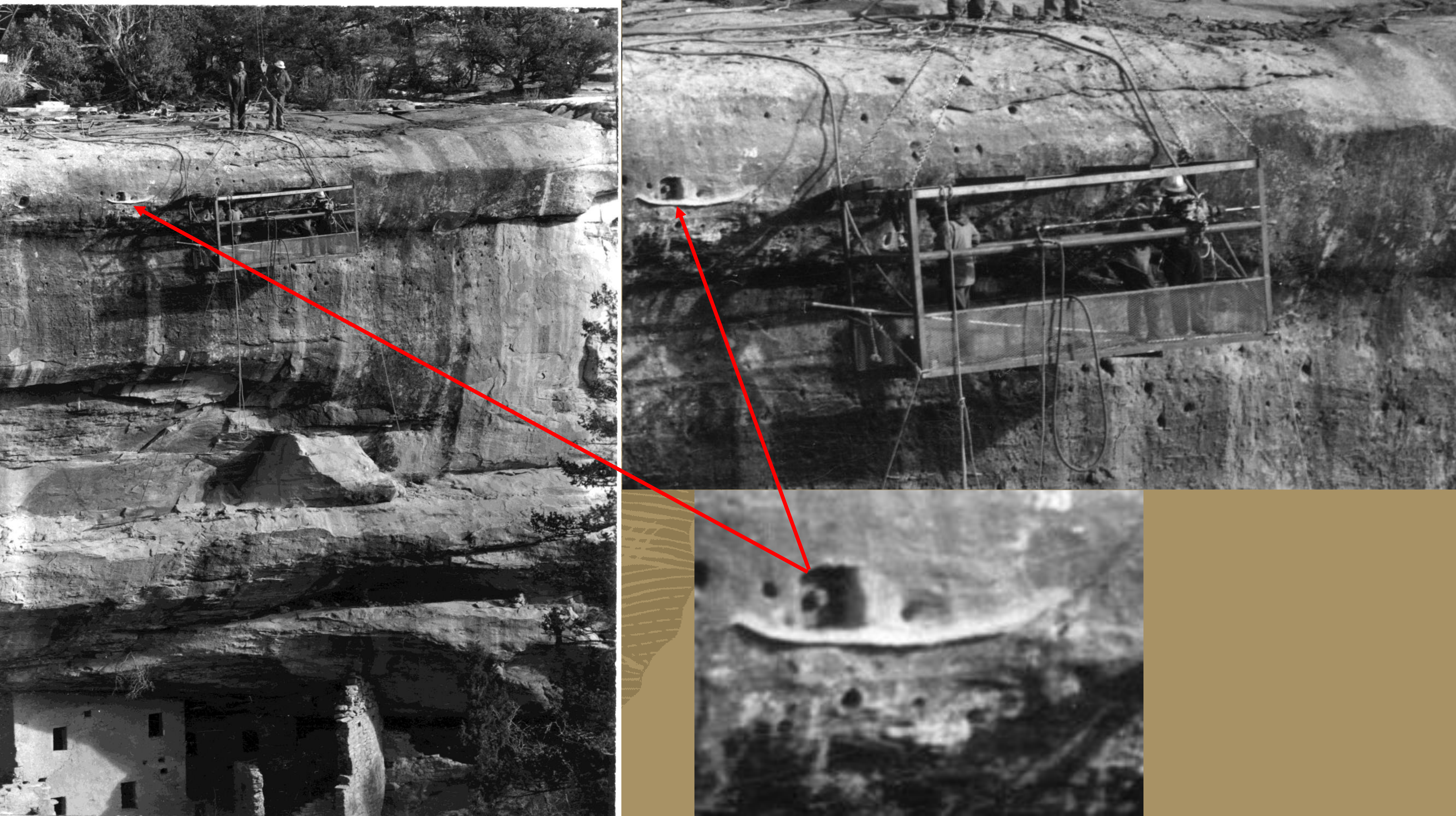
Deformed Shapes

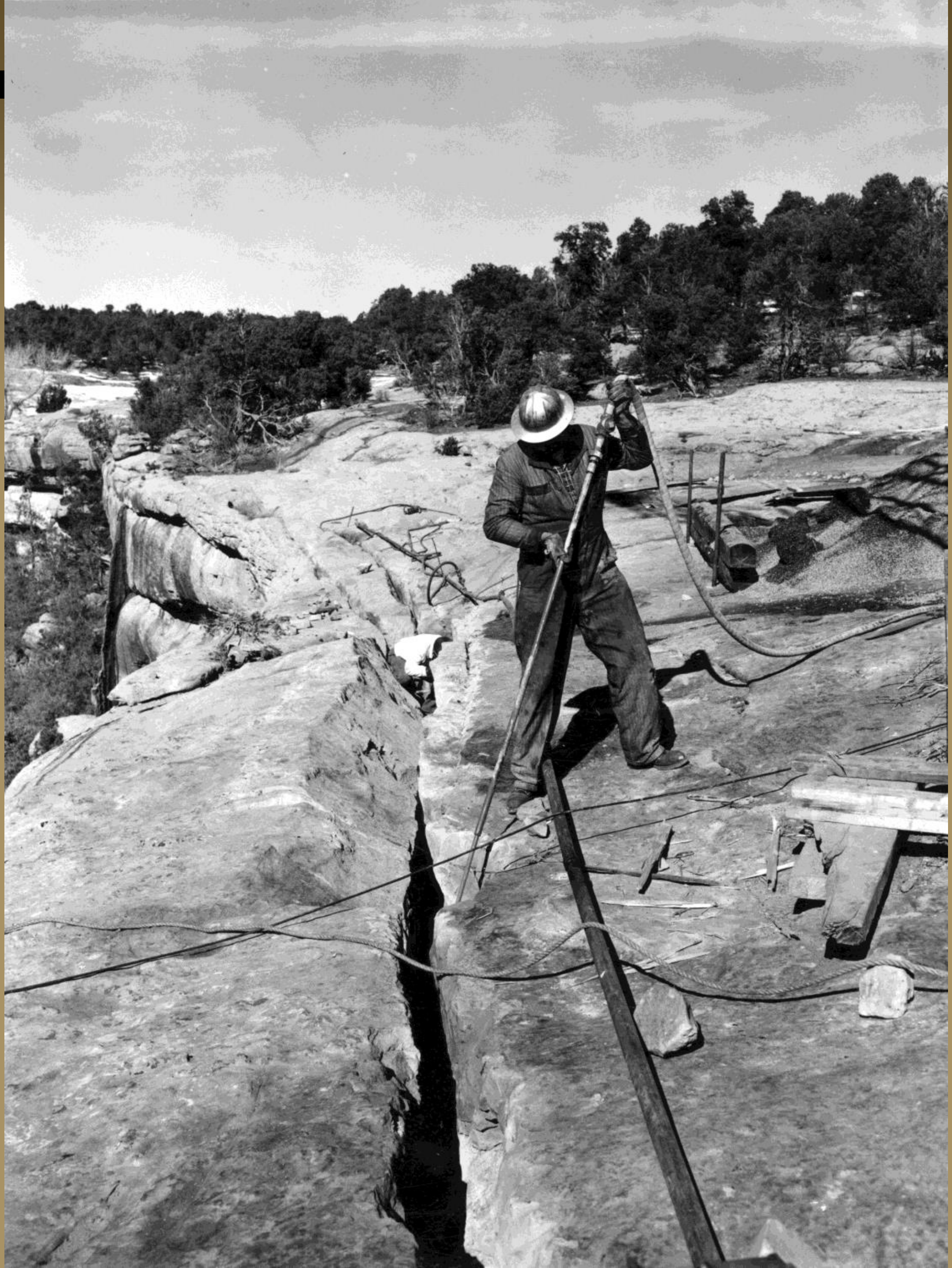


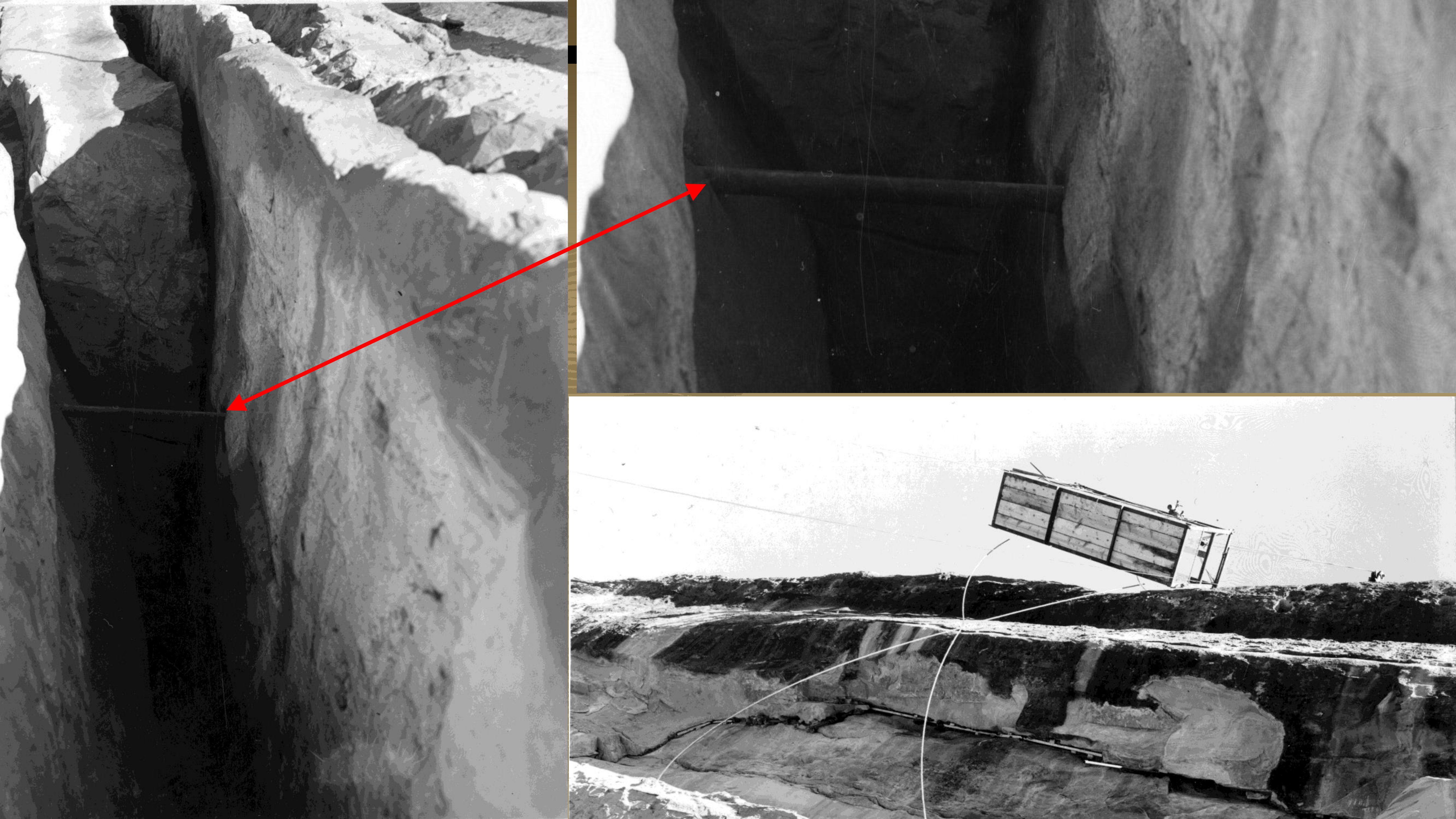


The Use of Reticulated Rock Bolts To Stabilize a Sandstone Arch In Mesa Verde National Park.

The Spruce Tree House Alcove Arch.








Prior Arch Collapse

Itasca Team: Dr. Lee Peterson, Ryan Peterson, Anya Brose, Derrick Blankama, Augusto Lucarelli, Prof. Peter Cundell

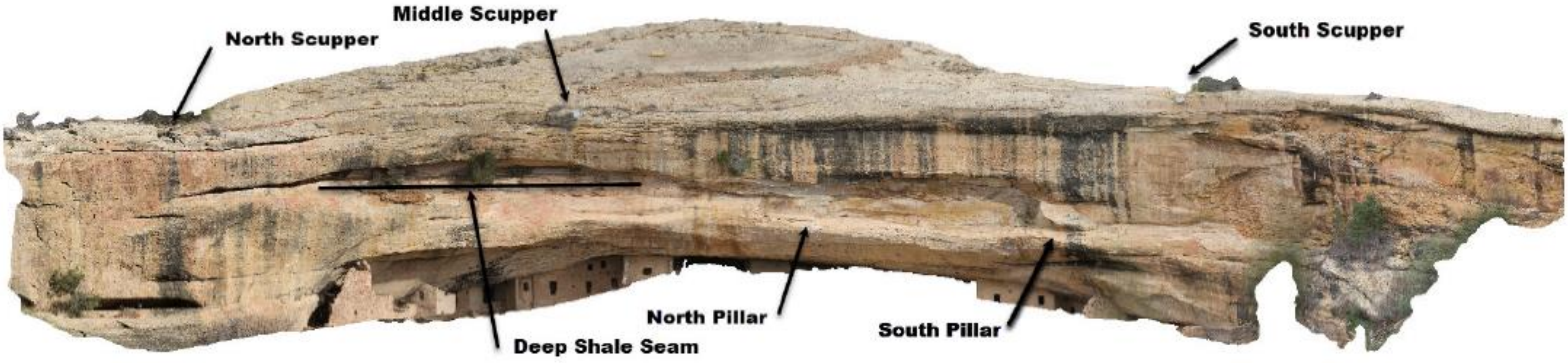


Figure 2 *Site location names.*

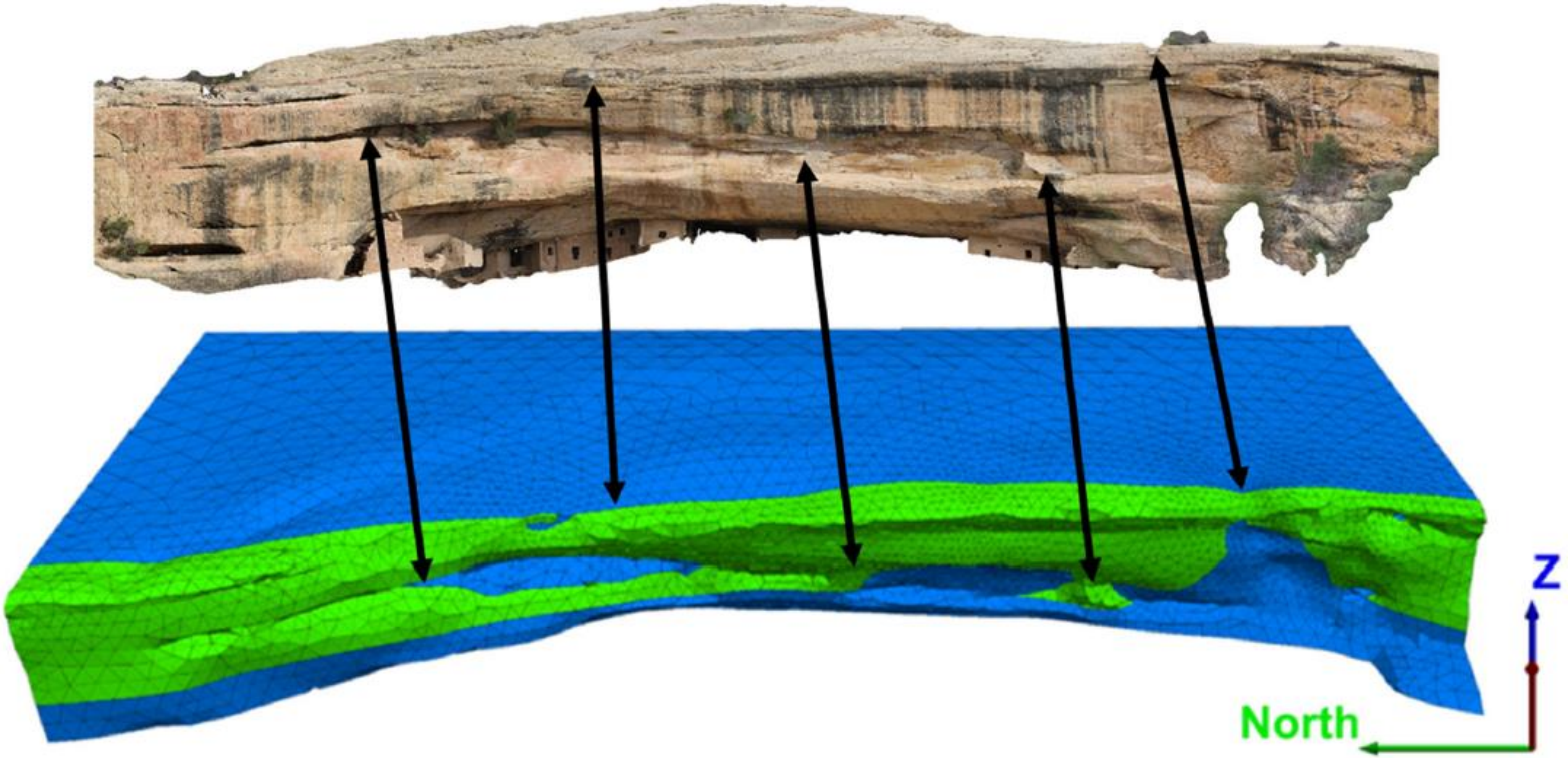


Figure 3 *Comparison of site geometry and 3DEC model. (Top image from photogrammetry, bottom image is the model representation. The local arch is green, and the intact rock is blue. The black arrows correlate geometric locations between the two images.)*

[redacted]

Figure 21 shows the open, closed, and intact shale seams in the model. Red indicates an open seam, blue is a closed seam, and green is an intact seam.

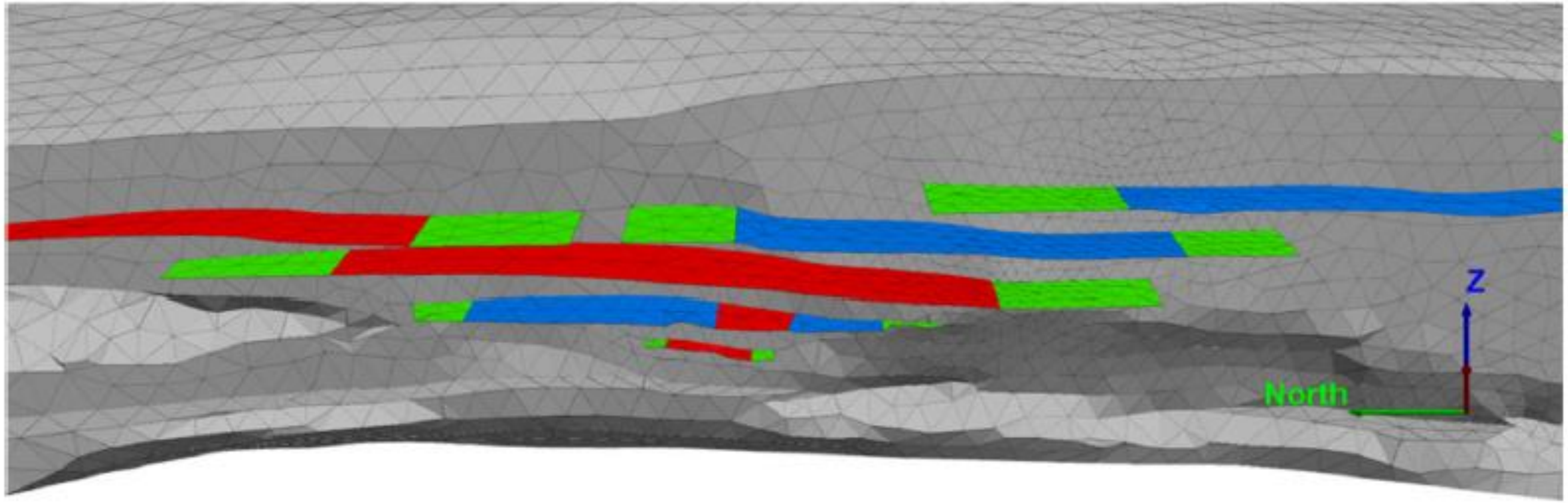


Figure 21 Open, closed, and intact shale seams in the 3DEC model.

principal stress (sigma 3) is illustrated by the other arm of the cross. If the stresses are tensile, the values are plotted in red. This figure confirms several behaviors.

- The local arch is behaving like an arch:
- the pillars are supporting the arch;
- the shale seams are separating the arch into several beams;
- arching is creating tensile stresses in the upper fiber of the beams, and compressive stresses in the lower fiber of the beams (e.g., above the north pillar);
- the lower left and lower right diagonal boundaries of the arch are also supporting the arch; and
- there are two relatively unstressed zones of the arch—above and north of the north pillar, and above the south pillar.

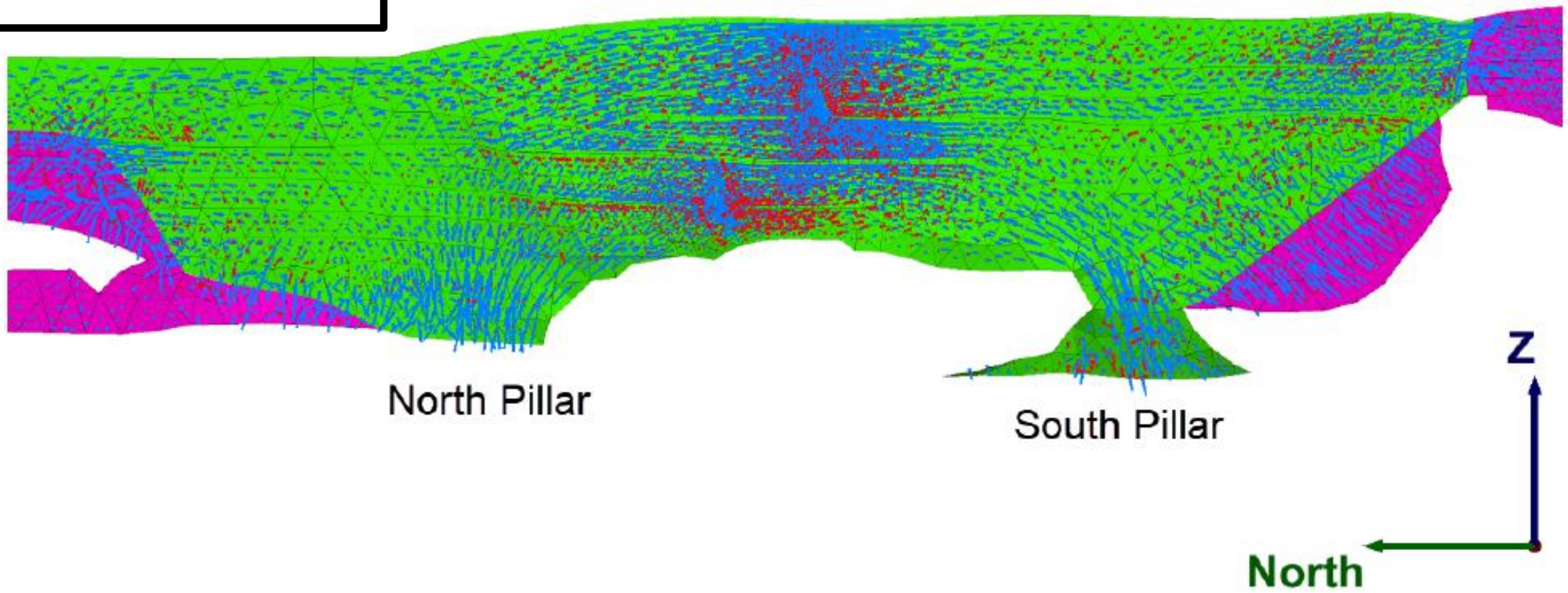


Figure 27 Stress tensors in the local arch, no rockbolts, SRF=1.0, blue is compression, red is tension (green background where the Richardson crack is known to exist, magenta background where the crack was extended in the model).

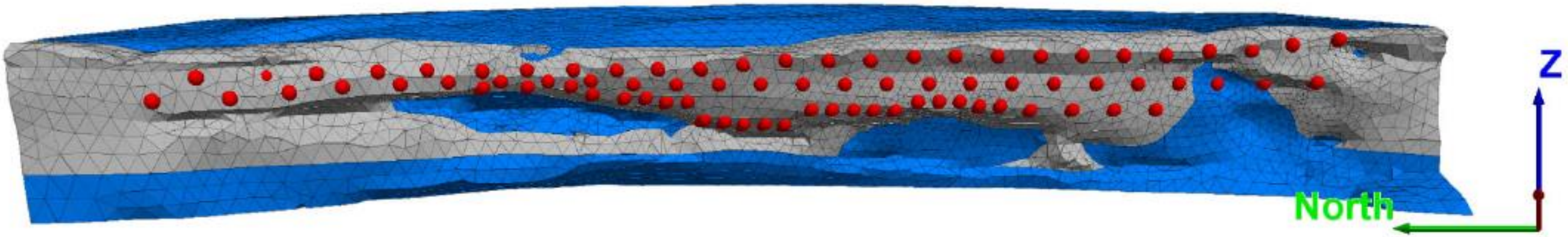


Figure 23 Rockbolt locations.

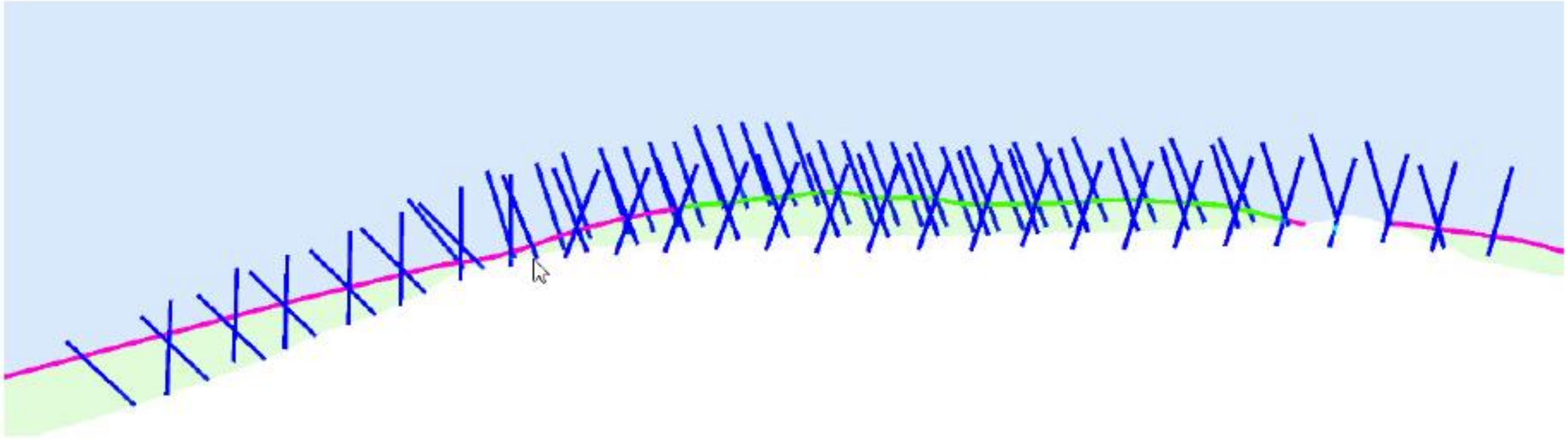


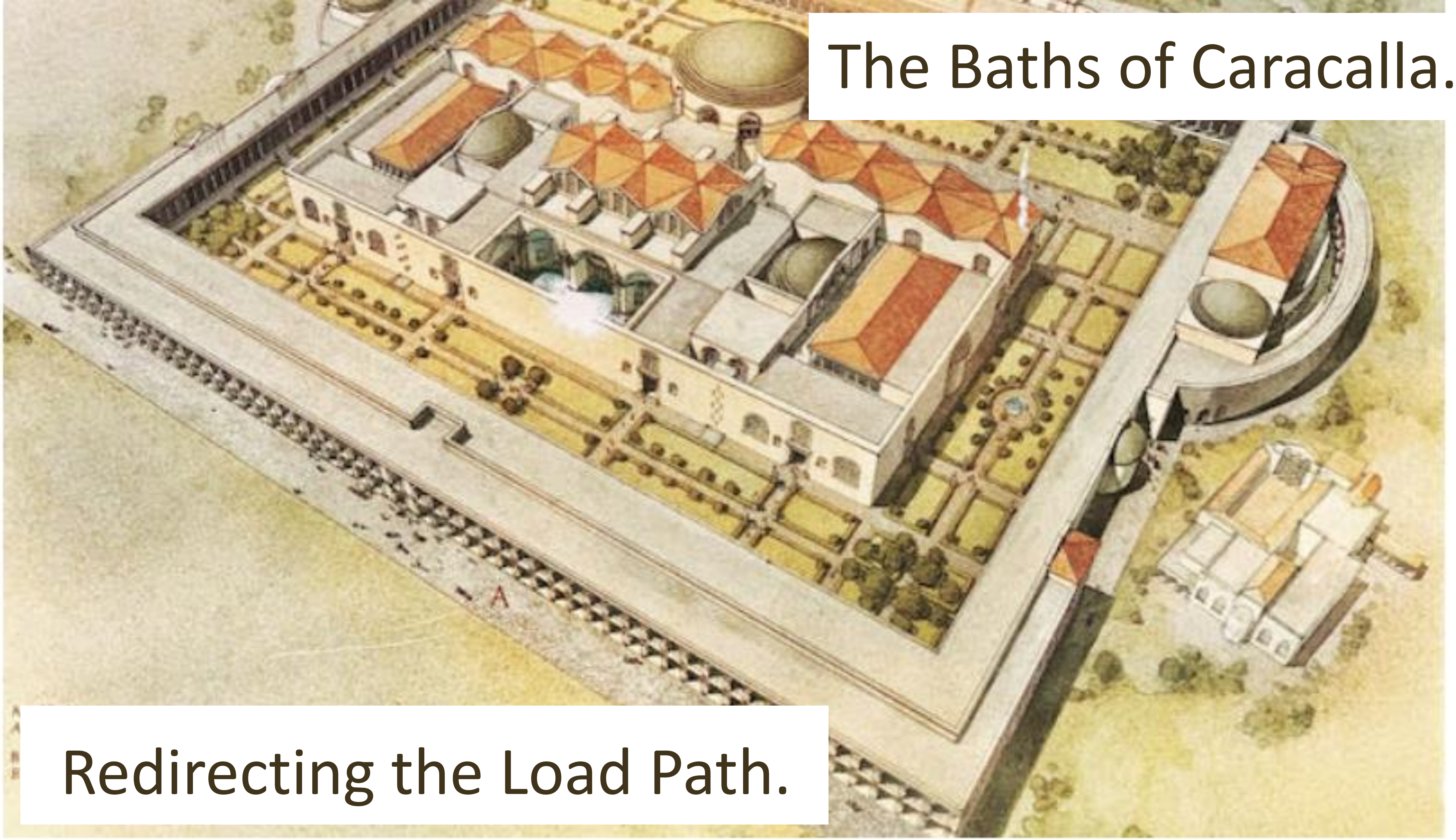
Figure 24 A top view of the reticulated rockbolt pattern.

Stabilizing an Ancient Puebloan Alcove Site. Cliff Palace In Mesa Verde National Park.

Using RRP Groups to Re-Direct Load Paths in both Soils and Structures.

The Romans were masters at redirecting the load path within a building wall. This was achieved primarily with arches constructed within the wall section.

The Baths of Caracalla.



Redirecting the Load Path.

The Romans had mastered building techniques and engineering, and were able to make massive structures all over the empire, in part due to the cement they made, and in part due to the arch they perfected.

Research Efforts in Support of Investigation, Documentation and Assessment at Cliff Palace, Mesa Verde National Park

NPS

National Park Service
Vanishing Treasures
Program

James A. Mason

UTSA

The University of Texas at San Antonio™

Center for Cultural Sustainability

William Dupont
Angela Lombardi
Sara Rodríguez Jimeno
Anthony Vannette
Samira Tafazzol
Tracie Quinn
Kelsey Brown

October 2022

Meet the Team

UTSA Center for Cultural Sustainability

Sara Rodríguez Jimeno
Preservation Engineering Fellow
Center for Cultural Sustainability
School of Architecture + Planning

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Center for Cultural Sustainability
Lecturer, School of Architecture + Planning

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Center for Cultural Sustainability
School of Architecture + Planning

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Professor
School of Architecture + Planning
Director, Center for Cultural Sustainability

Dr. Angela Lombardi
Associate Professor
School of Architecture + Planning

Dr. Blake Weissling
Asst. Professor of Practice
College of Science

NPS IMR Vanishing Treasures Program

James A. Mason, Ph.D., P.E.
Structural, Geotechnical, Preservation, and Seismic Engineer

Mesa Verde National Park

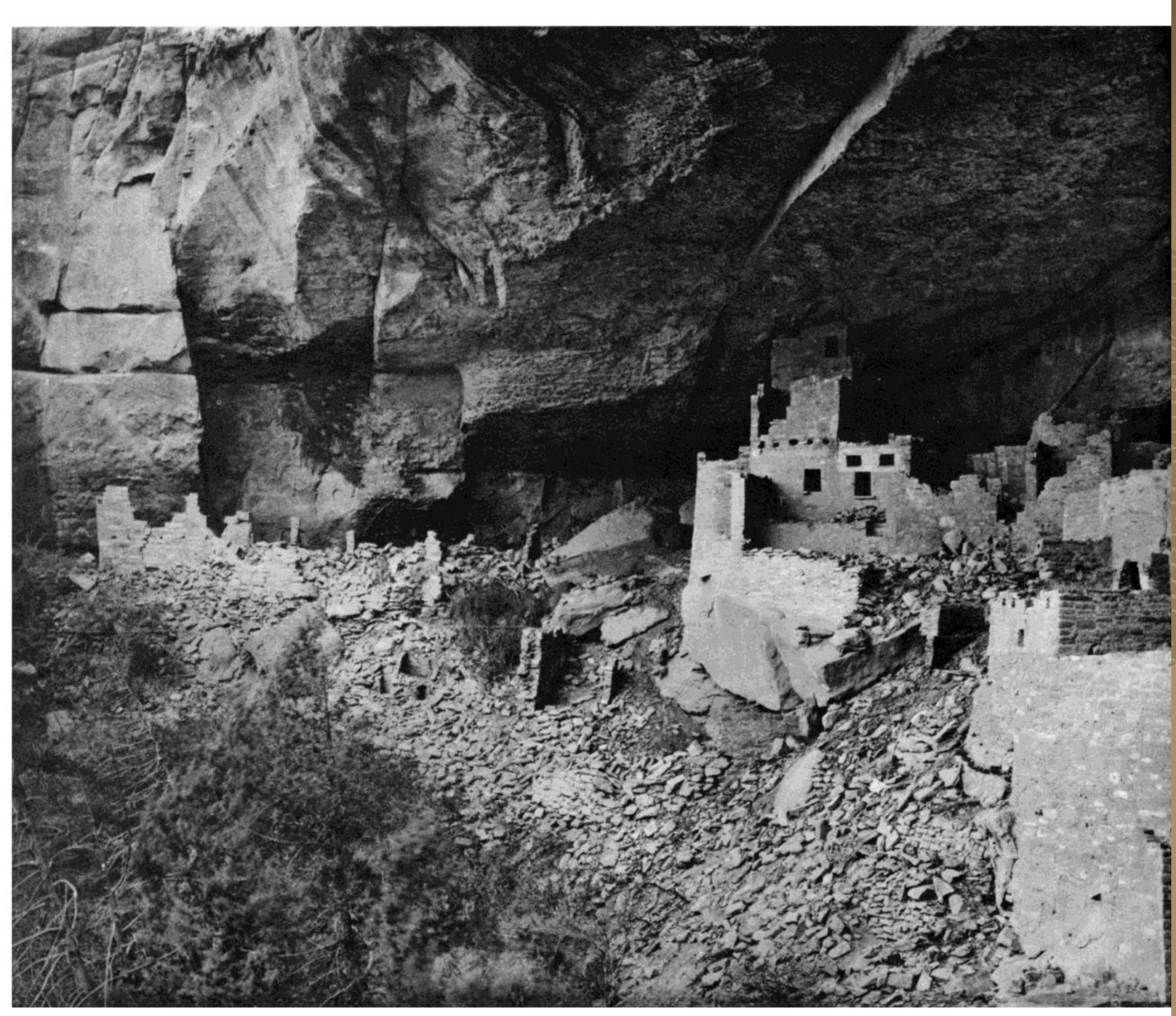
Kayci Cook | Superintendent

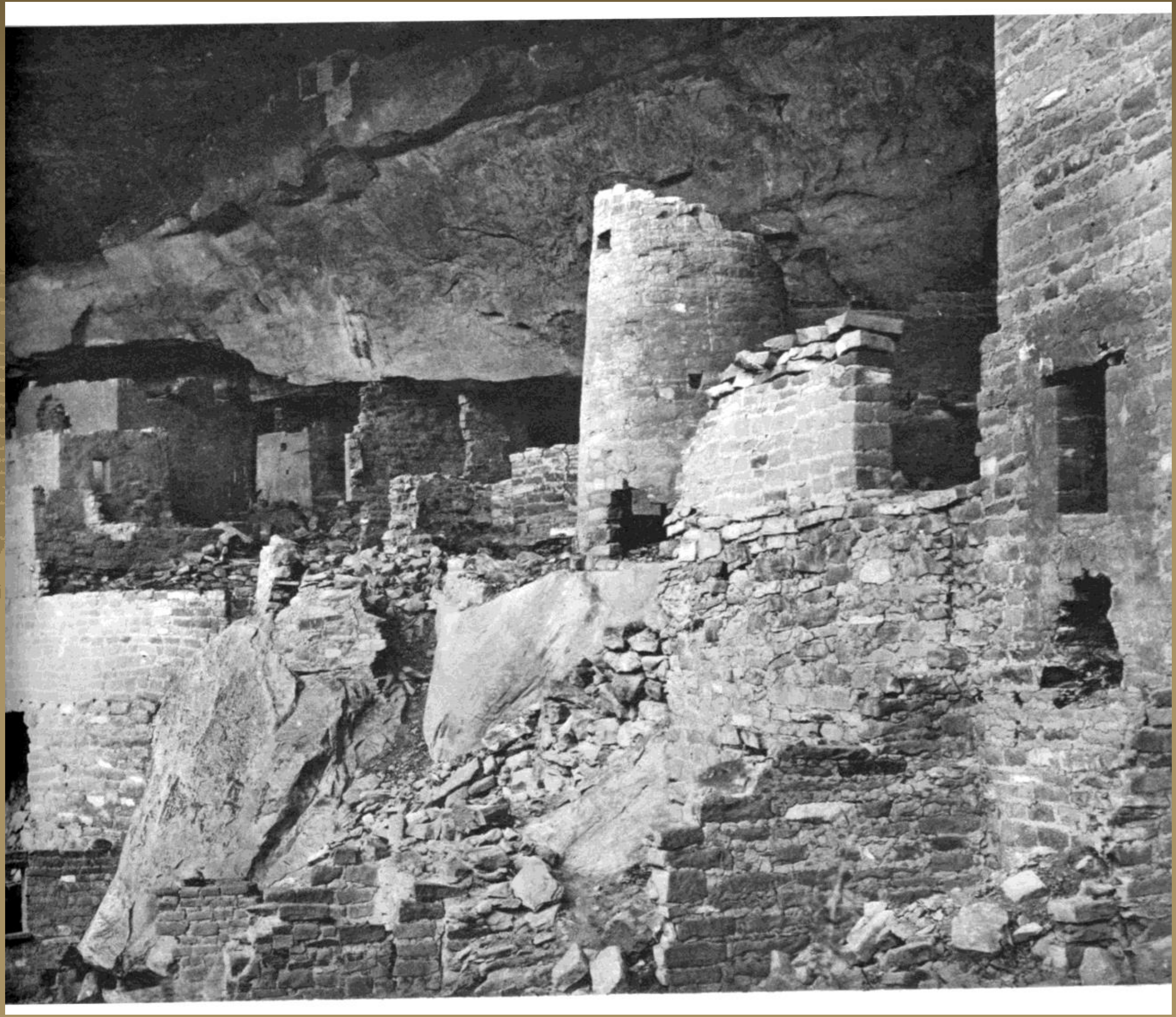
Bill Nelligan | Deputy Superintendent

Allan Loy | Project Manager

Cultural Resources Team
Elizabeth Dickey | Chief of Cultural Resources
Kay Barnett | Archaeologist
Gary Ethridge | Preservation Archaeologist (Ret.)
Christine McAllister | Archaeologist

Museum & Archives Team
Dr. Tara Travis | Supervisory Museum Curator
Samuel Denman | Museum Technician

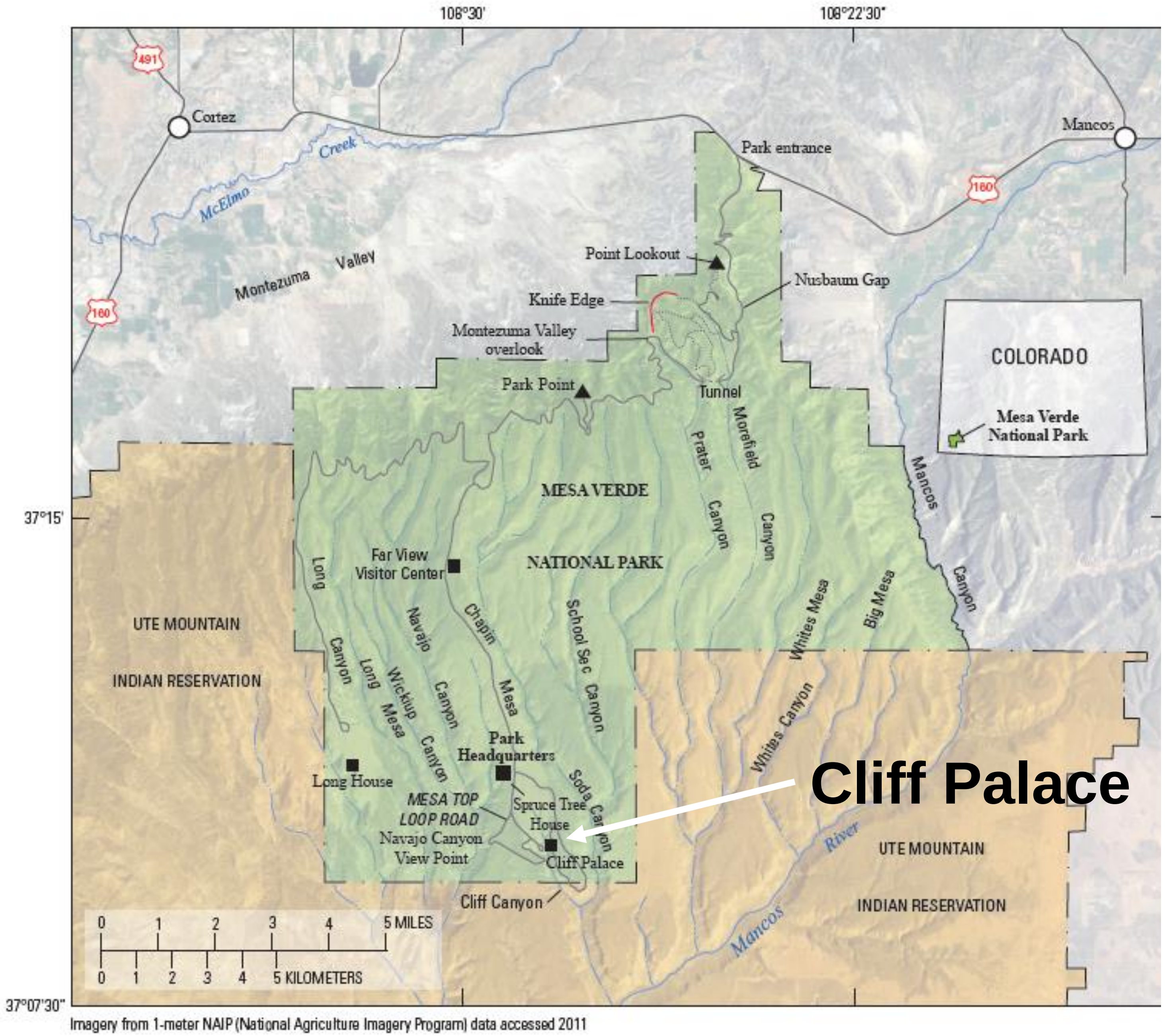




[redacted]

Introduction to Cliff Palace.

A virtual walkaround.



Carrara, P.E., 2012, Surficial geologic map of Mesa Verde National Park, Montezuma County, Colorado: U.S. Geological Survey Scientific Investigations Map 3224, 22 p. pamphlet, 1 sheet, scale 1:24,000.

Stratigraphic Units within Mesa Verde National Park

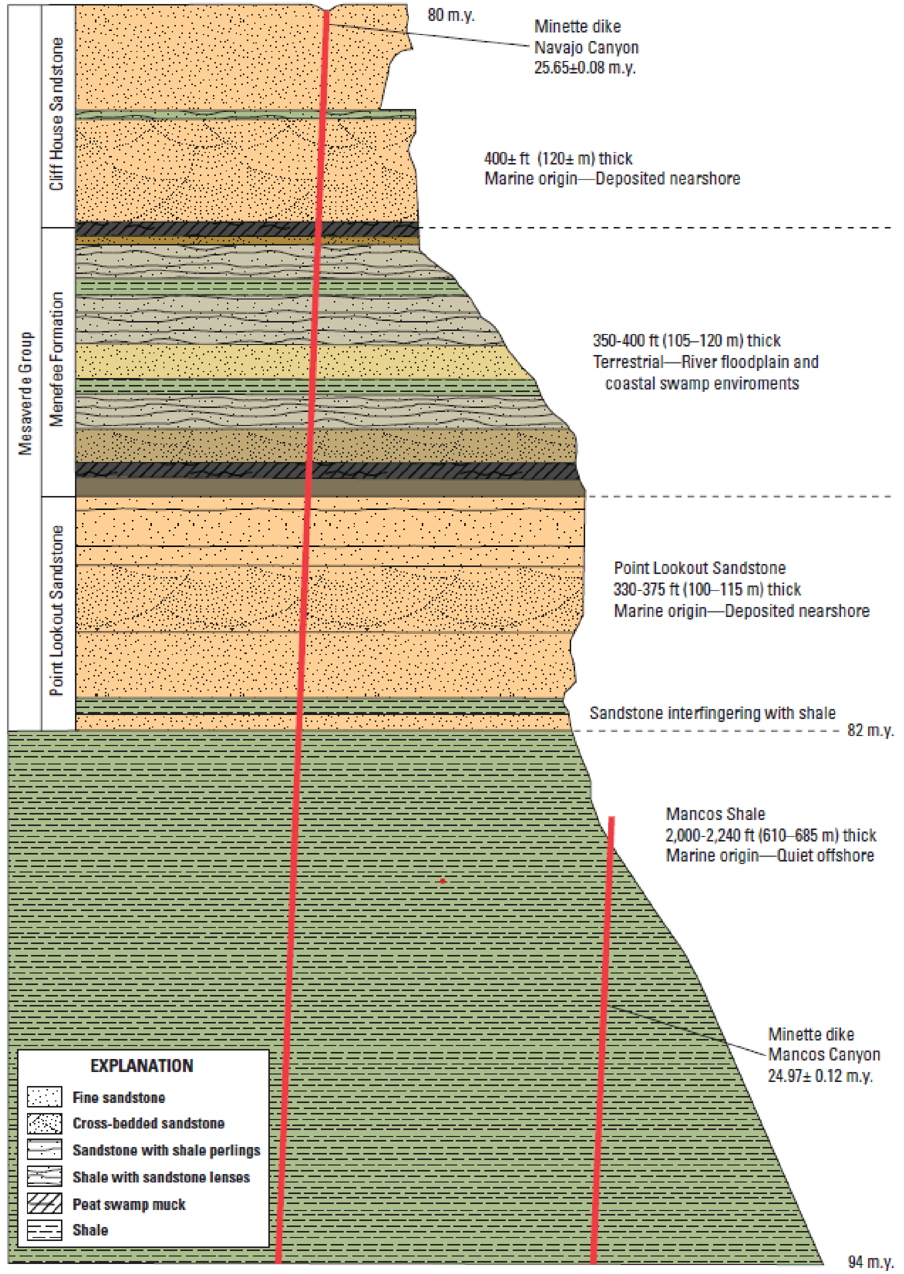
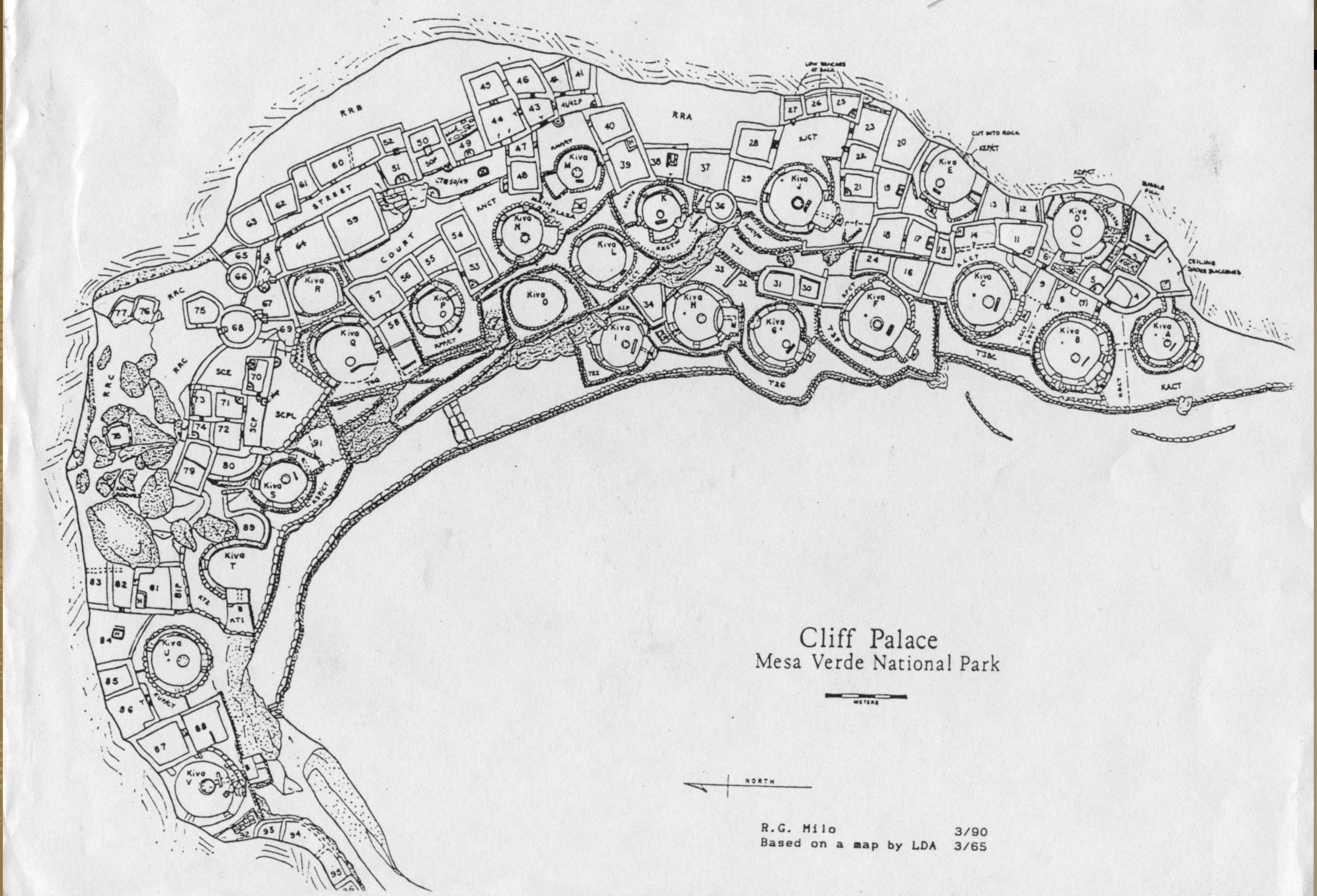
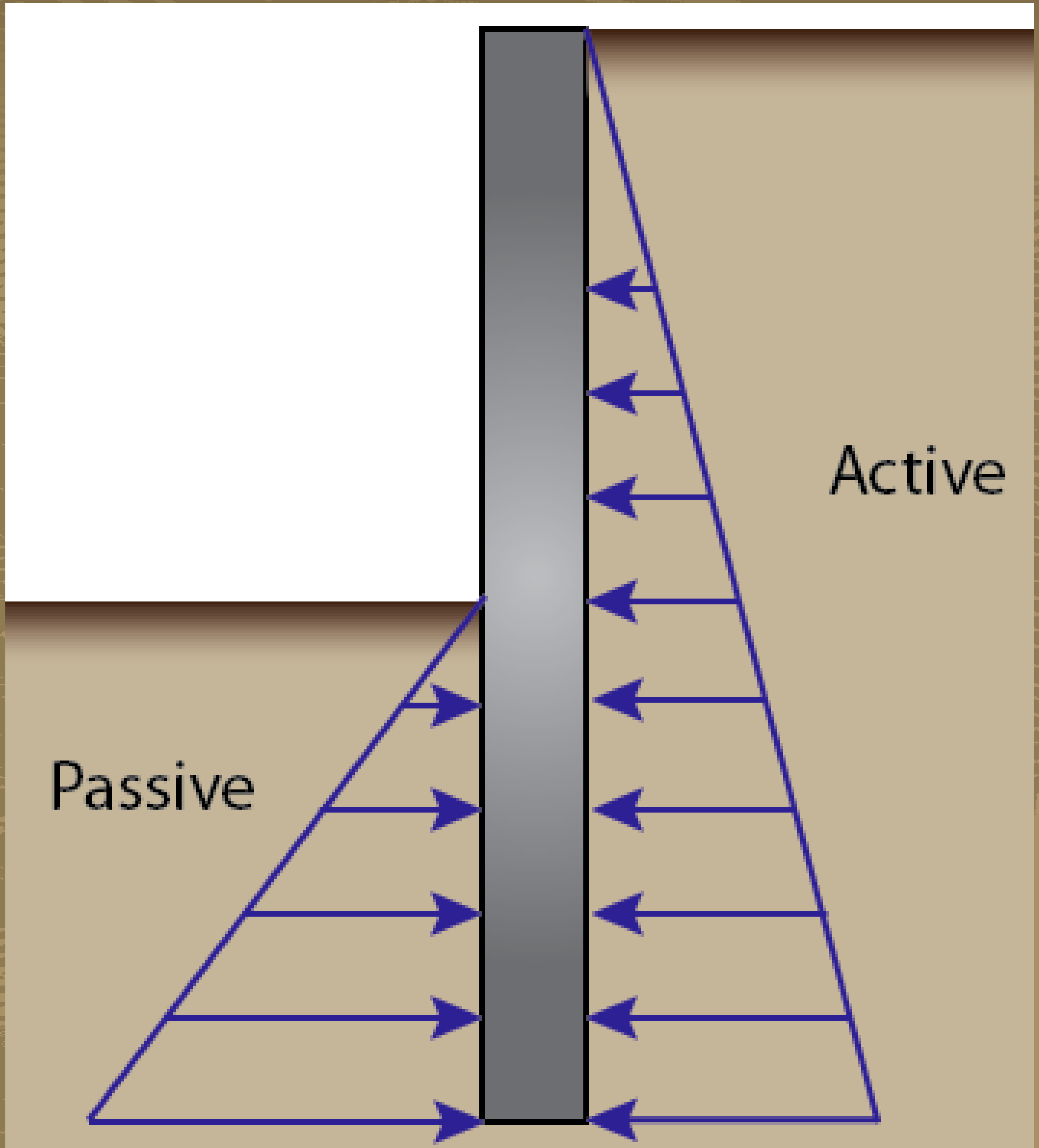


Figure 2. Stratigraphic section of Mesa Verde National Park (after Griffitts, 1990). Ages given are from Cobban and others (2006), W.A. Cobban, USGS, personal commun. (2007), and Peters (2011a, 2011b).

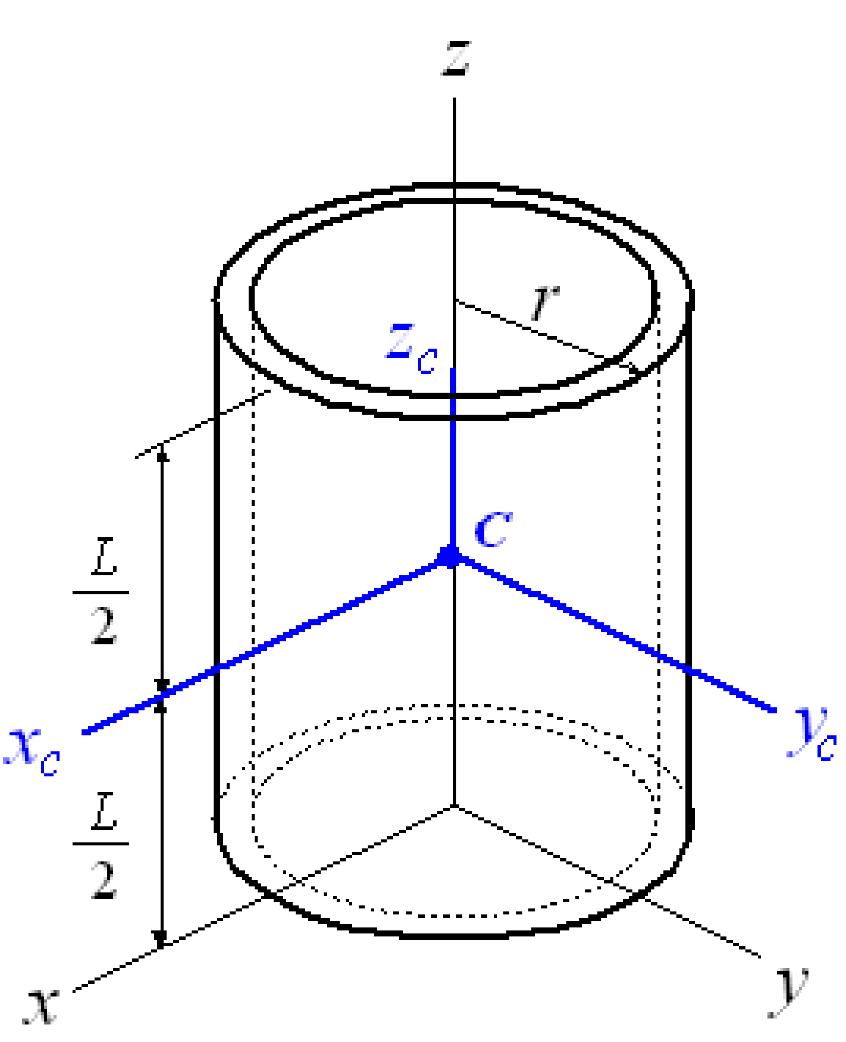


NATIONAL PARK SERVICE

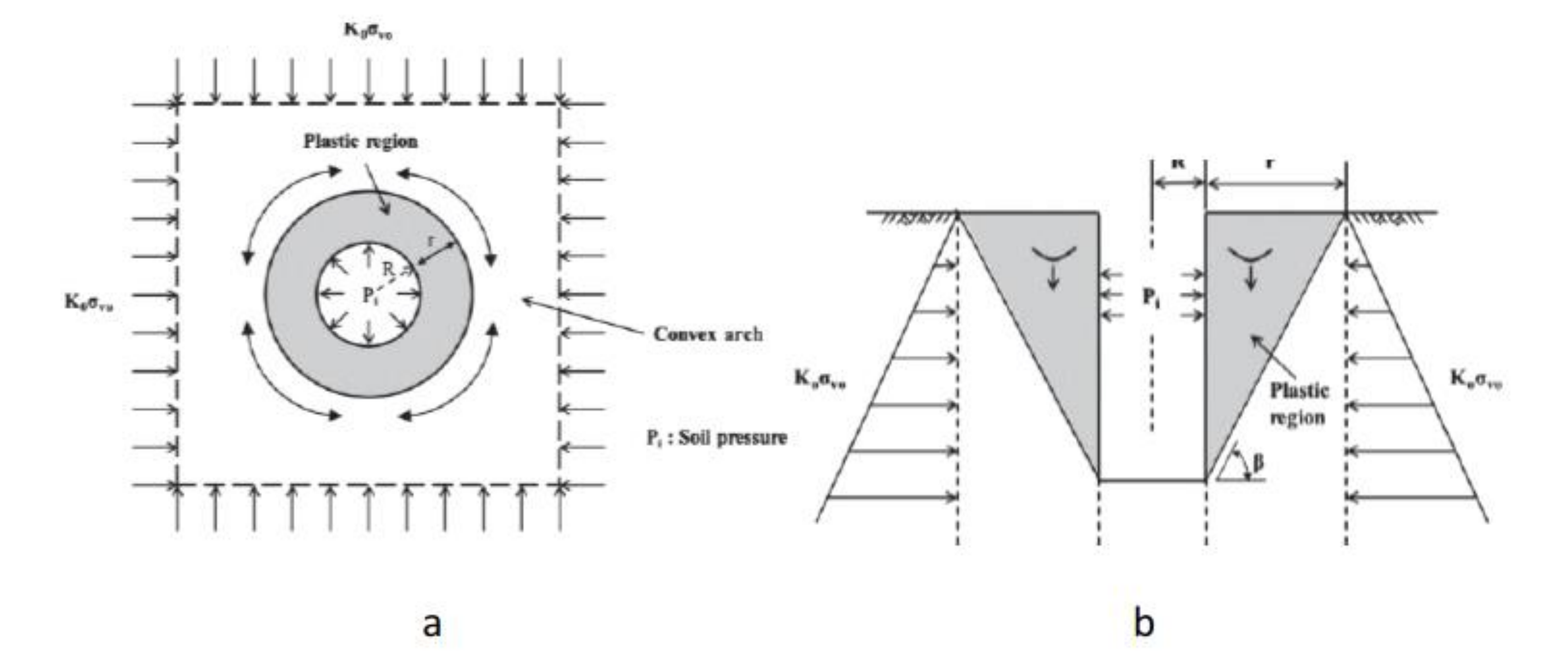
Lateral Earth Pressure



Cylindrical Shells of Revolution



Lateral Soil Pressure on Embedded Cylinder



[redacted]

ANOTHER PROJECT by Dr. Mason

Transferring reticulation technology to adobe buildings. Preliminary research conducted by Mason at Fort Union using Cintek Helifix anchors. (All of the Cintex technology is based on Lizzi's work.) Very promising results were obtained, which prompted NPS Vanishing Treasures program to coordinate with The University of Vermont, Burlington (a CSEU partner) where better loading and monitoring equipment confirmed the work from Fort Union.

UVM Adobe Helifix Investigation for NPS-VT

Merrick Gillies, Heidi Thorne, Douglas Porter, Eric Hernandez, and Mandar Dewoolkar

Civil and Environmental Engineering

The University of Vermont

12-20-2019

Helifix

PRODUCT DATA SHEET – PDS/DF01

HELIFIX

SUSTAINABLE STRUCTURAL SOLUTIONS

DryFix

Dry mechanical pinning and remedial tying system

Applications

- Versatile replacement wall tie
- For securing multiple layers of masonry
- For pinning delicate masonry features

Features

- Requires no resin, grout or mechanical expansion
- Quick, easy, non-disruptive installation using the Power Driver Attachment
- Installed tie is recessed below face of masonry
- Highly economical with low installed costs
- Effective in all common building materials
- Leaves masonry virtually unmarked
- Usable in all weather, temperature and environmental conditions

For full Product Information, Case Studies and downloadable Repair Details, giving specifications for many common structural faults, go to:

www.helifix.com/products/retrofit-products/dryfix

DryFix tie being power-driven into pilot hole

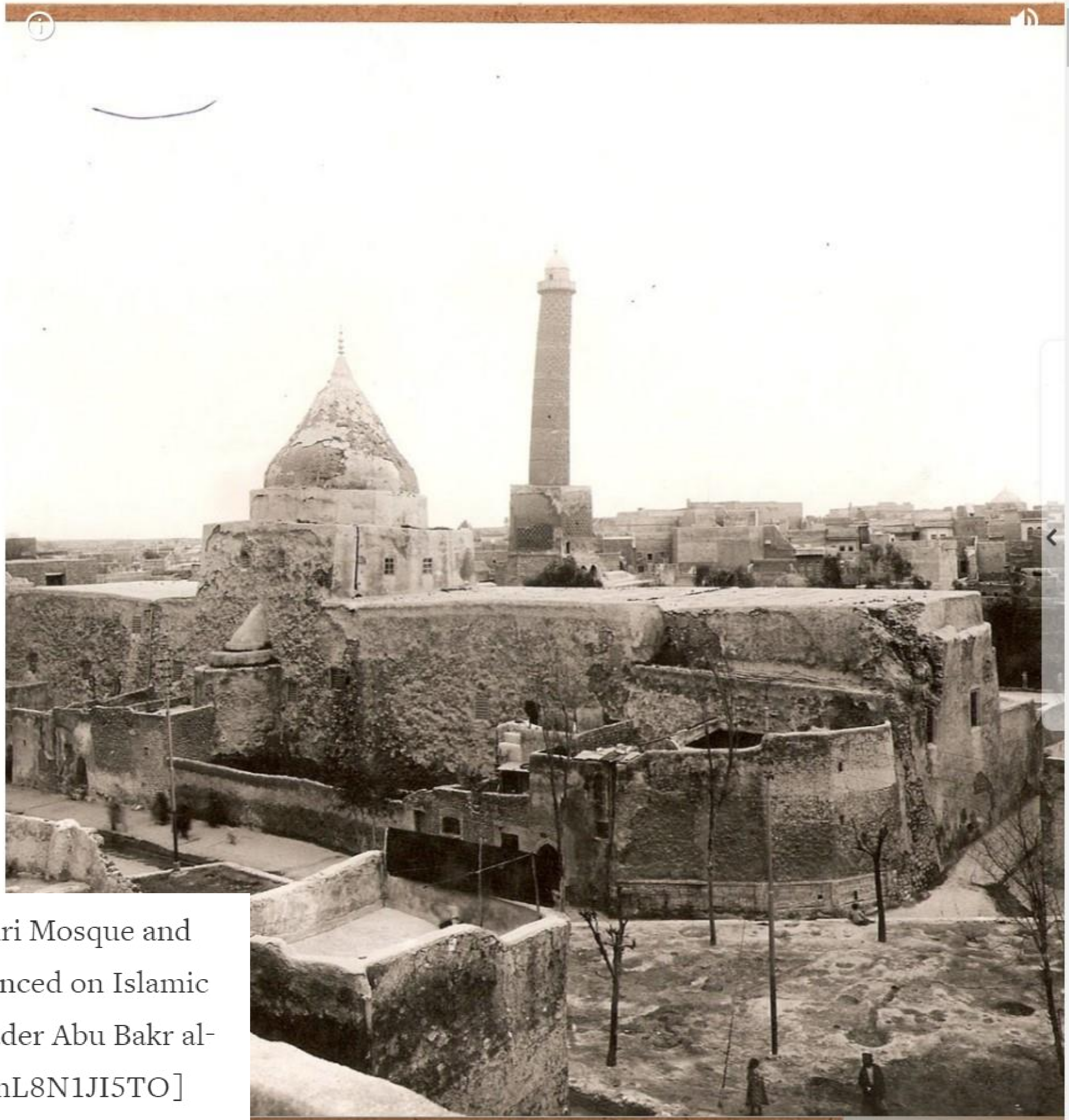
Testing Apparatus Continued

Deformation of Tie

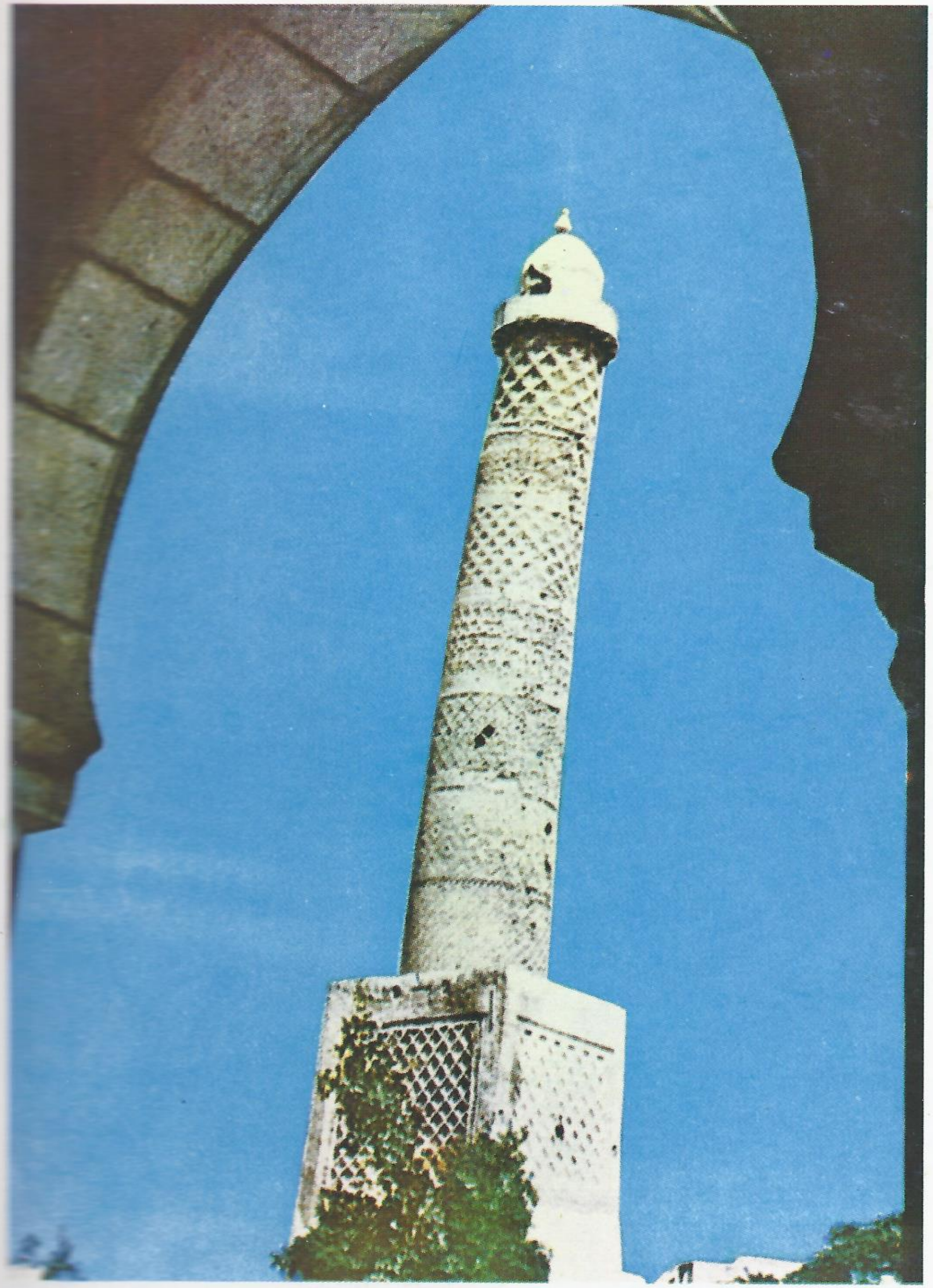
Deformation of tie:

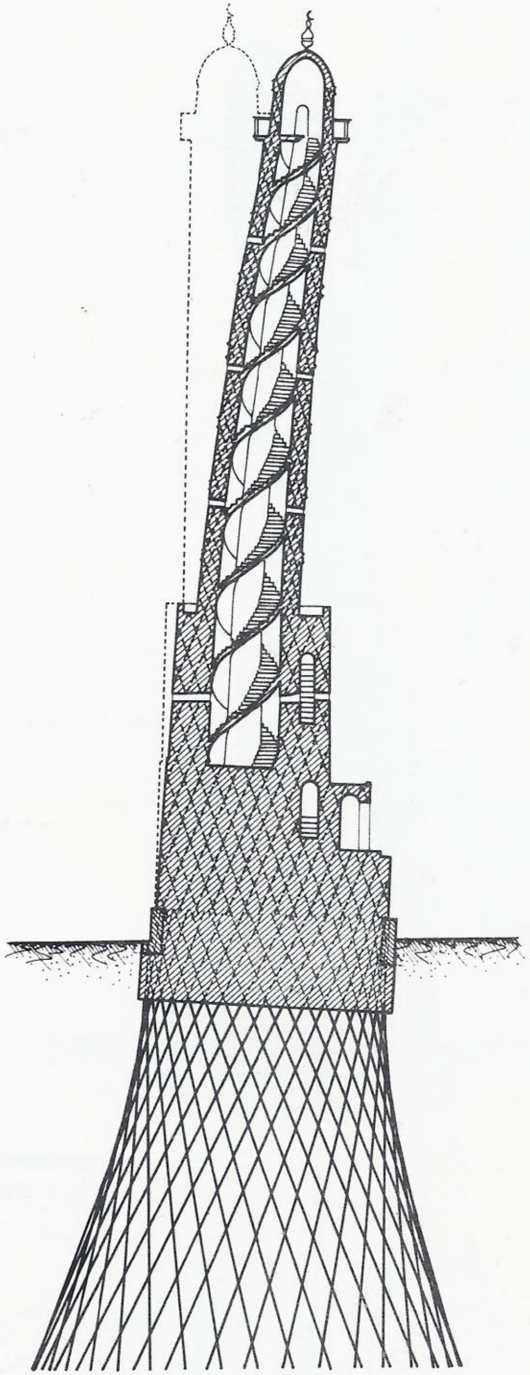
-Couplet still connected after failure.
-Implications for stability of structure

The strengthening of the Al-Hadba Minaret in Mosel, Iraq. XII century structure.



BAGHDAD (Reuters) - Here are key facts about Mosul's Grand al-Nuri Mosque and famous leaning minaret, blown up on Wednesday as Iraqi forces advanced on Islamic State's last stronghold. It was from this mosque that Islamic State leader Abu Bakr al-Baghdadi announced the creation of his "caliphate" on July 4, 2014.[nL8N1JI5TO]





ICA

ISIS forces had been shooting at the Minaret for weeks, thinking that they could destroy it with guns. Then they shot at it with bazookas. Still the structure stood firmly against the attacks. The attackers had no idea that the structure was reinforced by Lizzi. Finally, on June 21, 2017 massive amounts of explosives were placed inside of the tower.

al-Hadba' Minaret: A Beacon for 700 Years

By World Monuments Fund

The Reconstruction of Destroyed Historic Buildings in the Ukraine. Based on the Works of Dr. Fernando Lizzi.

List of damaged cultural sites during the Russian invasion of Ukraine

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From Wikipedia, the free encyclopedia

The **list of damaged cultural sites during the 2022 Russian invasion of Ukraine** is a list of cultural sites in Ukraine that have been verified by United Nations Educational, Scientific and Cultural Organization (UNESCO) as damaged and/or destroyed during the 2022 Russian invasion of Ukraine (that started on 24 February 2022).[1][2][3][4][5]

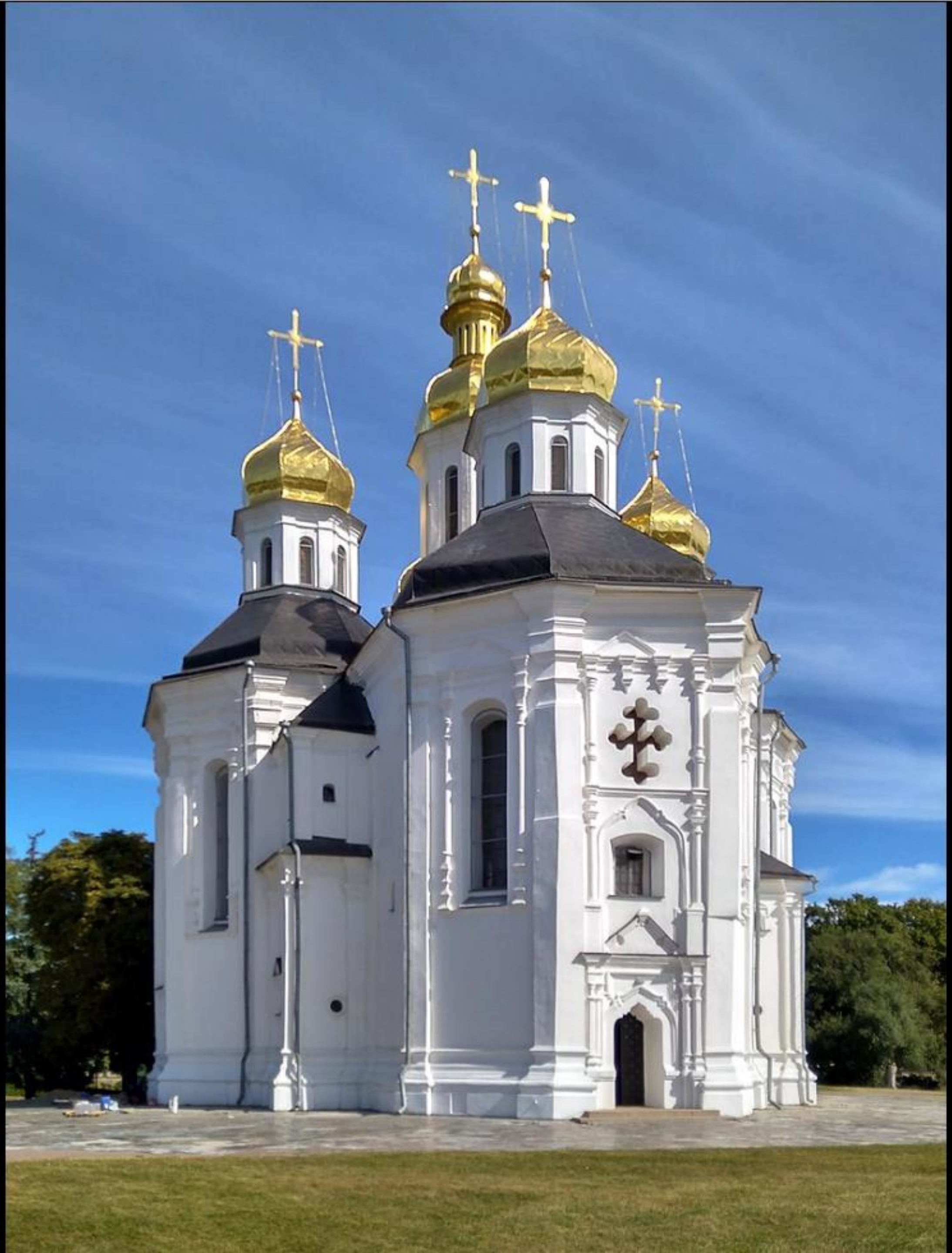
Both Ukraine and Russia have signed the Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict (the 1954 Hague Convention), which was drafted to safeguard cultural heritage during periods of armed conflicts. UNESCO is primarily responsible for the dissemination and monitoring of compliance.[6]

List [edit]

The list is current as of 29 August 2022 and based on information verified by UNESCO.[7]

This includes 183 sites in total:[7]

- 78 religious sites
- 13 museums
- 35 historic buildings
- 31 buildings dedicated to cultural activities
- 17 monuments
- 9 libraries



Saint Catherine’s Church in Chernihiv, Ukraine.
Church was dedicated in 1715.


Palace of Labor

Palace of Labor

49°59′20″ N 36°13′57″ E

Country	Ukraine
Town	Kharkiv
Type	building
Style	modern, neoclassicism[1]
Author of the project	Hippolyte Pretro
Construction	1914 —1916
Status	It is an architectural monument of local significance
State	partially destroyed

Palace of Labor (Ukraine)

Media files on Wikimedia Commons

Damaged Courtyard.