

From Rail Commuters to Autonomous Vehicles – Guastavino Vaulted Ceilings Have You Covered

TMS FALL MEETNG
DENVER COLORADO
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MICHIGAN CENTRAL STATION



Courtesy of the Burton Historical Collection, Detroit Public Library

- Dedicated January 4, 1914
- Michigan Central Railway
- Train Depot
- 18 Story office tower
- 2 mezzanine levels
- Top 3 levels never finished on the interior



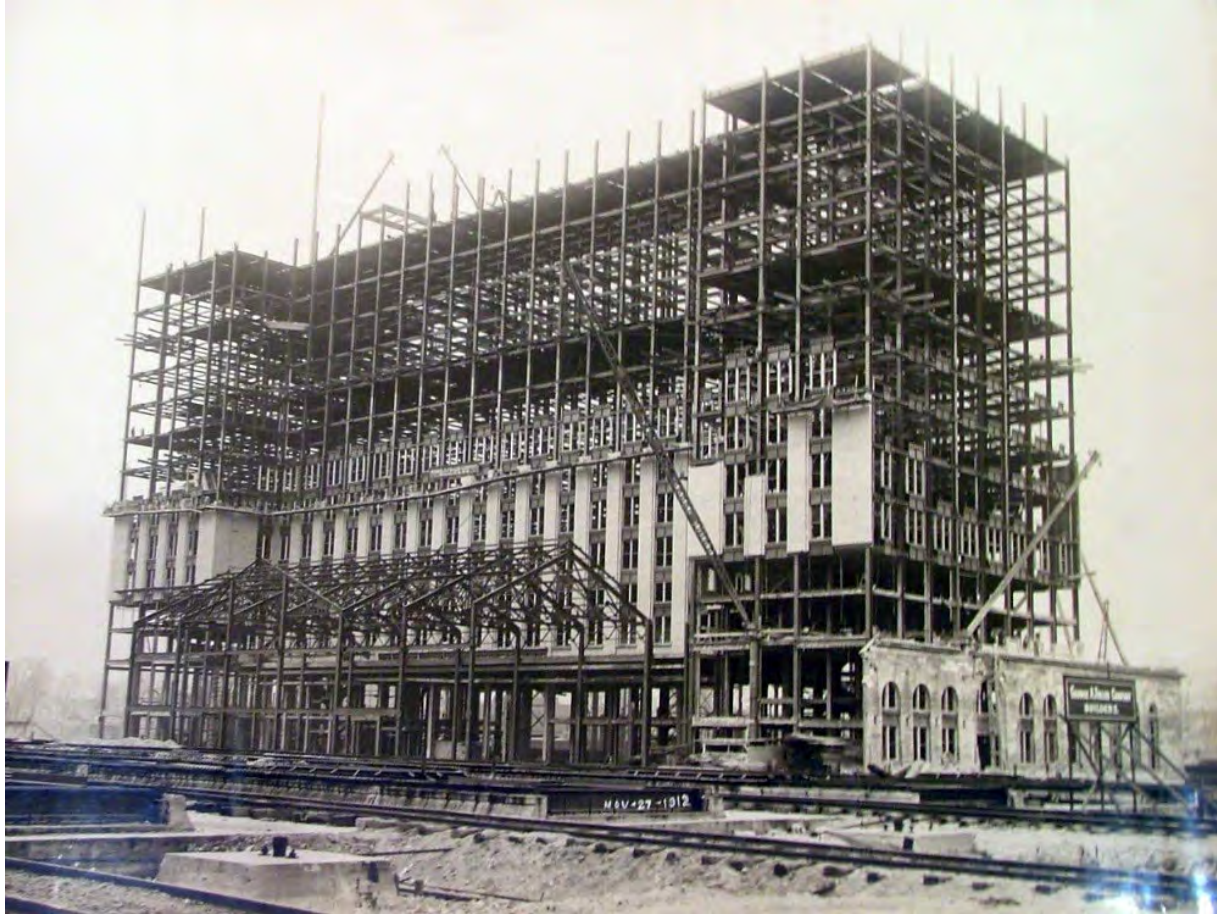


Photo by [Michelle & Chris Gerard](#)

- Beaux-Arts Classical
- Designed by Warren & Wetmore and Reed & Stem
- NY City and Grand Central Station



Transitional/Hybrid Building



- Steel frame
- Concrete backup
- Mass masonry/brick
- Masonry façade
- No shelf angles in brick

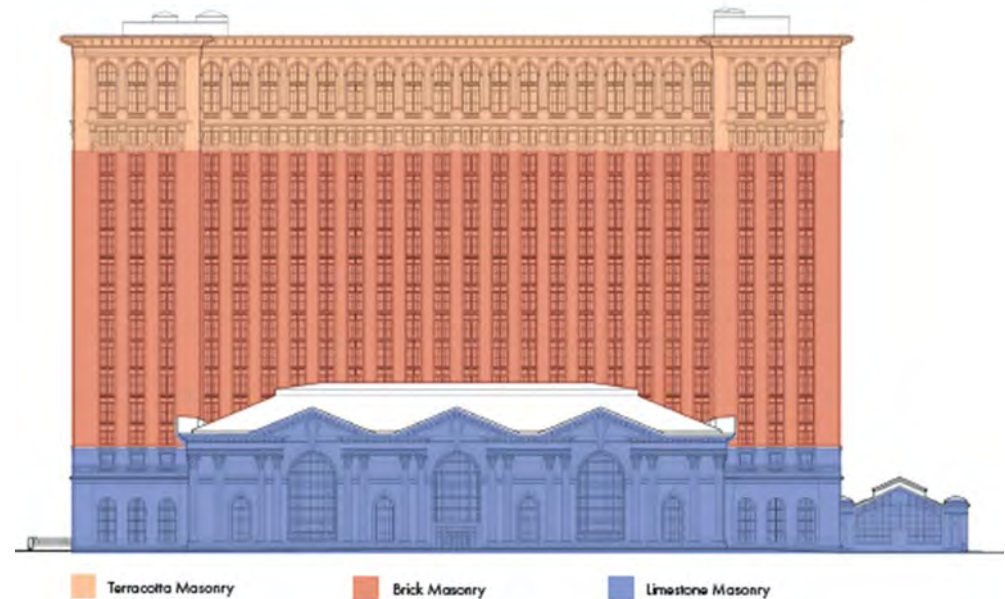
Michigan Central Station is erected in late 1912 or early 1913.
Avery Architectural and Fine Arts Library, Columbia University

Three Buildings/One Structure

- 18 Levels
- 640,000 SF
- Six-foot mat slab foundation
- Eight acres of exterior masonry
- Reinforced concrete podium
- Steel riveted
- Concrete encased
- Masonry bearing walls



Photo courtesy of the Christman Company-Ron Staley



Last Train Out-End of Rail Era



- Amtrak # 353
last train out
- January 5, 1988



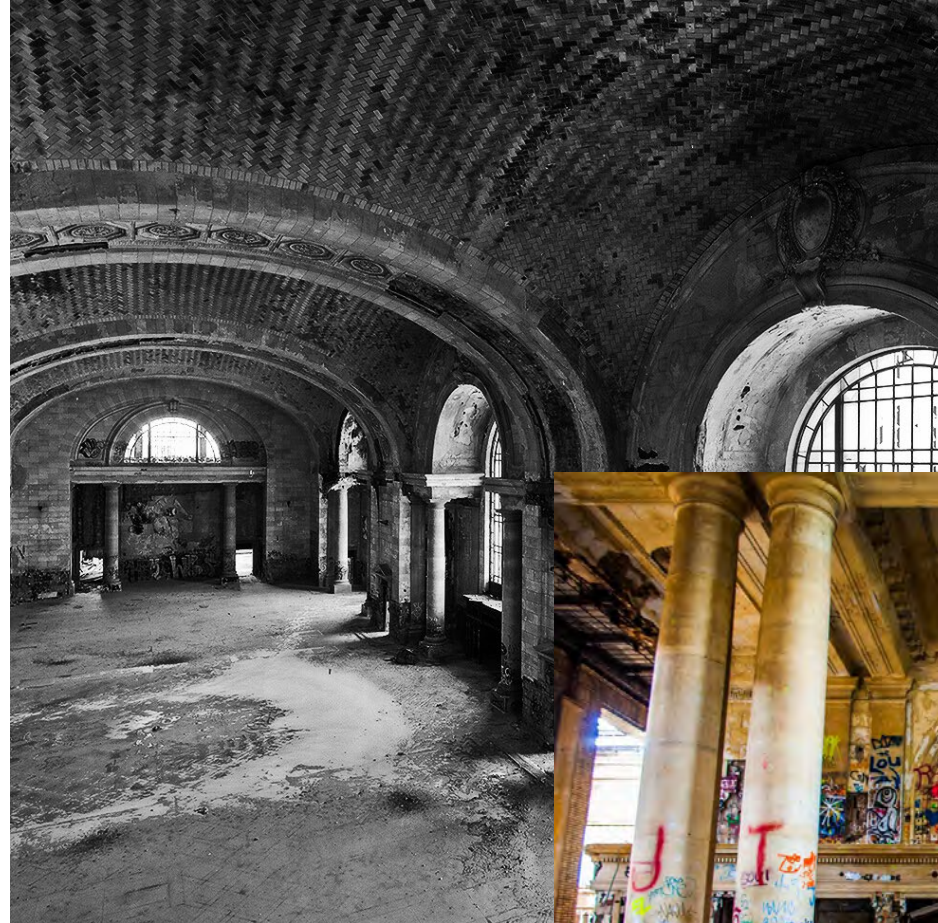
The last train from MC Station, Amtrak #353, on 05 January 1988 at Detroit, MI

©1988, 2015 Jeffrey Dobek

RRPictureArchives.NET Image Contributed by Jeffrey Dobek

MICHIGAN CENERAL STATION-SAVED

- Multiple owners
- 2009 City Council votes to demolish Michigan Central Station
- Election/budget constraints/lawsuit arguing for its historic merit prevail.



FORD MOTOR COMPANY



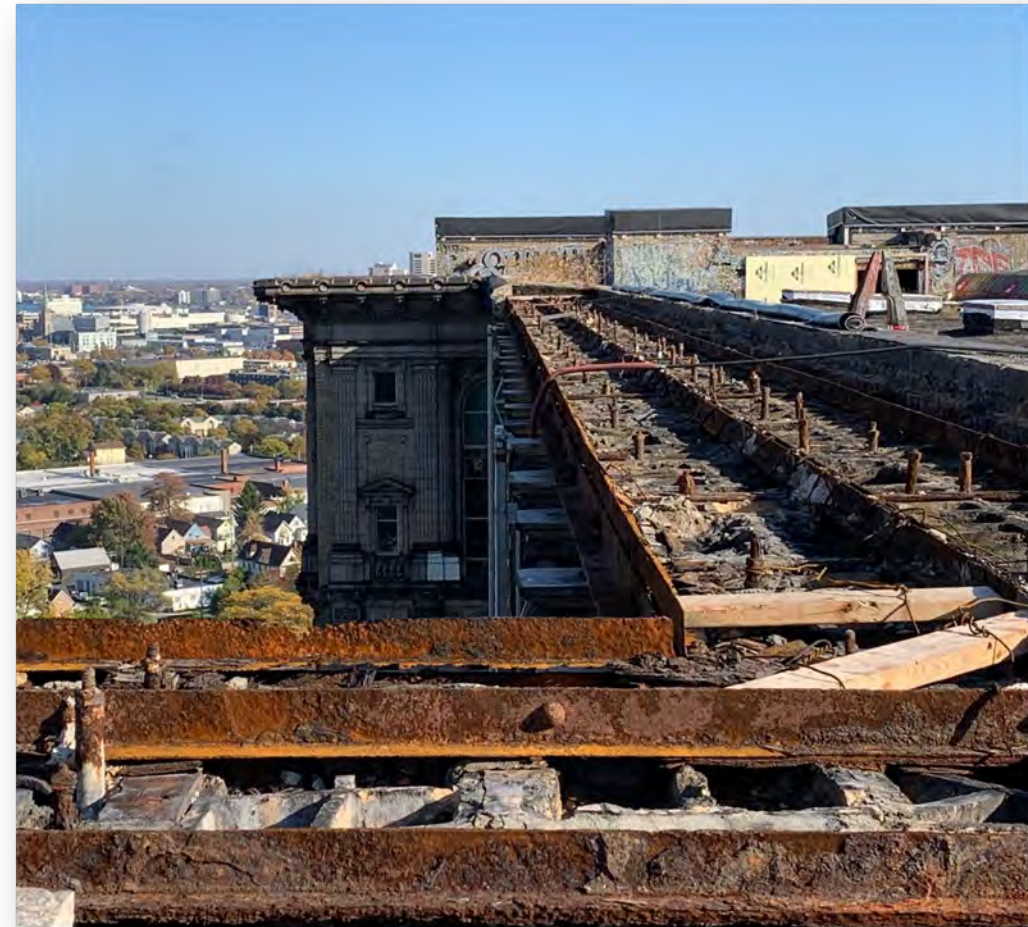
June 2018

Photo courtesy of the Christman Company-Ron Staley

2018

Ford purchases Michigan Central Station and announces plans to restore it as the centerpiece for a new hub for the future of mobility.

UNDER MAINTAINED



Moisture



The largest single factor to MCS's condition

Water removal

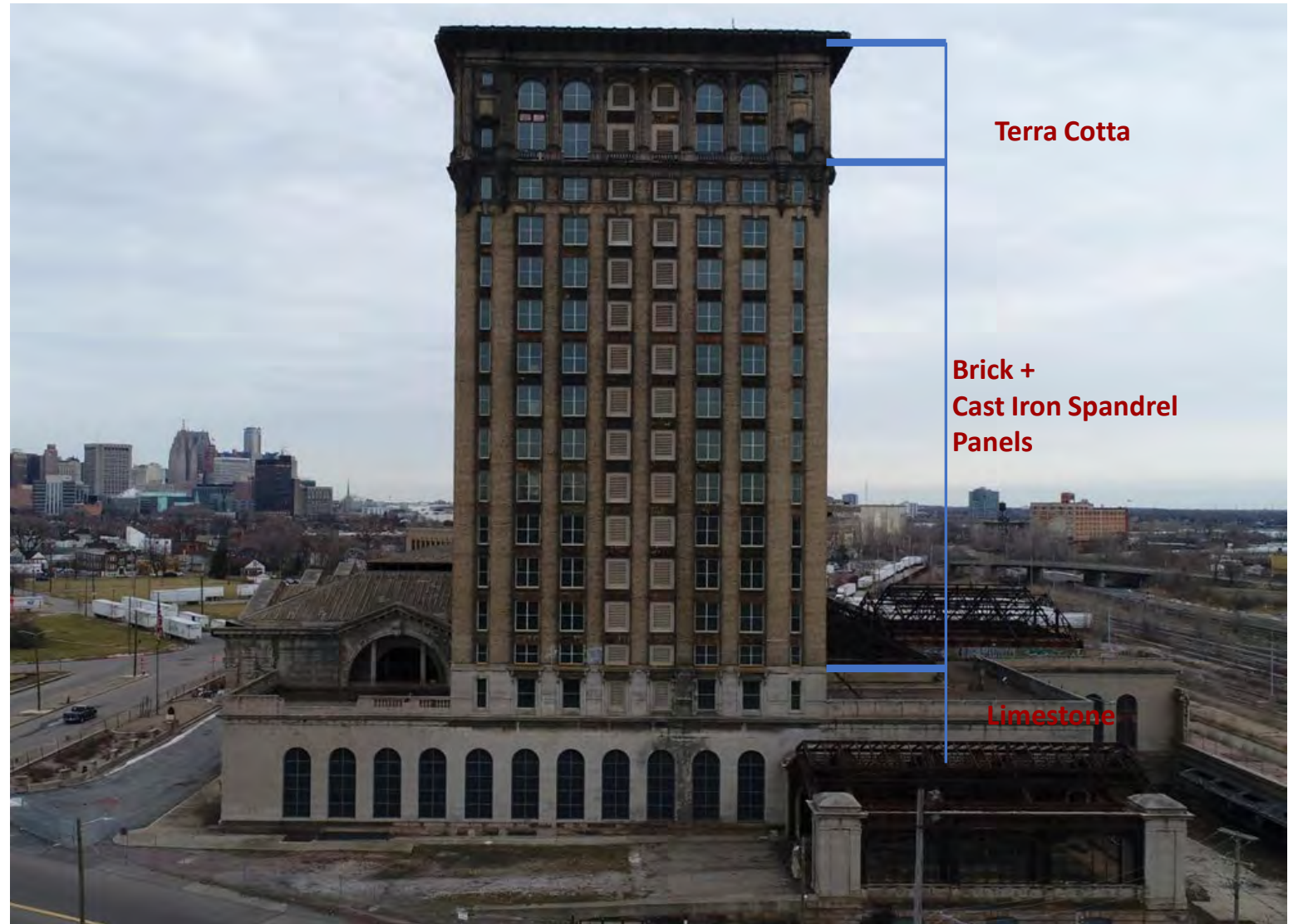


Five foot or more of standing water in lower level



MASONRY SCOPE

- Project Cost \$322M
- Masonry \$86M
- Not including tile or concrete work
- Masonry 27% of project



Terra Cotta-Glass fiber reinforced plastic

GFRP

- Severe damage
- Elements removed in 80's
- Terra Cotta replaced with GFRC
- Terra cotta lead times



EXTERIOR FAÇADE



- Stone support lintel repairs
- Pointing >1%
- 10,000 LN' of brick pointing
- Stone patching/replacement
- Terra Cotta repairs

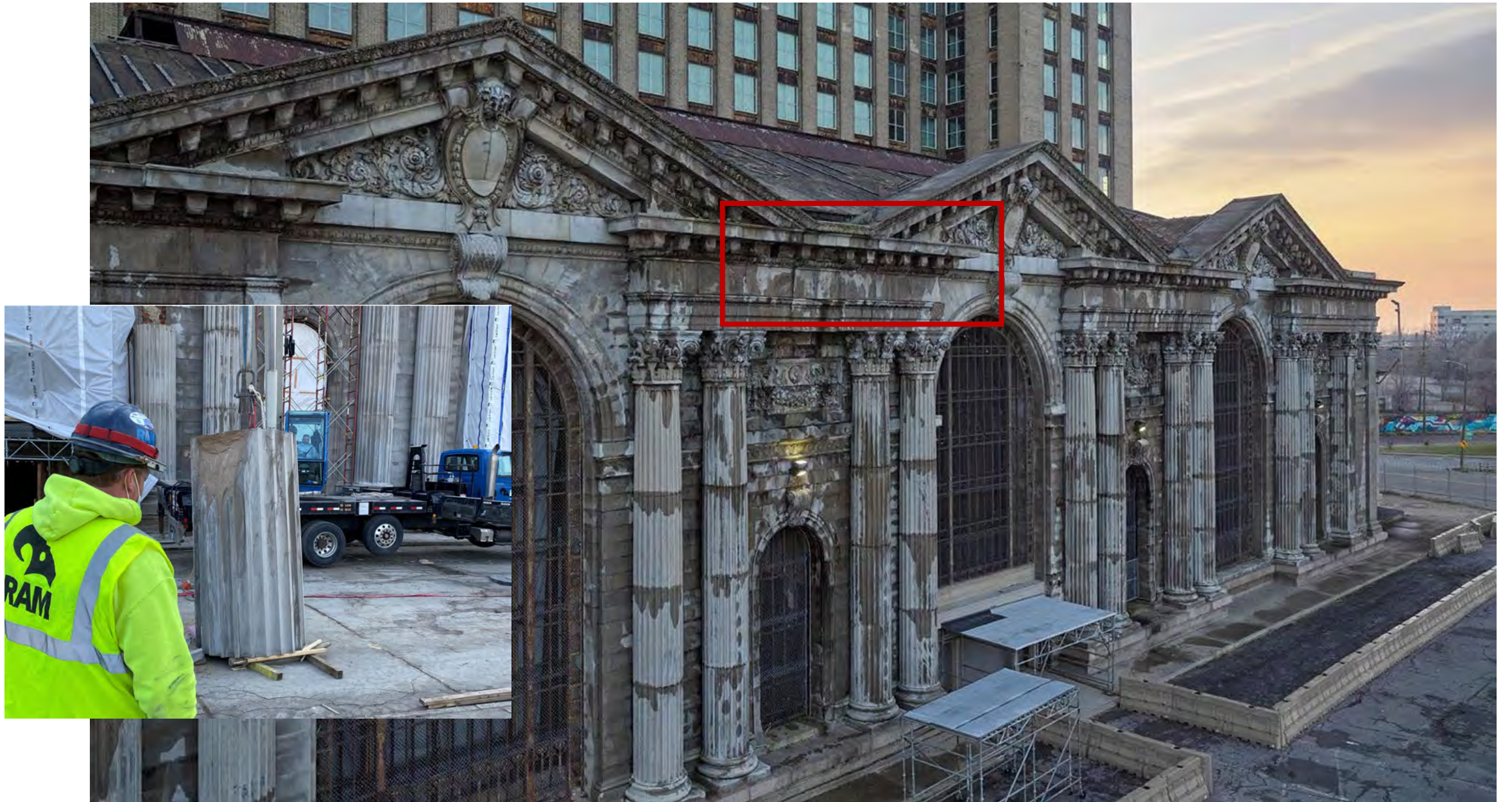


Photo courtesy of the Christman Company-Ron Staley

LIMESTONE REPAIRS

- Stone replacement
- Steel repairs and replacement

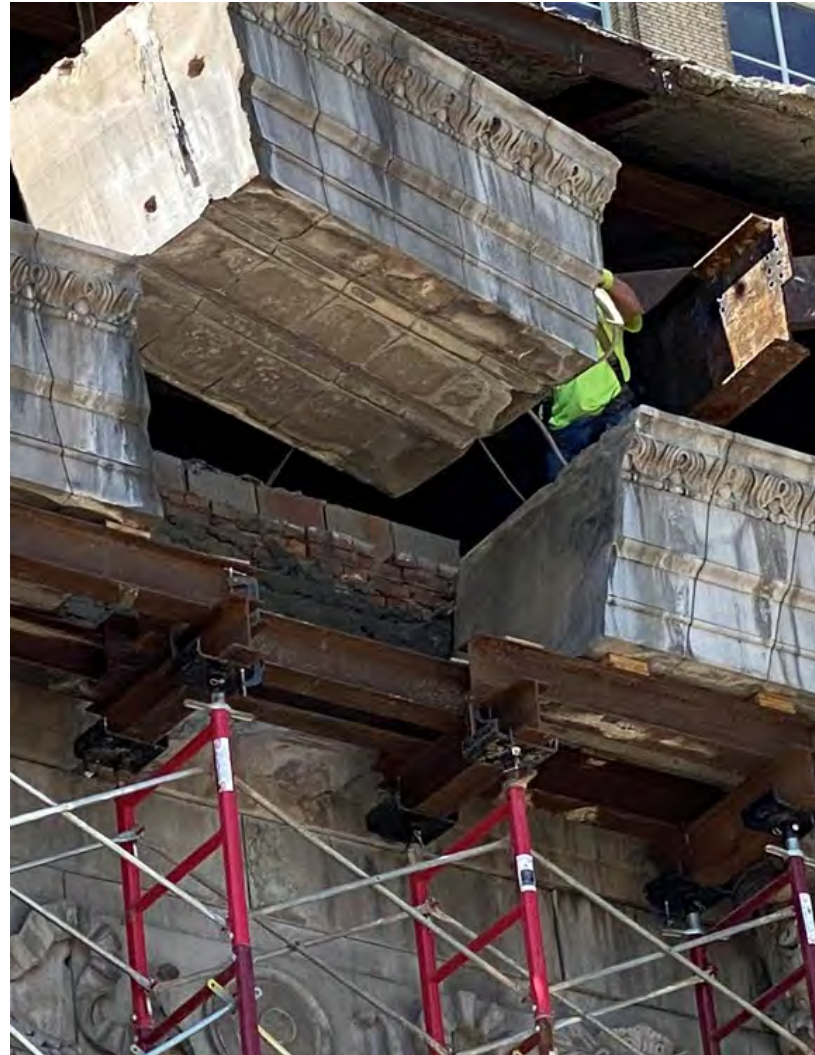


Photo courtesy of the RAM Construction Services

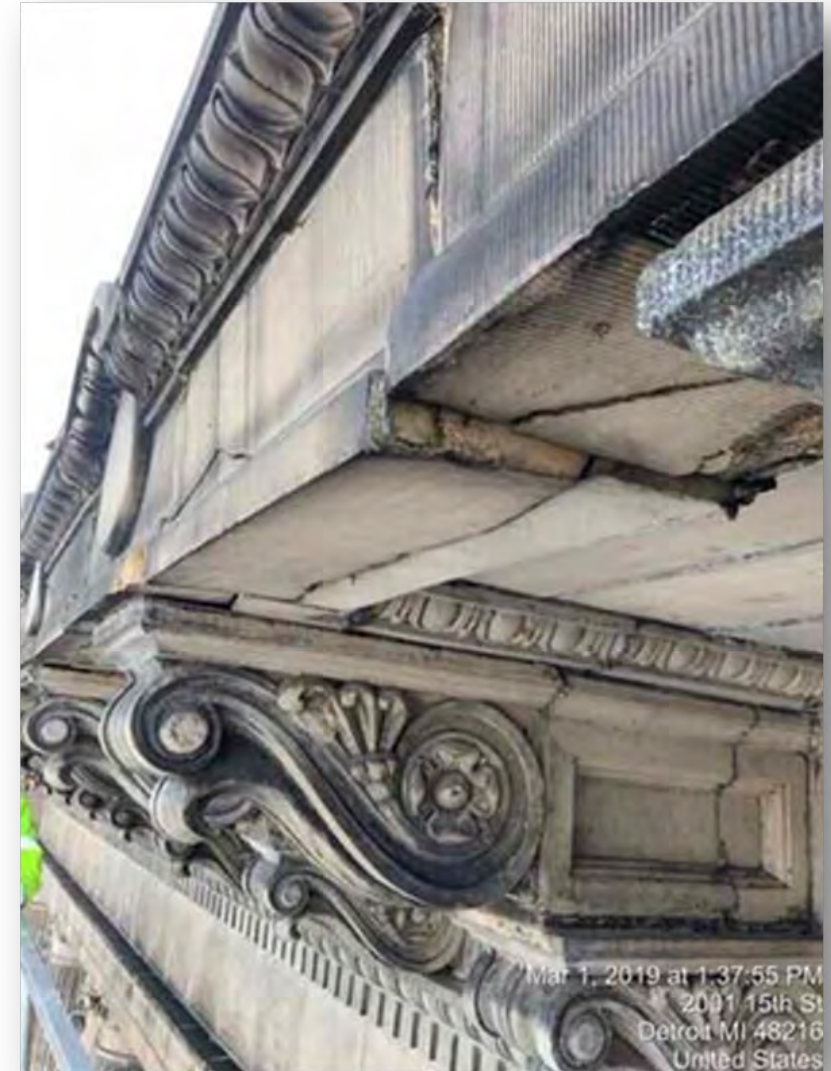


Photo courtesy of the Christman Company-Ron Staley

LIMESTONE REPAIRS



Photo courtesy of IMI-Tom Elliott

LIMESTONE REPAIRS



Photo courtesy of the Christman Company-Ron Staley



- Dark Hollow Quarry
- Lawrence Indiana
- 80 miles south of Indianapolis
- 360 miles MCS

<https://digitalcollections.detroitpubliclibrary.org/>



Dark Hollow Quarry-S/Indiana



Photo courtesy of the Christman Company-Ron Staley



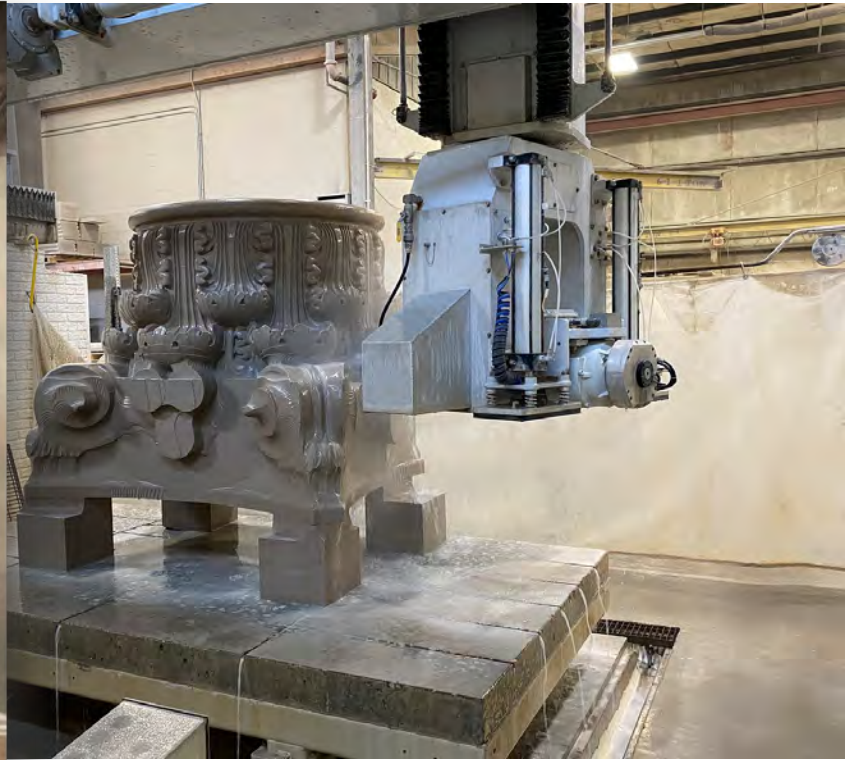
300 New stones salvaged from the forest



8,000 cubic feet
or a 4'x4' block 500 feet long!

Photo courtesy of the Christman Company-Ron Staley





One single 7-ton block of stone – 440 craftsman-hours

Photo courtesy of the Christman Company-Ron Staley

INTERIOR RESTORATION



Courtesy of the Burton Historical Collection, Detroit Public Library

INTERIOR RESTORATION

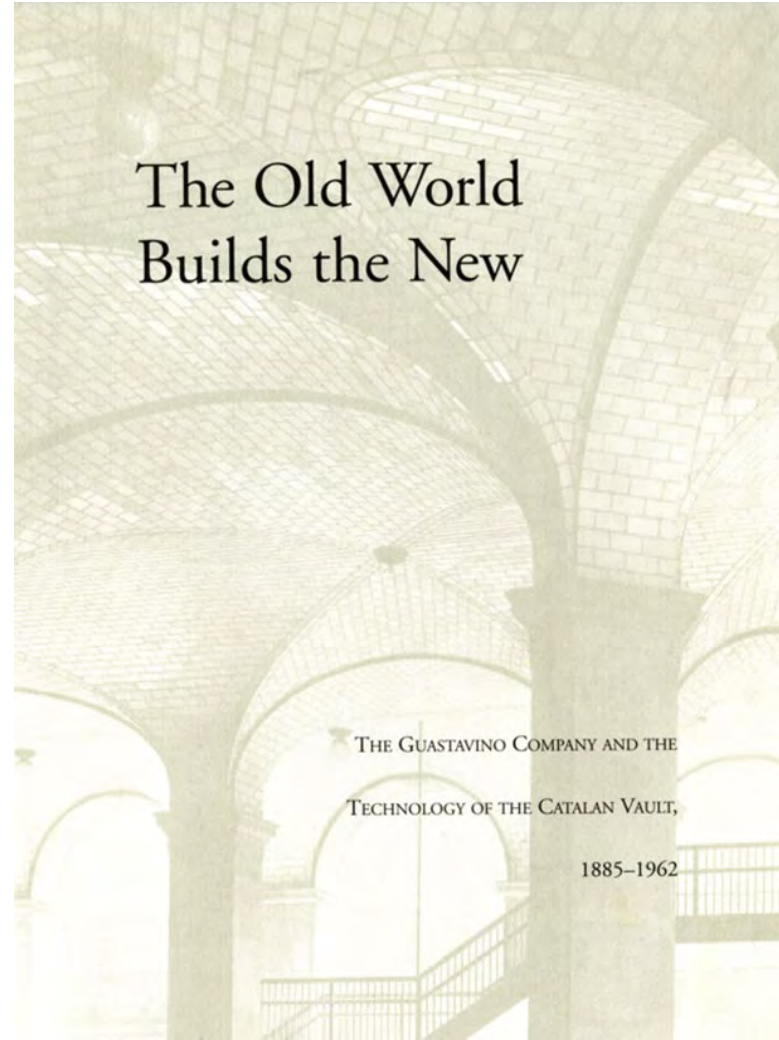


Photo courtesy of the Christman Company-Ron Staley



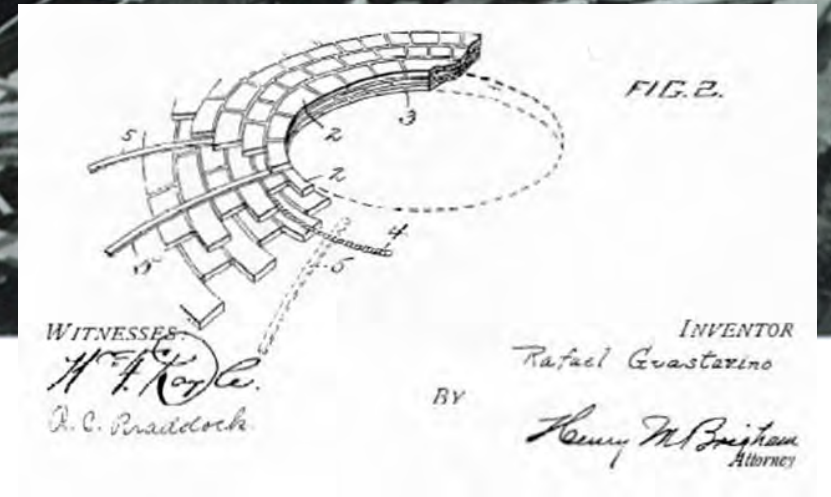
Photo courtesy of IMI-Tom Elliott

RAFAEL GUASTAVINO



Guastavino Fireproof Construction Company

- Rafael Guastavino –Spanish engineer
- Immigrated to US in 1881
- Created Guastavino tile
- Patented tile arch system in 1885
- Major buildings across the US



MCS WAITING ROOM

- Main floor waiting room modeled after ancient roman bathhouse
- Vaulted ceilings
- Guastavino tile



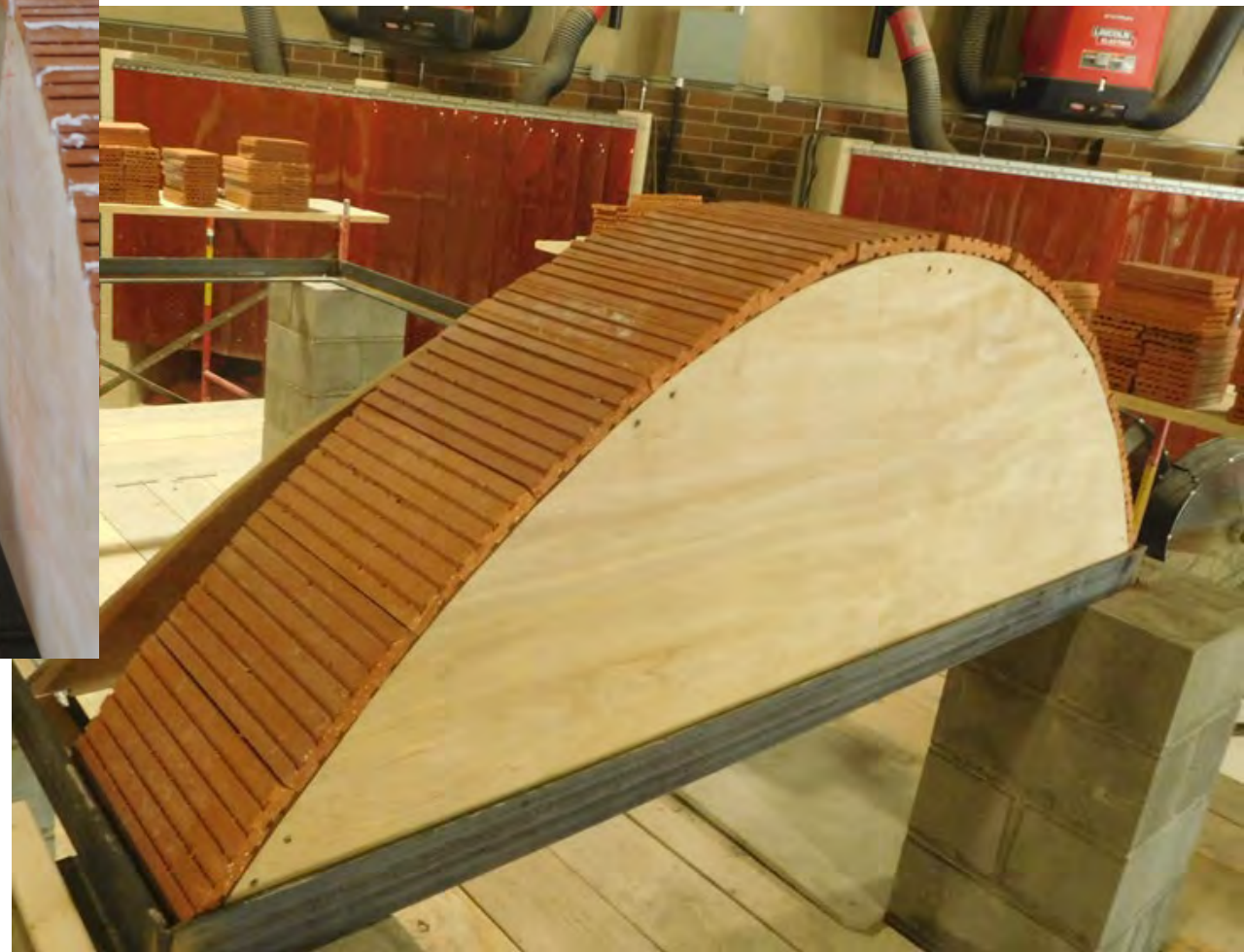
Guastavino=Catalan vault or timbrel vault

- Type of low brickwork arch supporting a ceiling/roof
- Constructed by laying a first layer of light bricks lengthwise "in space"
- Much gentler curve than most other methods of construction.



GUASTAVNO VAULT

- Without formwork
- "Tile Arch System" in 1885
- Robust self-supporting arches
- Interlocking terracotta tiles/mortar
- 11.5" X 6-3/8" X 5/8"



TOP SIDE REPAIRS



BOTTOM SIDE REPAIRS



Guastavino vaulted ceiling waiting room



- Undermaintained
- Loose tiles
- Missing mortar
- No structural damage to the expose bottom side



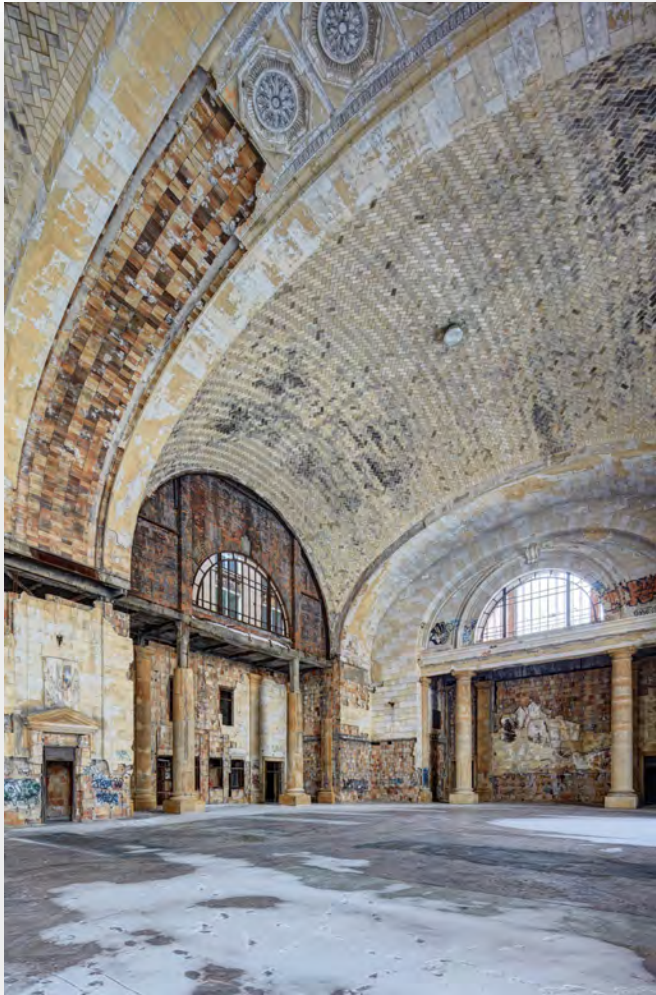
Guastavino vaulted ceiling repair plan

- Creative partnership with mason contractors
- Pre-order/purchase tiles
- Sound testing of entire ceiling
- Mortar analysis
- One change order for scope- a credit!

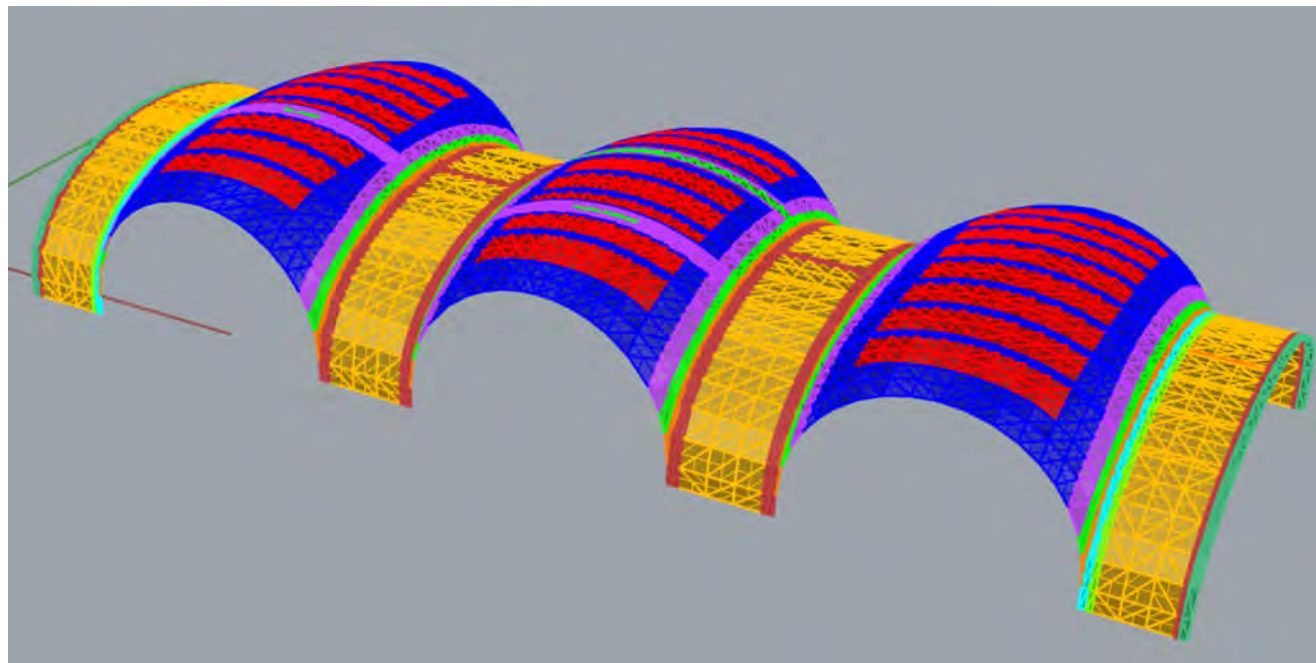
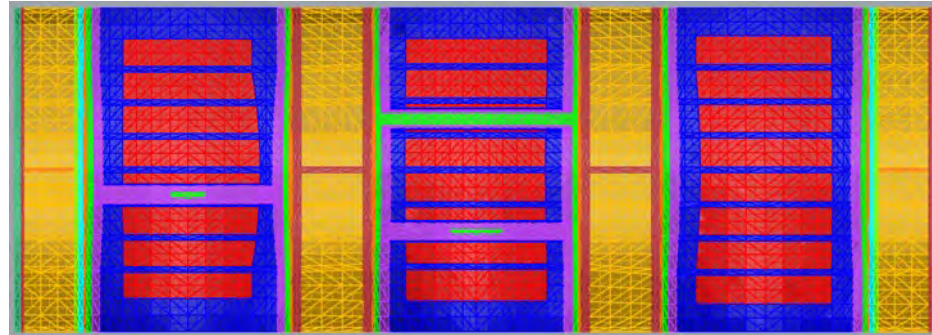


GUASTAVINO DOME ICE PACKS

- “Perma frost” found on top side of ceiling
- Severe in lower areas
- Melting ice well after May
- Areas with several feet of ice
- Extreme damage to steel



STRUCTURAL ANALYSIS OF WAITING ROOM

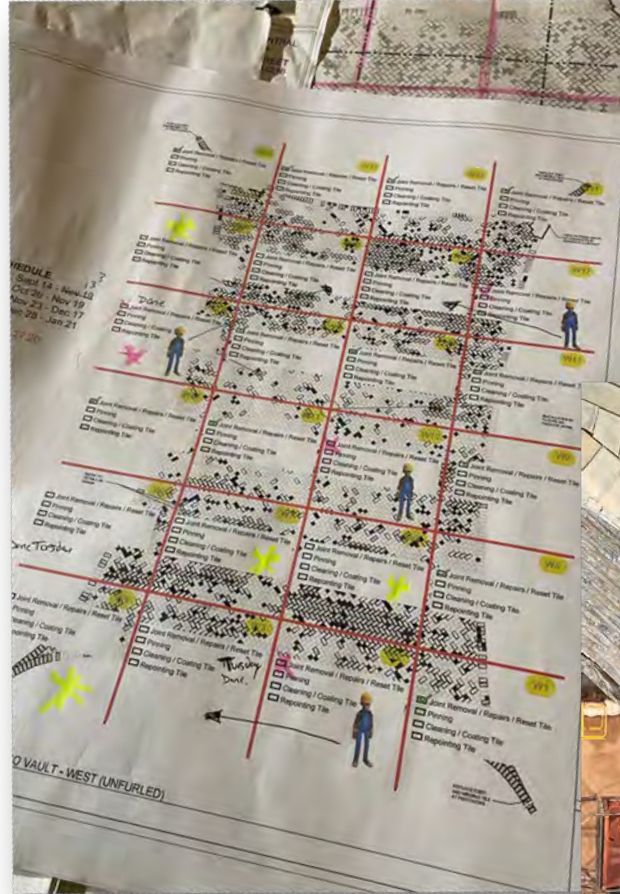


- 3 layers
- 4 layers
- 5 layers
- 6 layers
- 7 layers
- 4 layers w plaster
- 6 layers w plaster
- 7 layers w plaster
- 9 layers w plaster
- 10 layers w plaster
- 11 layers w plaster
- 16 layers w plaster



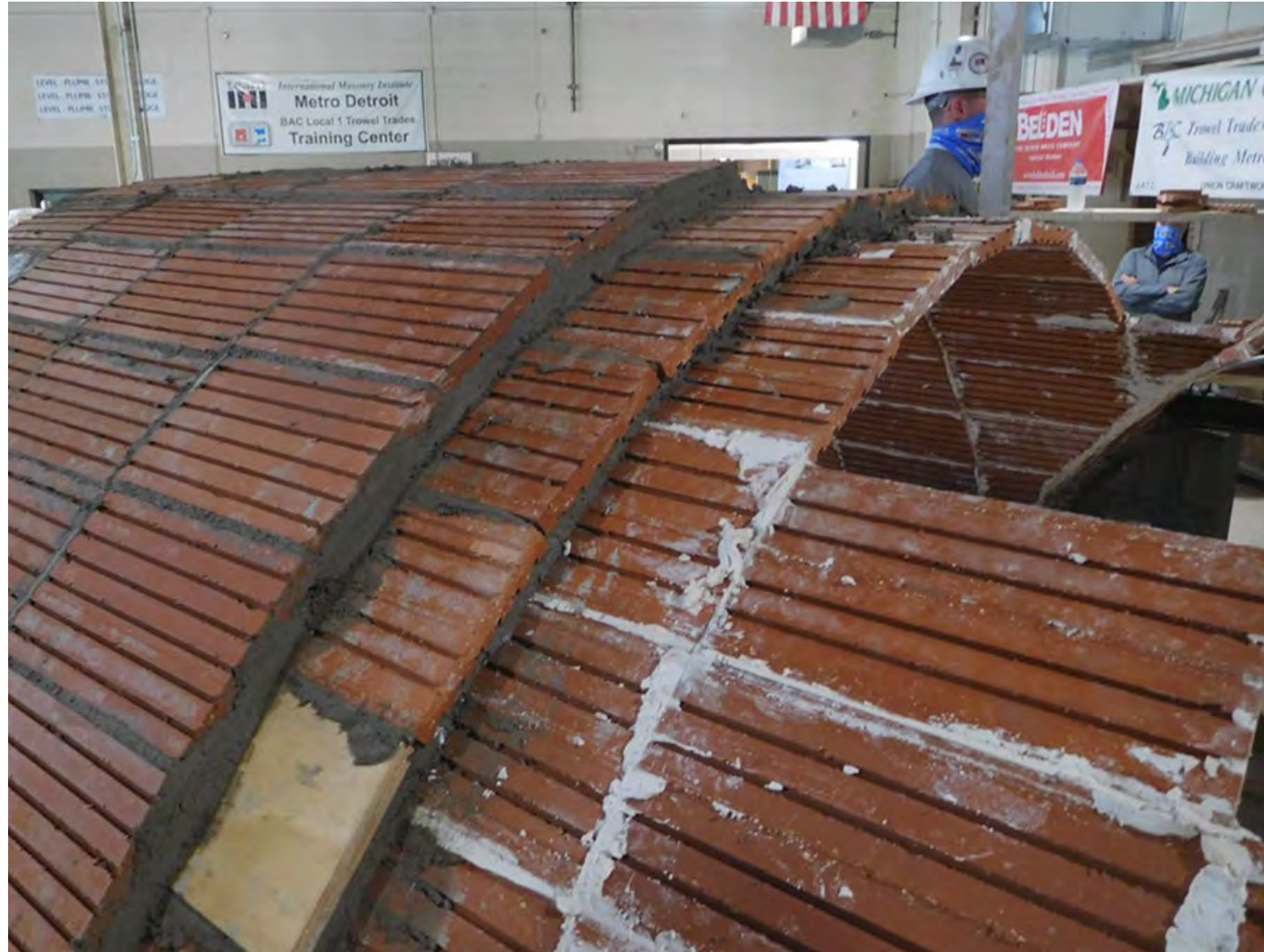
STRUCTURAL ANALYSIS OF WAITING ROOM

- Joint Removal/Repairs/Reset Tile
- Cleaning/Coating Tile
- Pinning
- Repointing Tile



GUASTAVINO MOCK-UP

- BAC Local #2
Warren MI
- Consultant-Vertical
Access
- Two-day session
w/craftworkers &
contractors
- Built in failed tiles



GUASTAVINO MOCK-UP

- Hands on training for craftworkers
- Educational sessions
- Design/Construction team
- Ford Motor Company



GUASTAVINO TRAINING



Photo courtesy of the IMI

GUASTAVINO TRAINING

- Five layers of tile
- Cutting units
- Repair areas of defective tiles
- Repair strategies



TOP SIDE REPAIRS



Photo courtesy of Lidel & Hart

- 7-layers
- Pointing
- Tile replacement
- Pinning
- Structure of the ceiling

EXTENSIVE AREAS OF REPAIRS

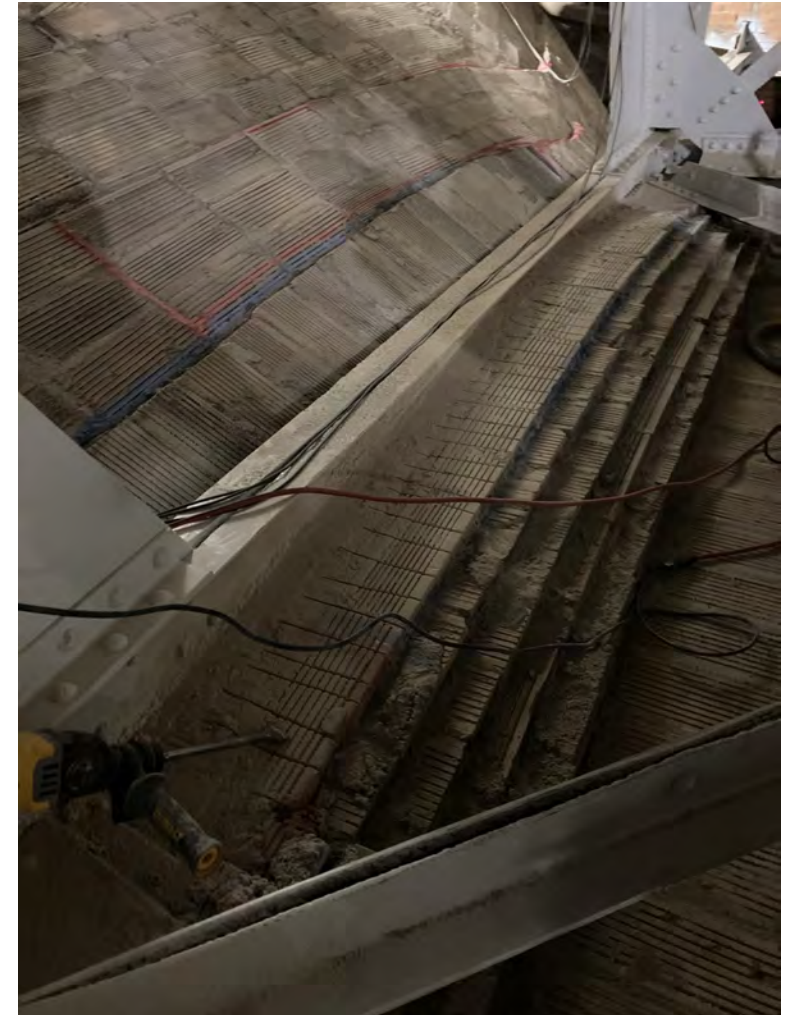


Photo courtesy of Lidel & Hart-Mike Hipes

GUASTAVINO VAULT-PINNING

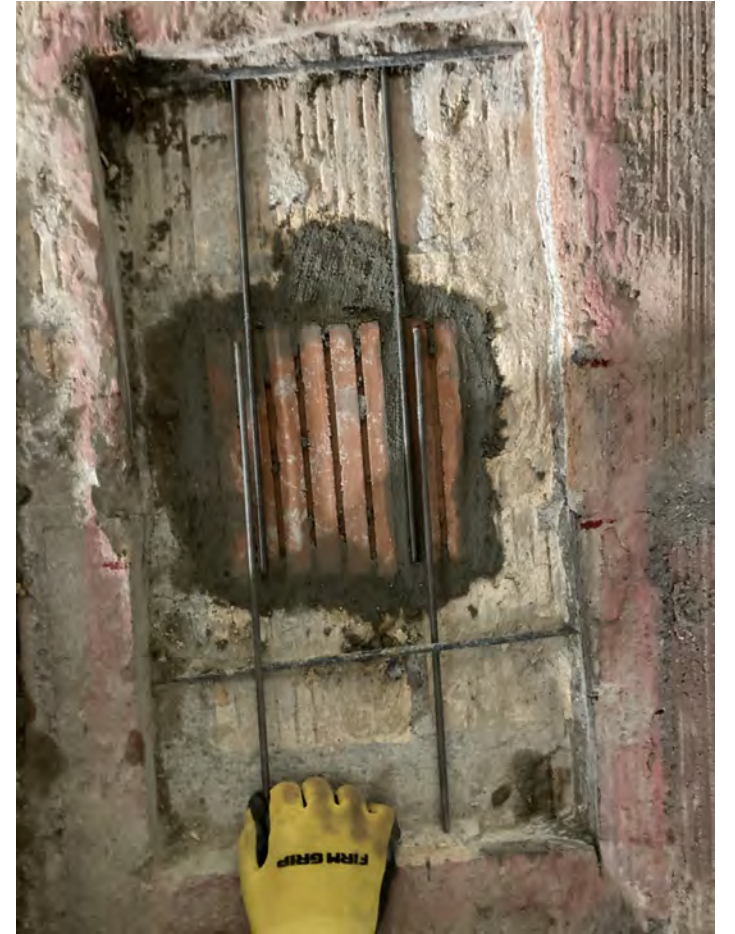


Photo courtesy of Lidel & Hart-Mike Hipes

GUASTAVINO VAULT



TOP SIDE REPAIRS

- Deteriorated tiles
- Steel exposed
- Prepped for painting crews



BOTTOM SIDE REPAIRS



Photo courtesy of IMI-Tom Elliott

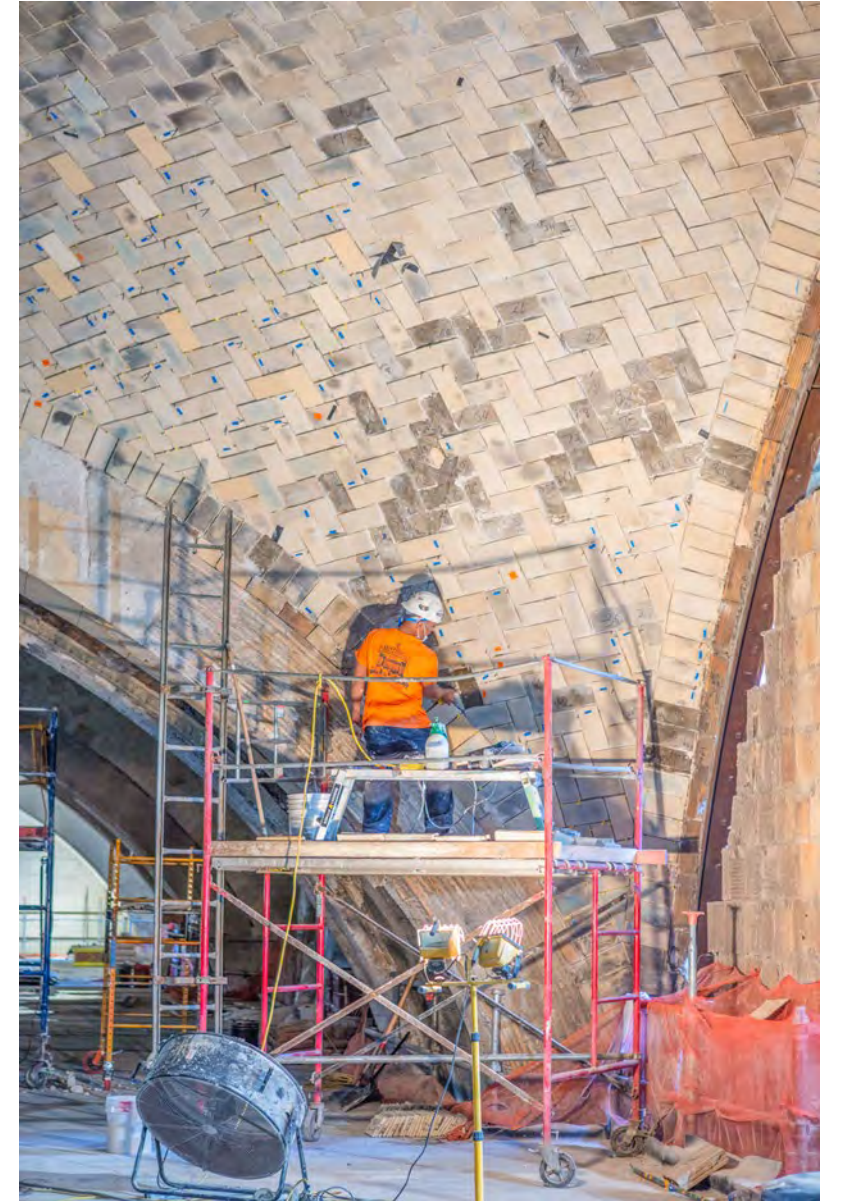


Photo courtesy of Grunwell-Cashero-Jelane Raycraft

BOTTOM SIDE REPAIRS

- Joint venture
- Two Mason contractors worked together
- 29,000 face tile cleaned and restored



- 45,000 l.f. or 8.5 miles of pointing
- 100% mortar replacement
- Finished with a beaded joint



Michigan Central Station Guastavino Tile Mortar Recipe

White Portland Cement Type I	Pigment	Hydrated Lime Type S	Aggregate	Aggregate
Federal White Portland Cement Type I	Kremer Iron Oxide yellow Pigment	Carmeuse Miracle Morta-Lok Masons	Quikrete Fine Sand	Quikrete Play Sand
2 cups	2 Tablespoons	4 cups	3 cups	3 cups

Photo courtesy of Grunwell-Cashero-Jelane Raycraft

BOTTOM SIDE REPAIRS

- Replace tile
- Pinning of tiles
- Repoint
- Staining of tiles



- Work overhead
- Multiple crews
- Rolling Scaffolding
- Allowed other work to occur simultaneously



Photo courtesy of Grunwell-Cashero-Jelane Raycraft



Photo courtesy of Grunwell-Cashero-Jelane Raycraft





Photo courtesy of Grunwell-Cashero-Jelane Raycraft



Photo courtesy of IMI-Tom Elliott

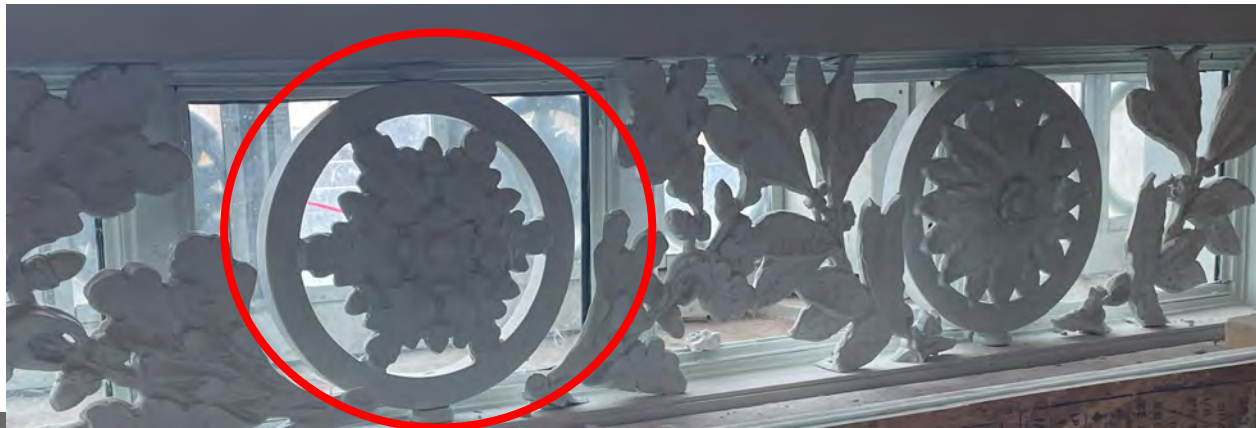
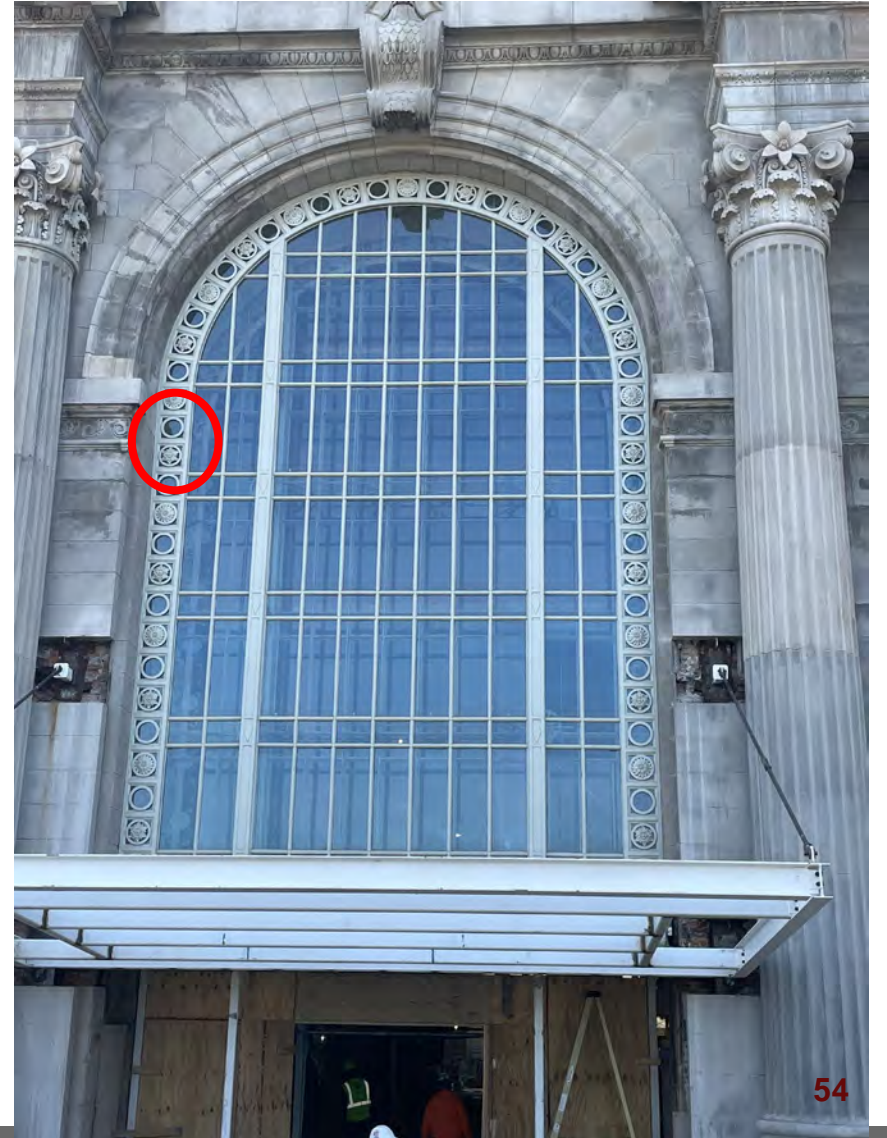
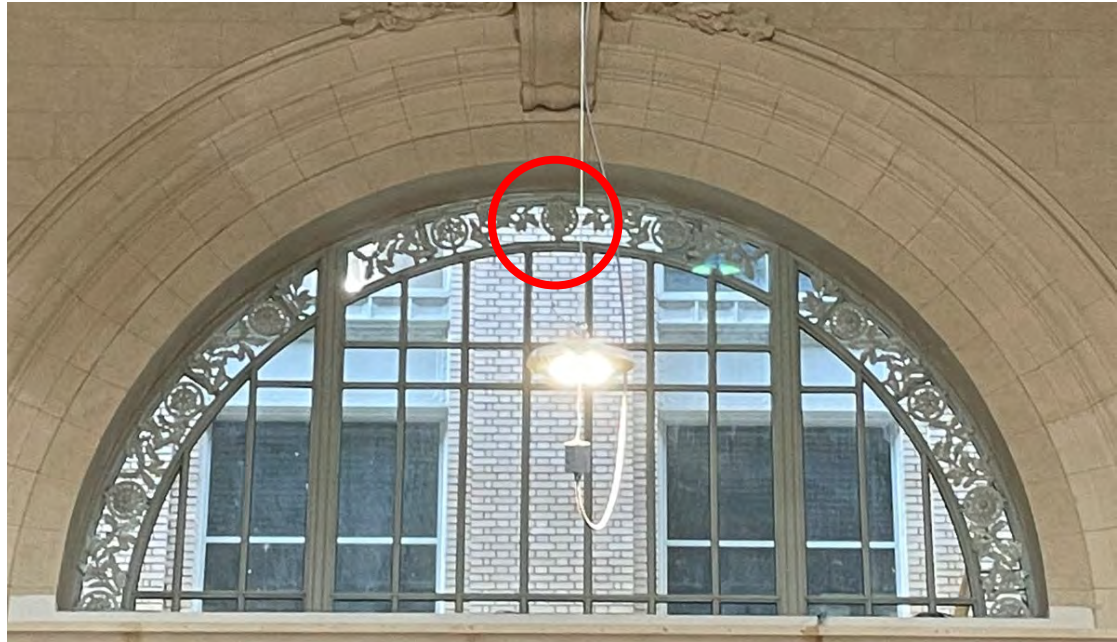
INTERIOR MASONRY REPAIRS



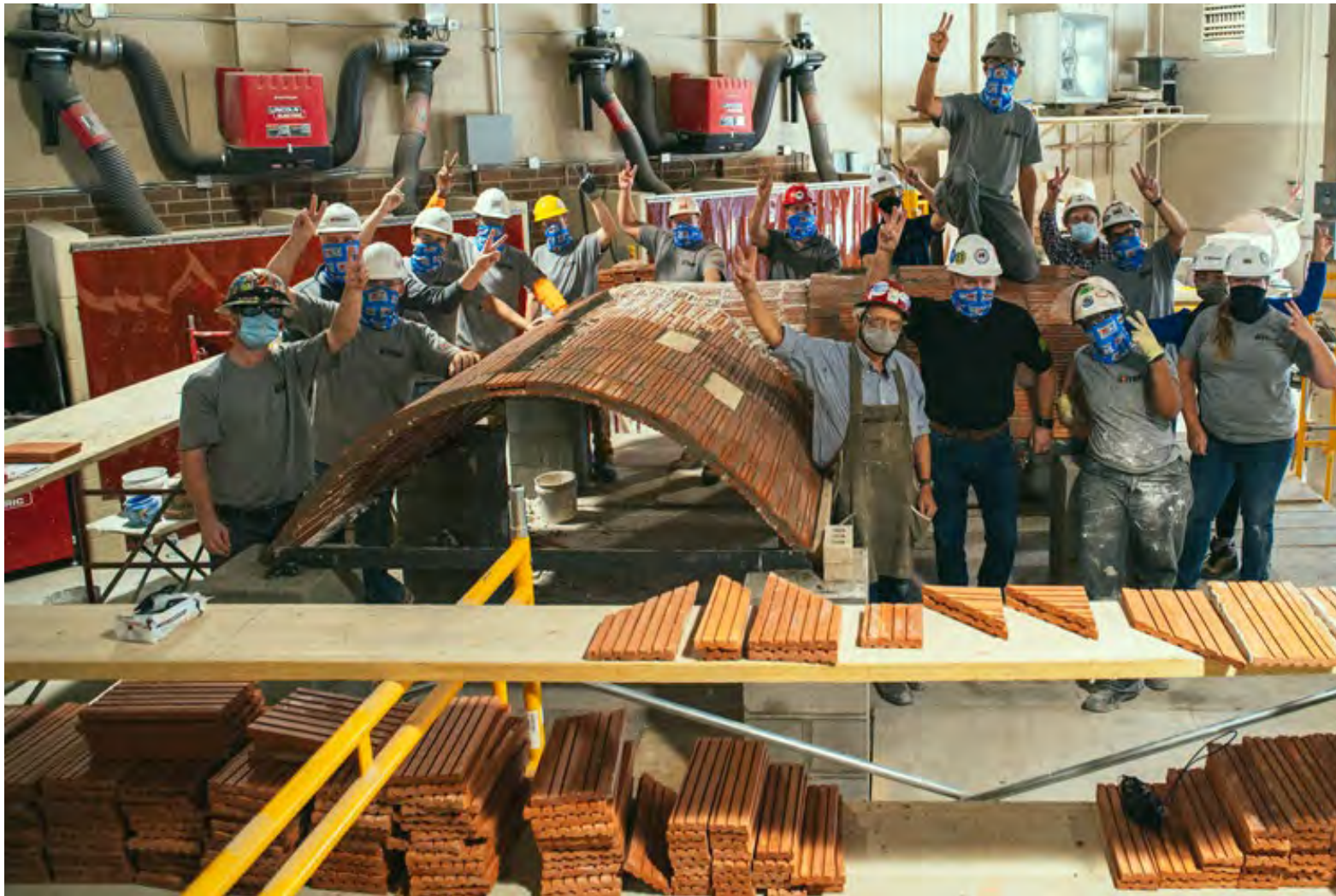
Plaster repairs



NEW WORLD MEETS OLD-3D PRINTING



QUESTIONS?



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