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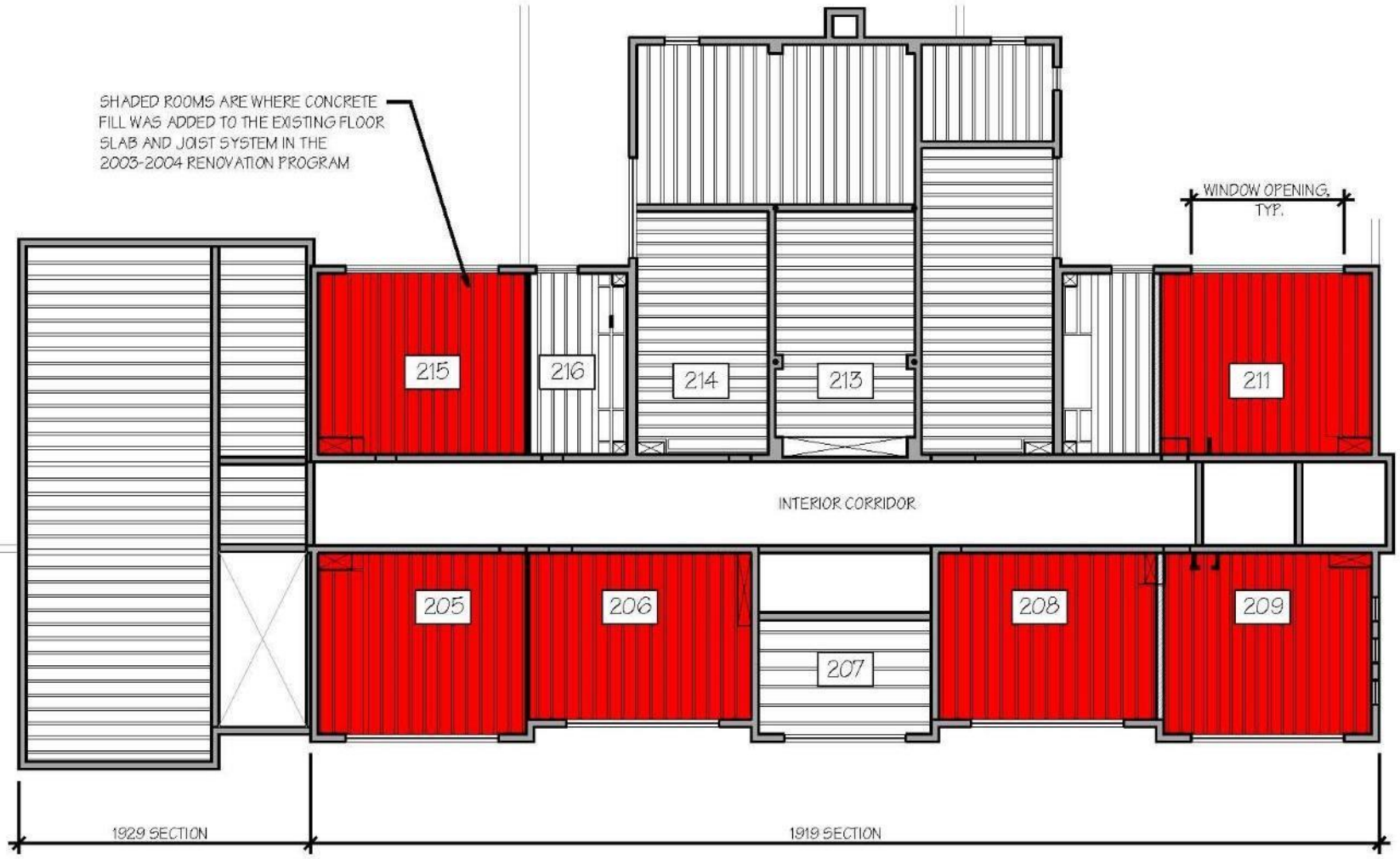
Complex and Innovative Structural Repair of Severely Damaged, 1917 era School Structures

A comprehensive renovation of two existing, 1917-era concrete-framed, historic school buildings in a Midwestern city resulted in serious structural problems.

The structural problems were severe enough to require evacuation and complete closure of one of the buildings, and portions of the other, until comprehensive structural repairs could be made.

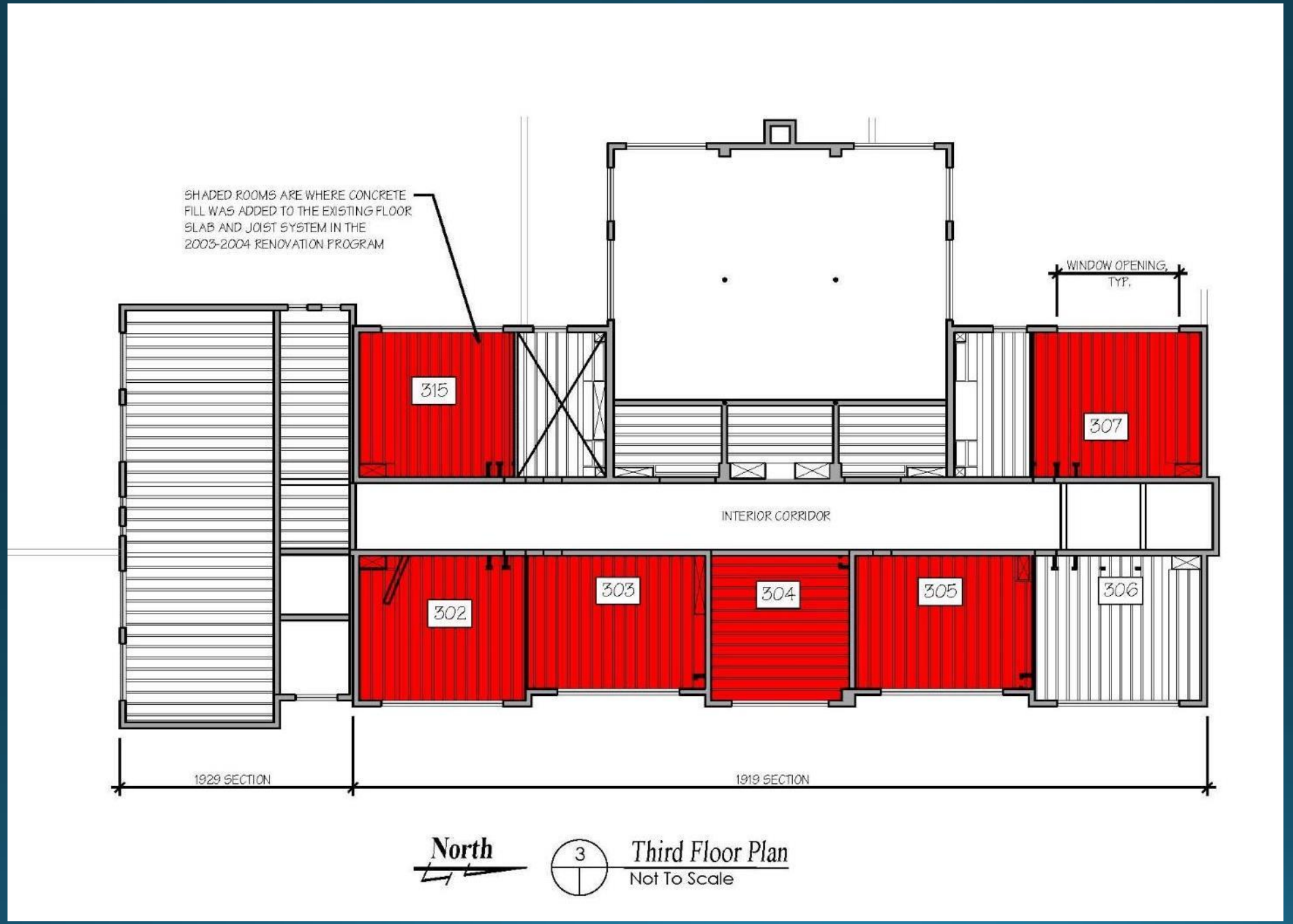
Existing long span, one-way, concrete pan joist floor systems were severely overloaded, and cracked extensively as a result.



North

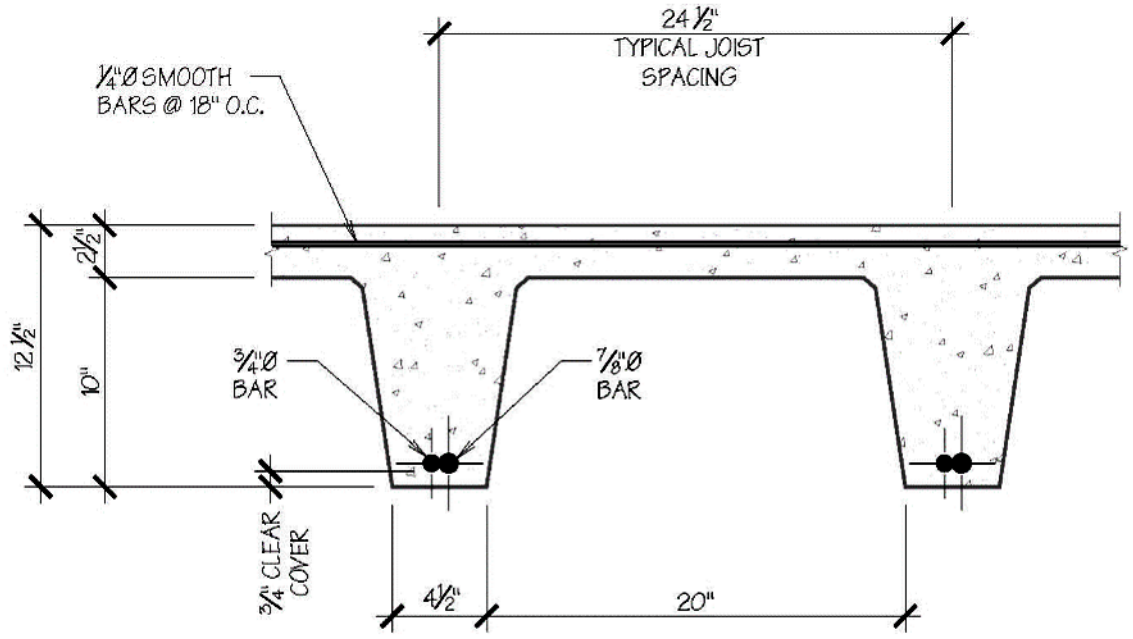
2 Second Floor Structural Framing Plan

Not To Scale

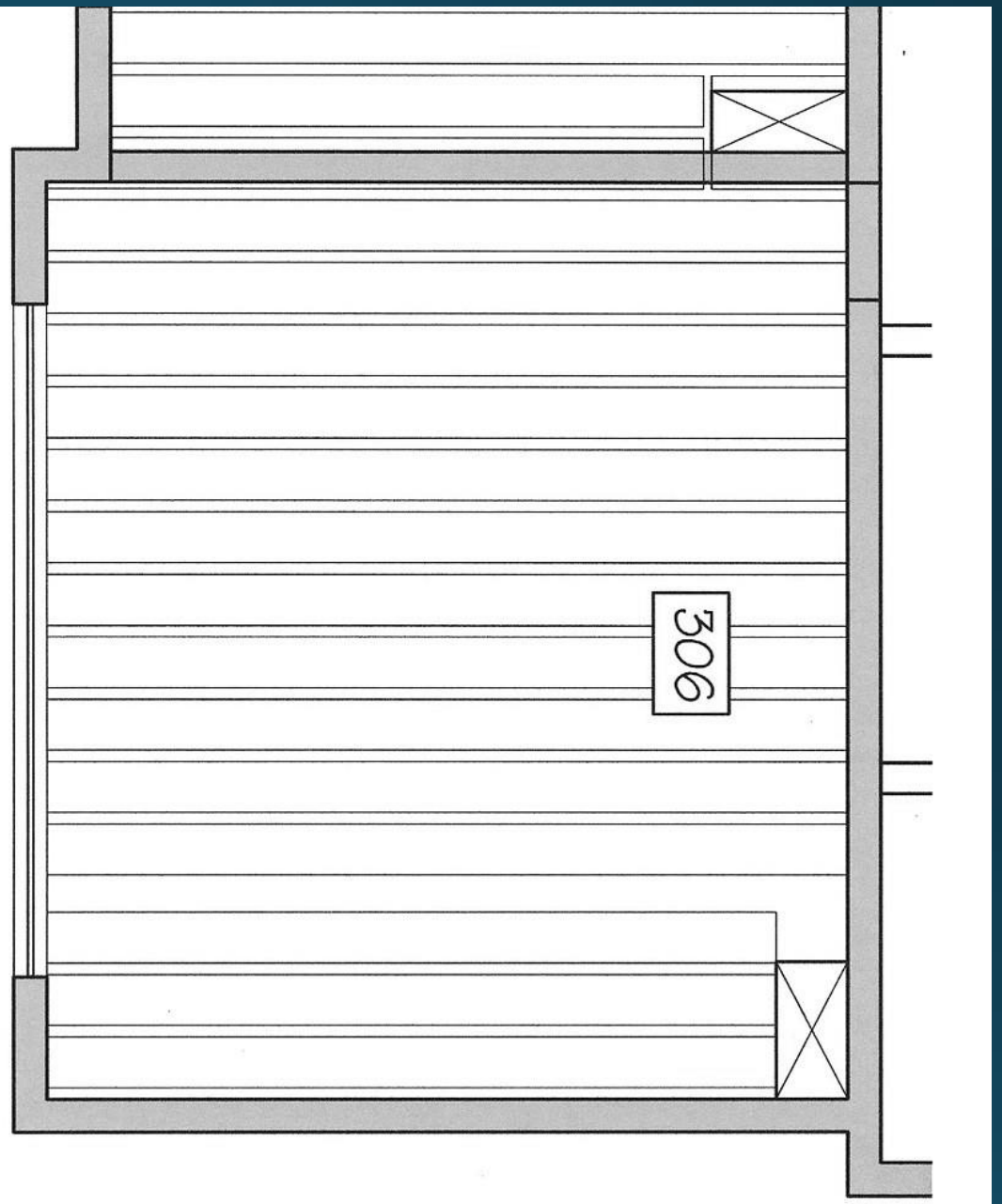

SHADED ROOMS ARE WHERE CONCRETE FILL WAS ADDED TO THE EXISTING FLOOR SLAB AND JOIST SYSTEM IN THE 2003-2004 RENOVATION PROGRAM
WINDOW OPENING, TYP.
315
307
INTERIOR CORRIDOR
302
303
304
305
306
1929 SECTION
1919 SECTION
North
3
Third Floor Plan
Not To Scale

NOTES:

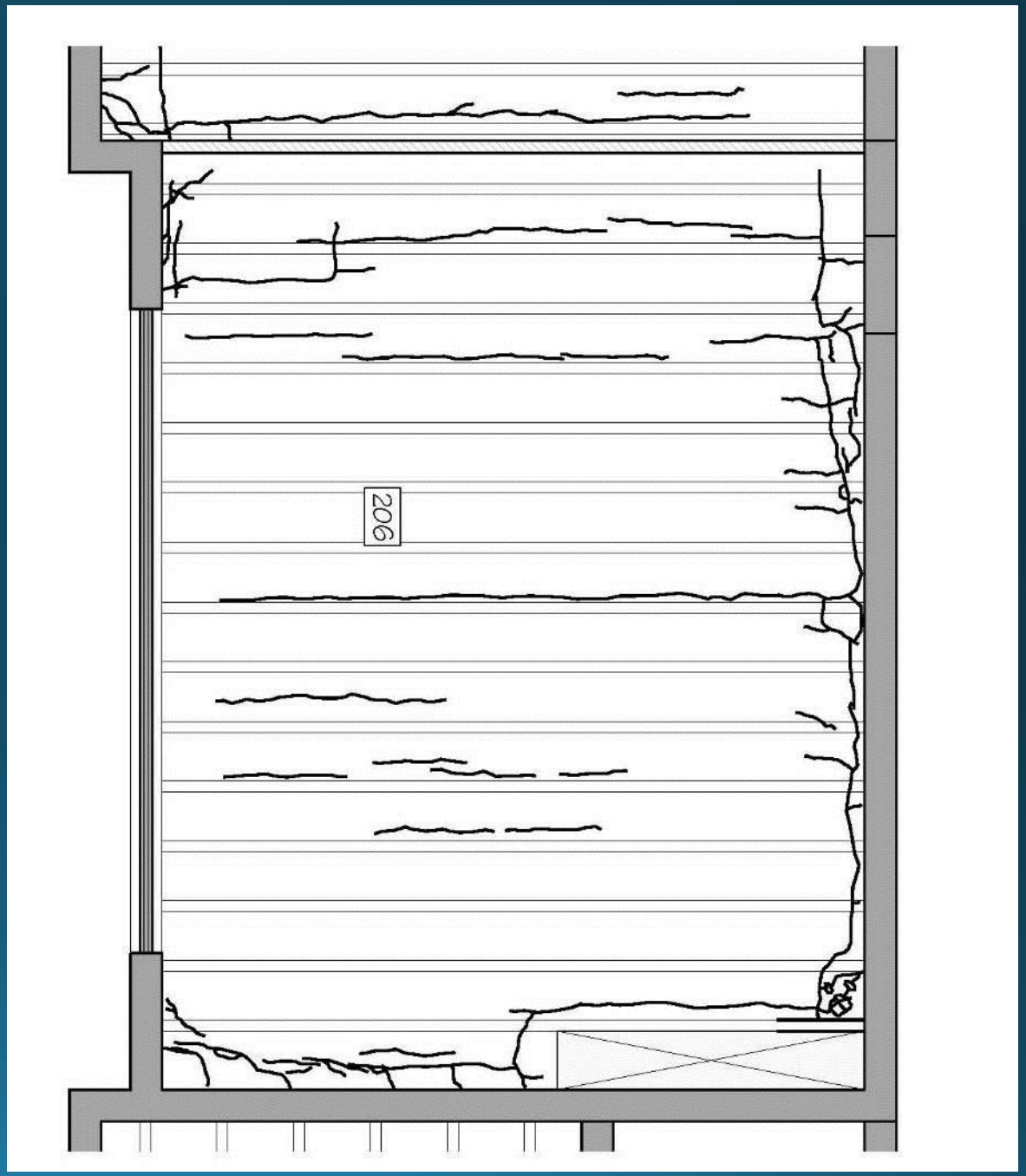
f'c = 2,100 PSI - 2ND FLOOR
f'c = 2,500 PSI - 3RD FLOOR
STEEL = ASTM A15-14,
"STRUCTURAL GRADE"
(Fy = 33,000 psi)



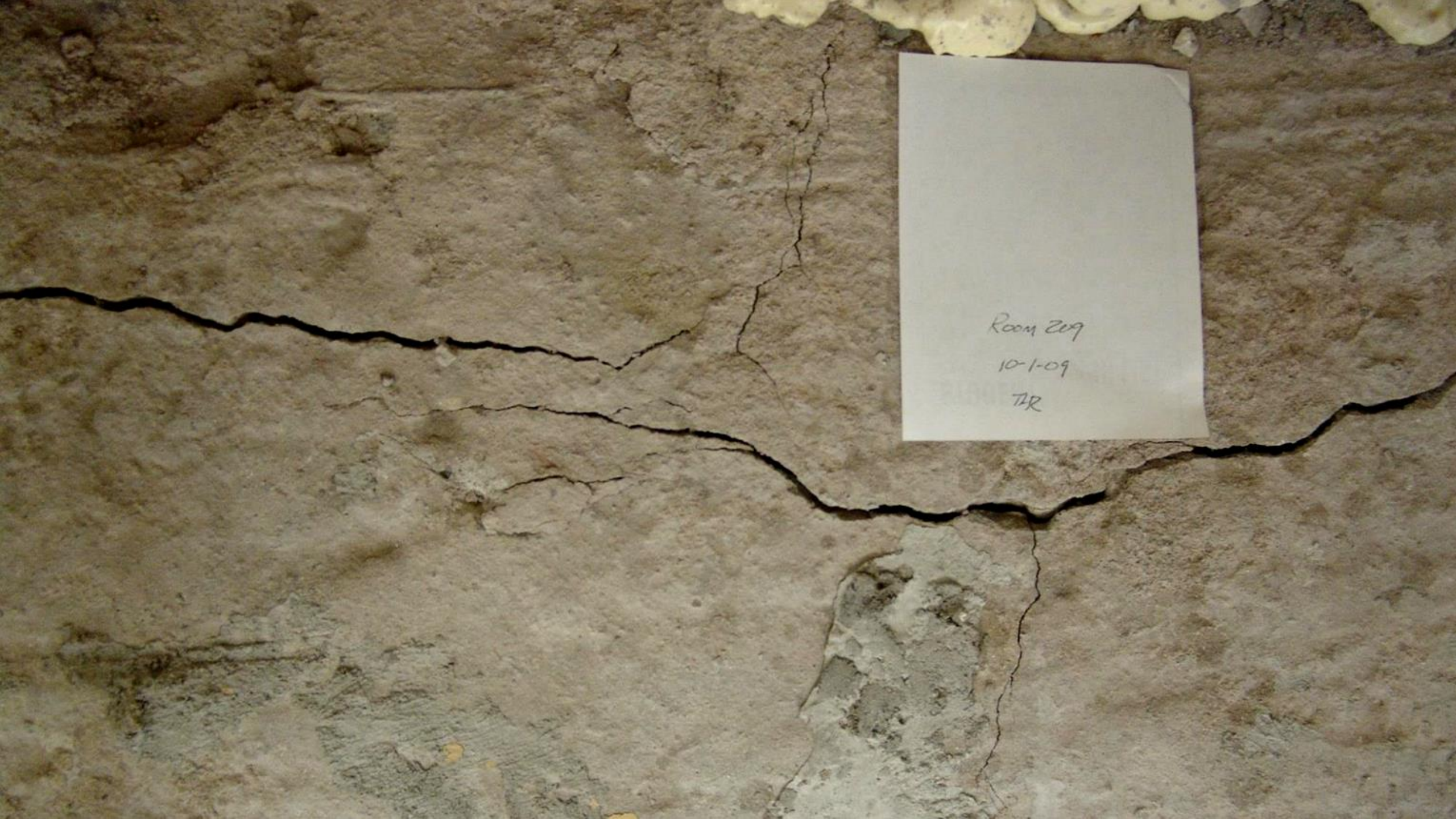
C Vertical Section Thru Typical Floor Joist Slab System
Not To Scale




JUN 6 2009


206


Room 211
10-01-09
TLR


Room 209
10-1-09
TLR


2009 3


Underside of the concrete slab above
Face of the concrete distribution beam
Face of the joist stem


L.0407
L.0407
L.0507
AUG 6 2010

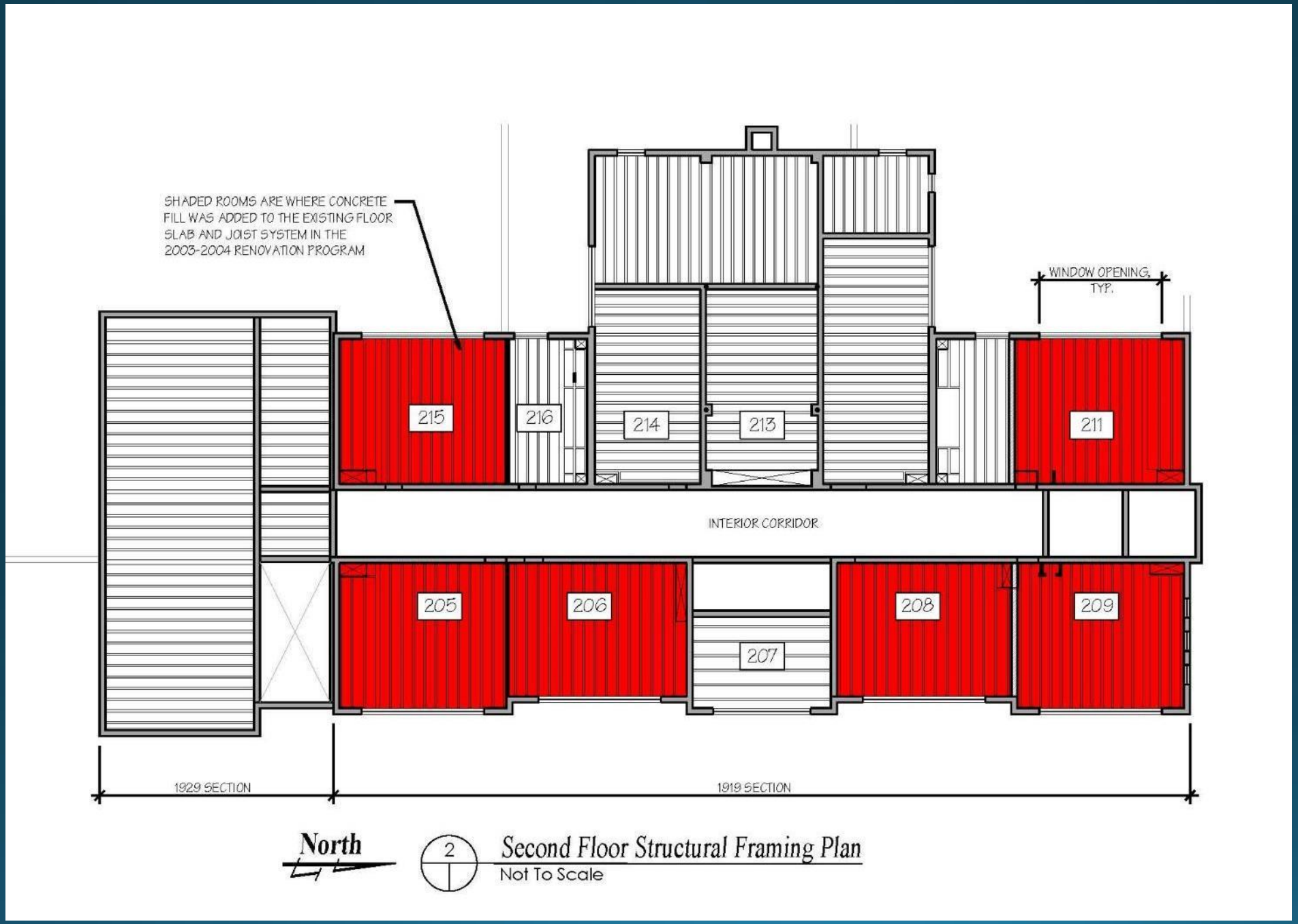

Underside of the concrete slab above
Face of the joist stem
Face of the concrete distribution beam
NOV 6 2009


MAY 1 2009

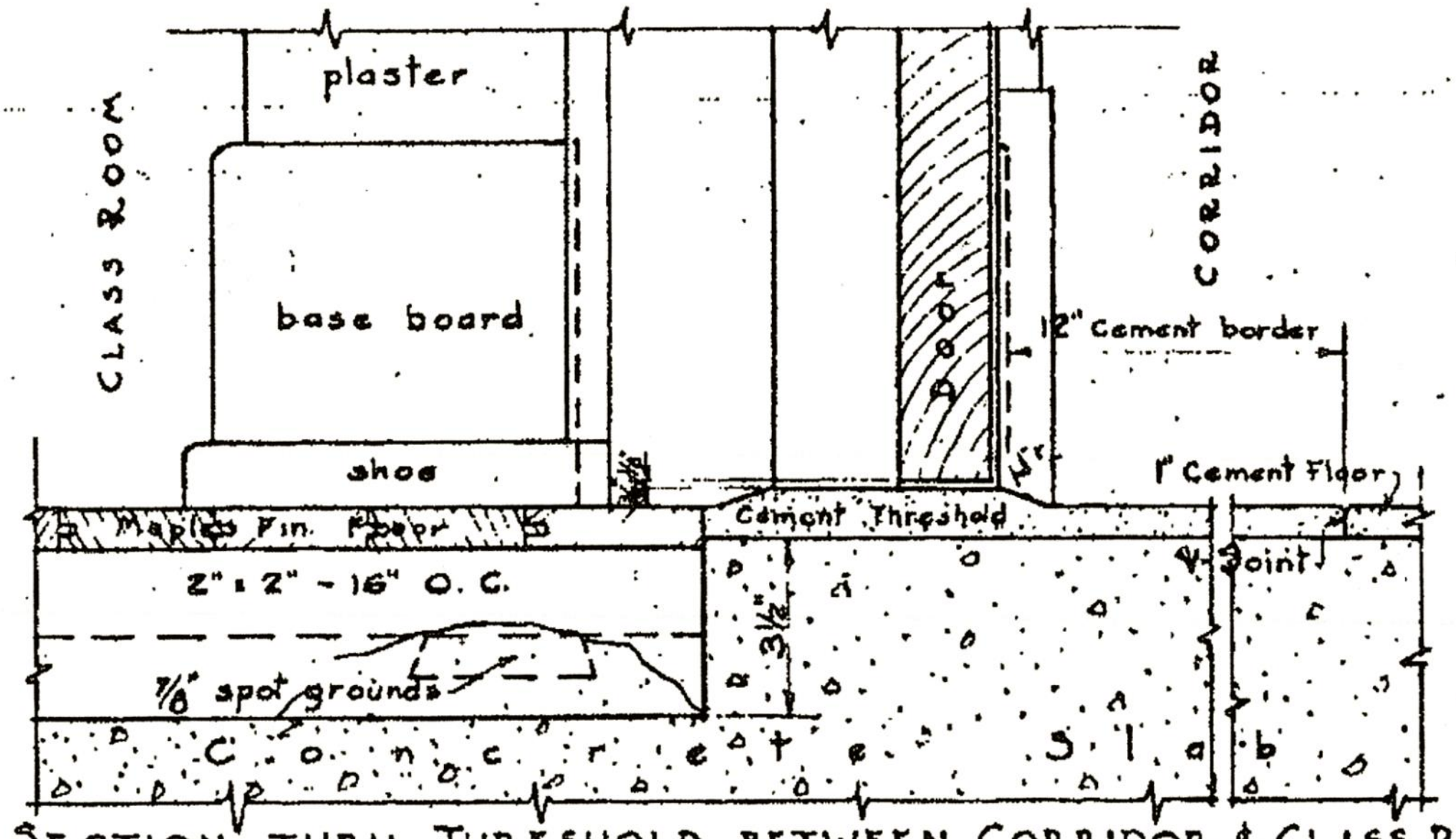

JUN


0 cm 1 2 3 4 5 6 7 8
0 in 1 2 3


See next Figure

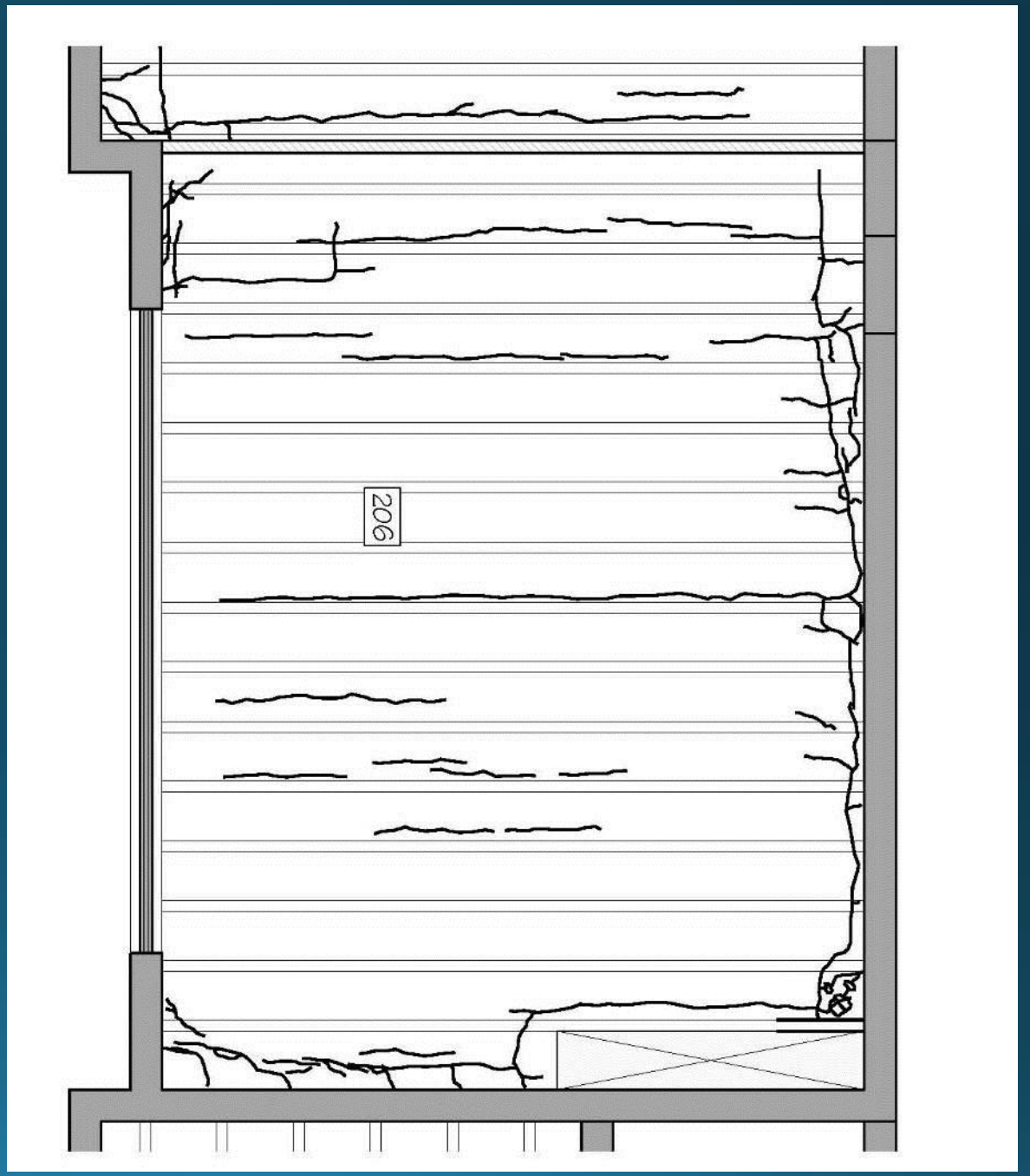

SHADED ROOMS ARE WHERE CONCRETE FILL WAS ADDED TO THE EXISTING FLOOR SLAB AND JOIST SYSTEM IN THE 2003-2004 RENOVATION PROGRAM
WINDOW OPENING, TYP.
215
216
214
213
211
INTERIOR CORRIDOR
205
206
207
208
209
1929 SECTION
1919 SECTION
North
2
Second Floor Structural Framing Plan
Not To Scale

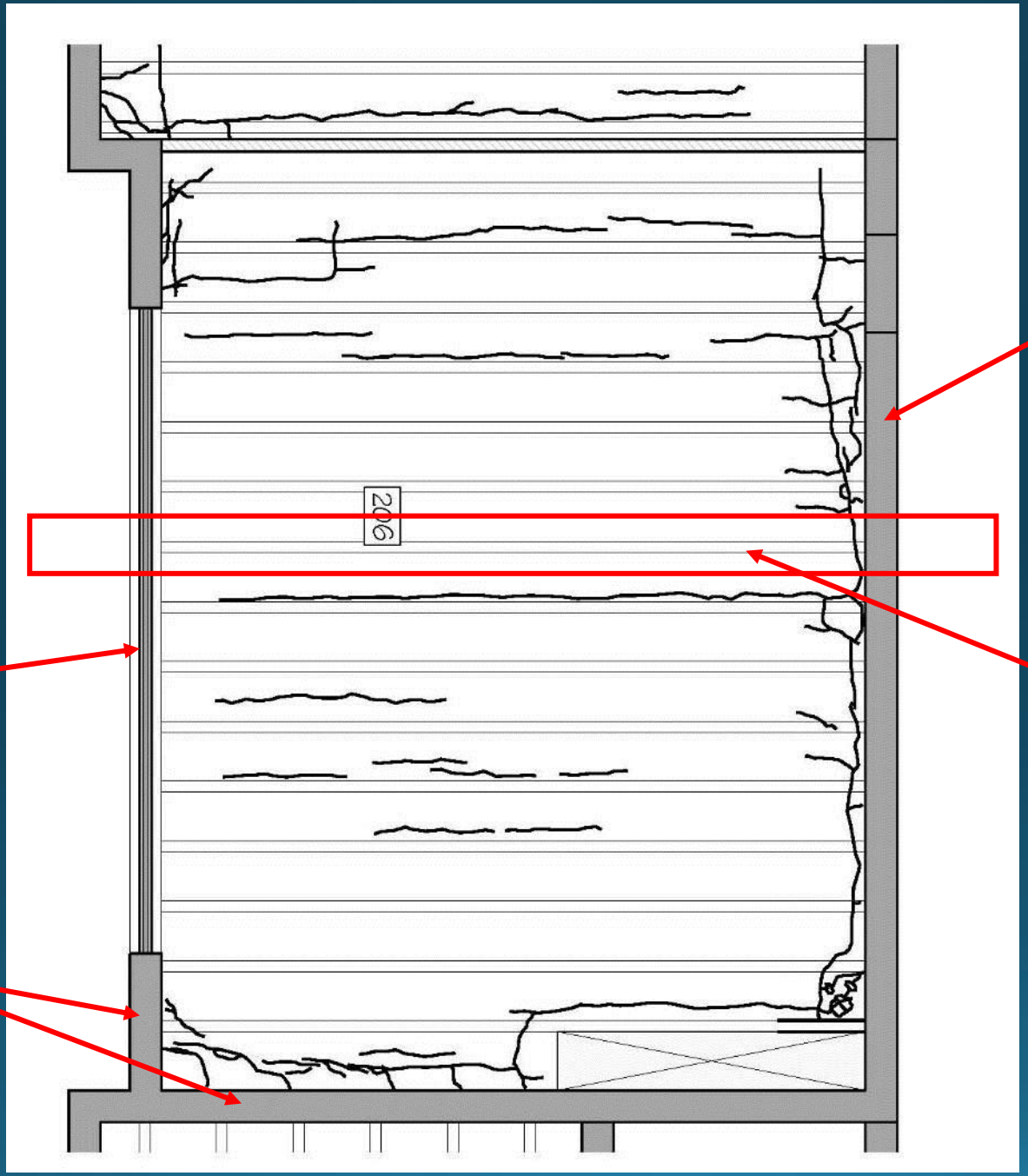

HELIX
STAINLESS STEEL
FLEXIBLE



SECTION THRU THRESHOLD BETWEEN CORRIDOR & CLASS ROOMS


JUN 6 2009


206

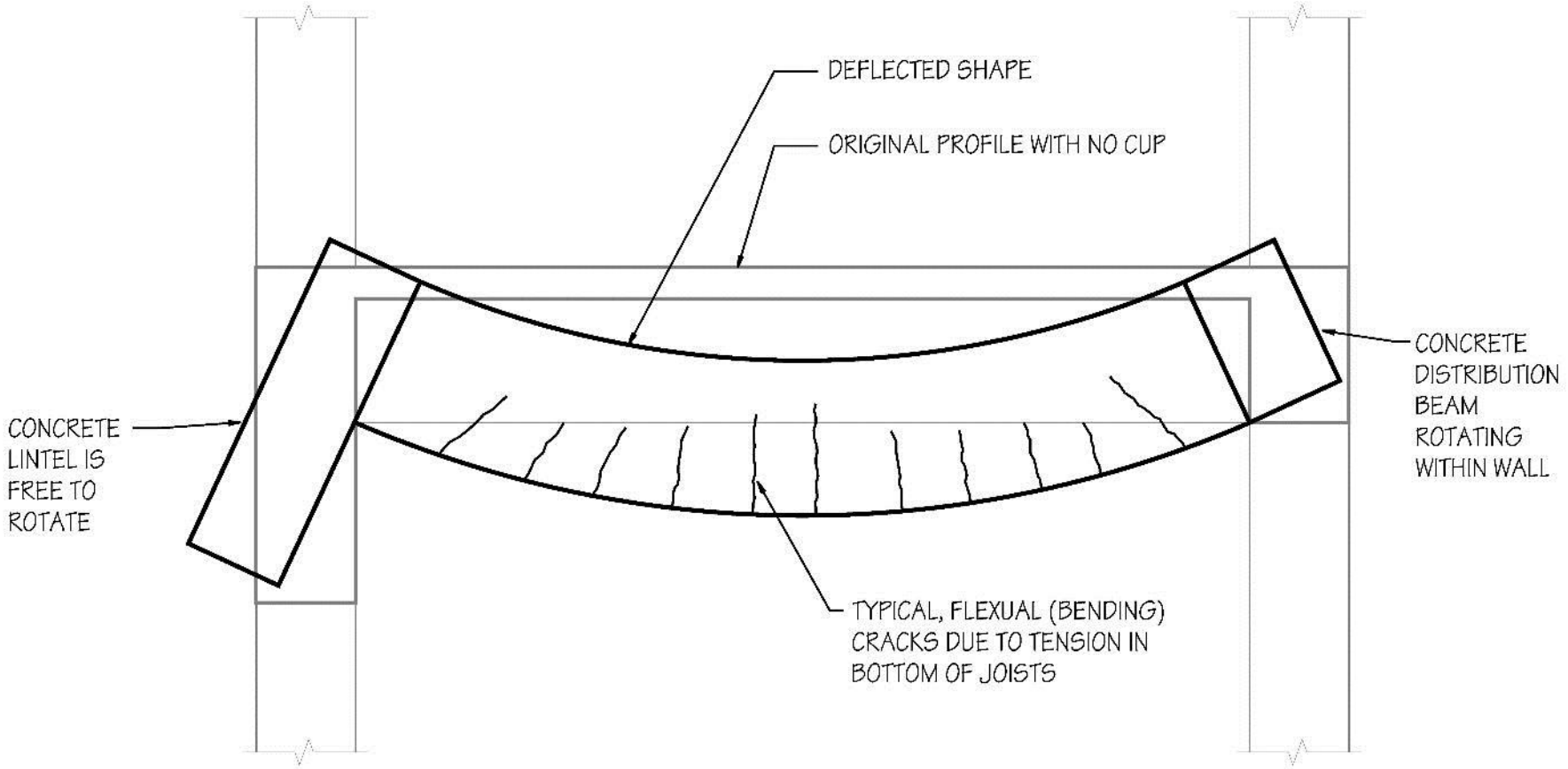


Load bearing, structural clay tile interior corridor wall

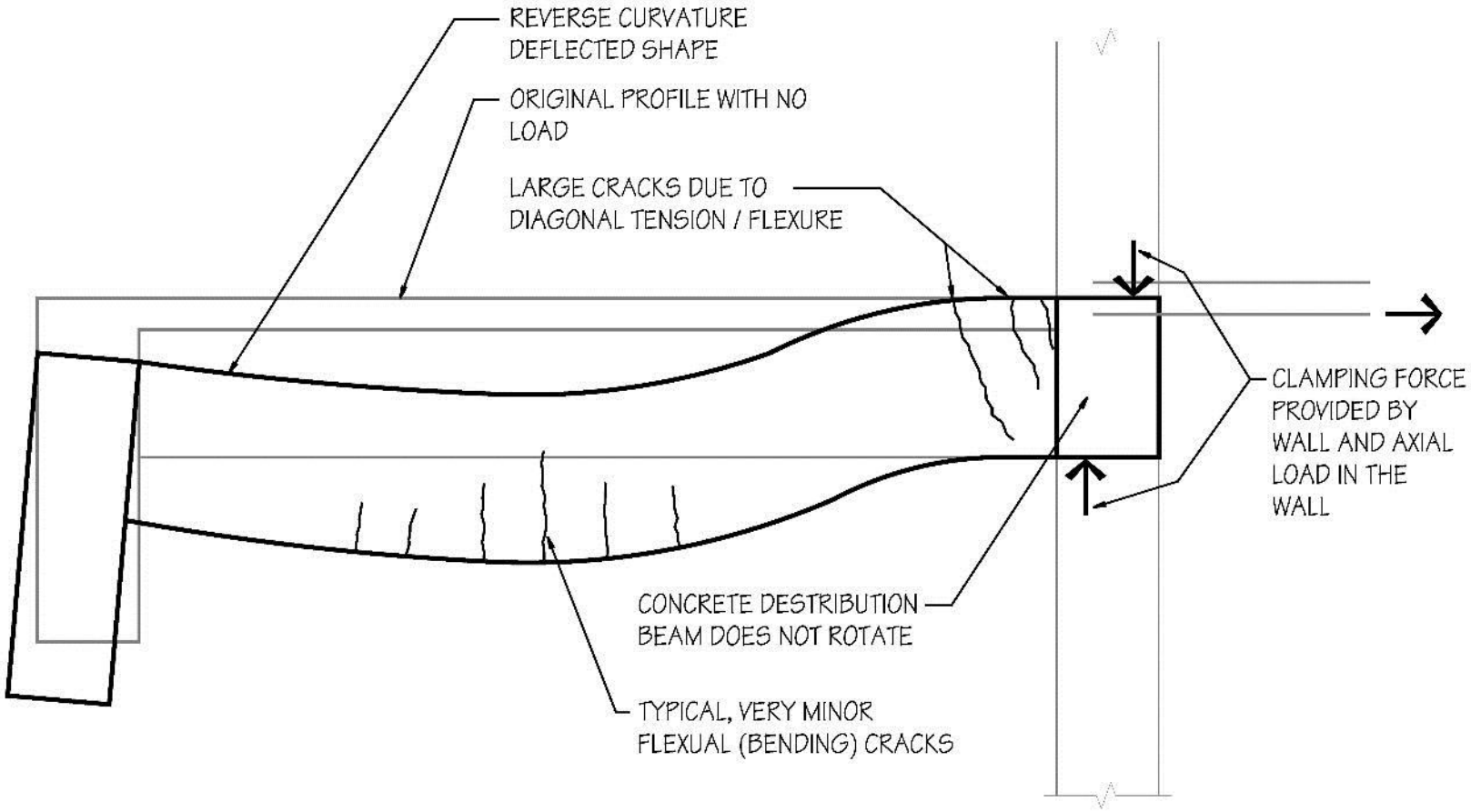
Concrete lintel over windows, with masonry above

Typical interior joist framing into window lintel

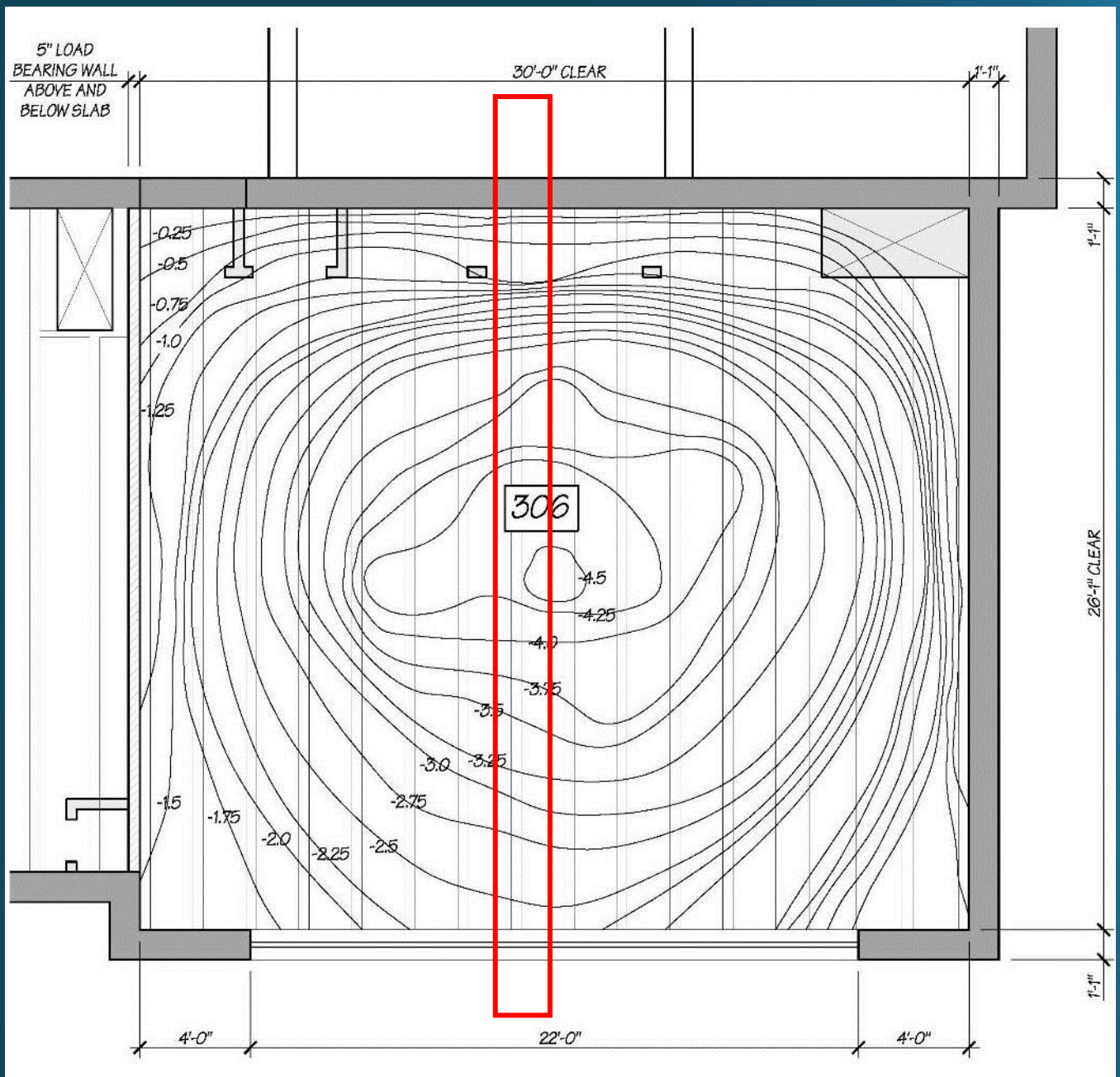
Load bearing, brick masonry and structural clay tile exterior wall

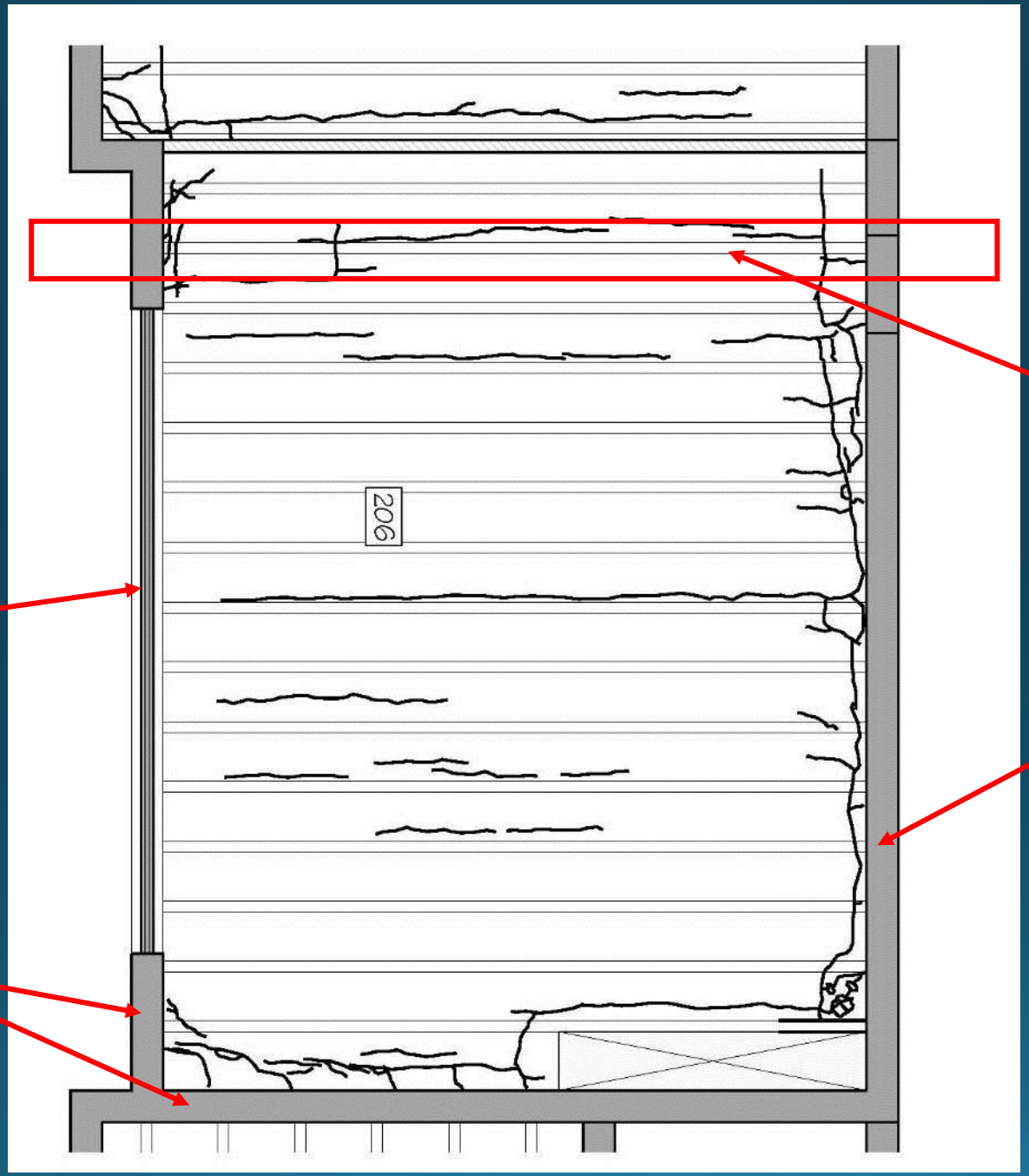


Cross Section Thru The Typical Concrete Floor Slab & Joist System Illustration Simple Span Behavior



Cross Section Thru Concrete Floor Slab & Joist System Illustrating the Actual Behavior in This Building (At Window Locations)


5" LOAD BEARING WALL ABOVE AND BELOW SLAB
30'-0" CLEAR
1'-1"
1'-1"
26'-1" CLEAR
1'-1"
306
-0.25
-0.5
-0.75
-1.0
-1.25
-1.5
-1.75
-2.0
-2.25
-2.5
-2.75
-3.0
-3.25
-3.5
-3.75
-4.0
-4.25
-4.5
4'-0"
22'-0"
4'-0"



Typical interior joist framing into exterior wall

Concrete lintel over windows, with masonry above

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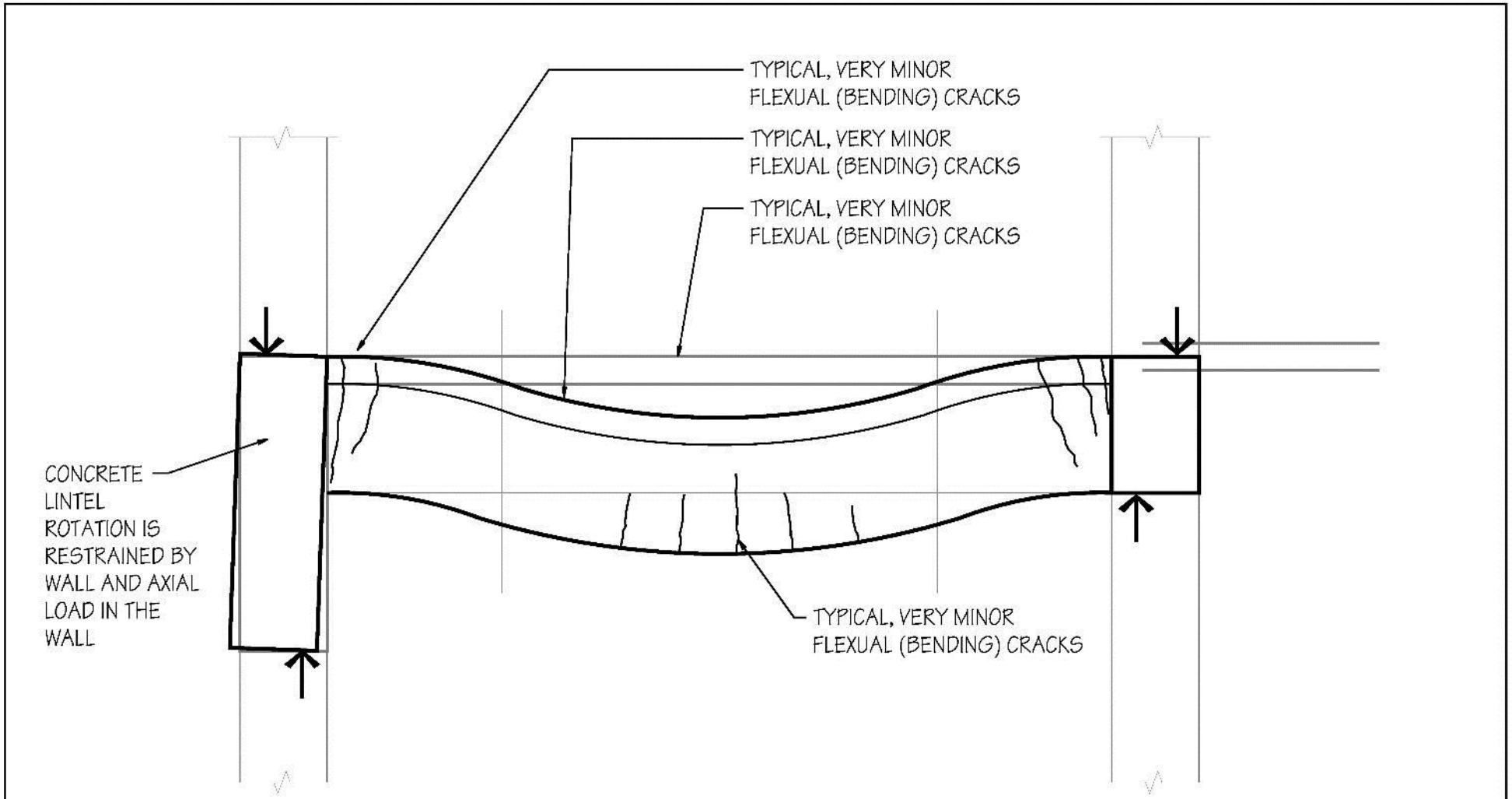
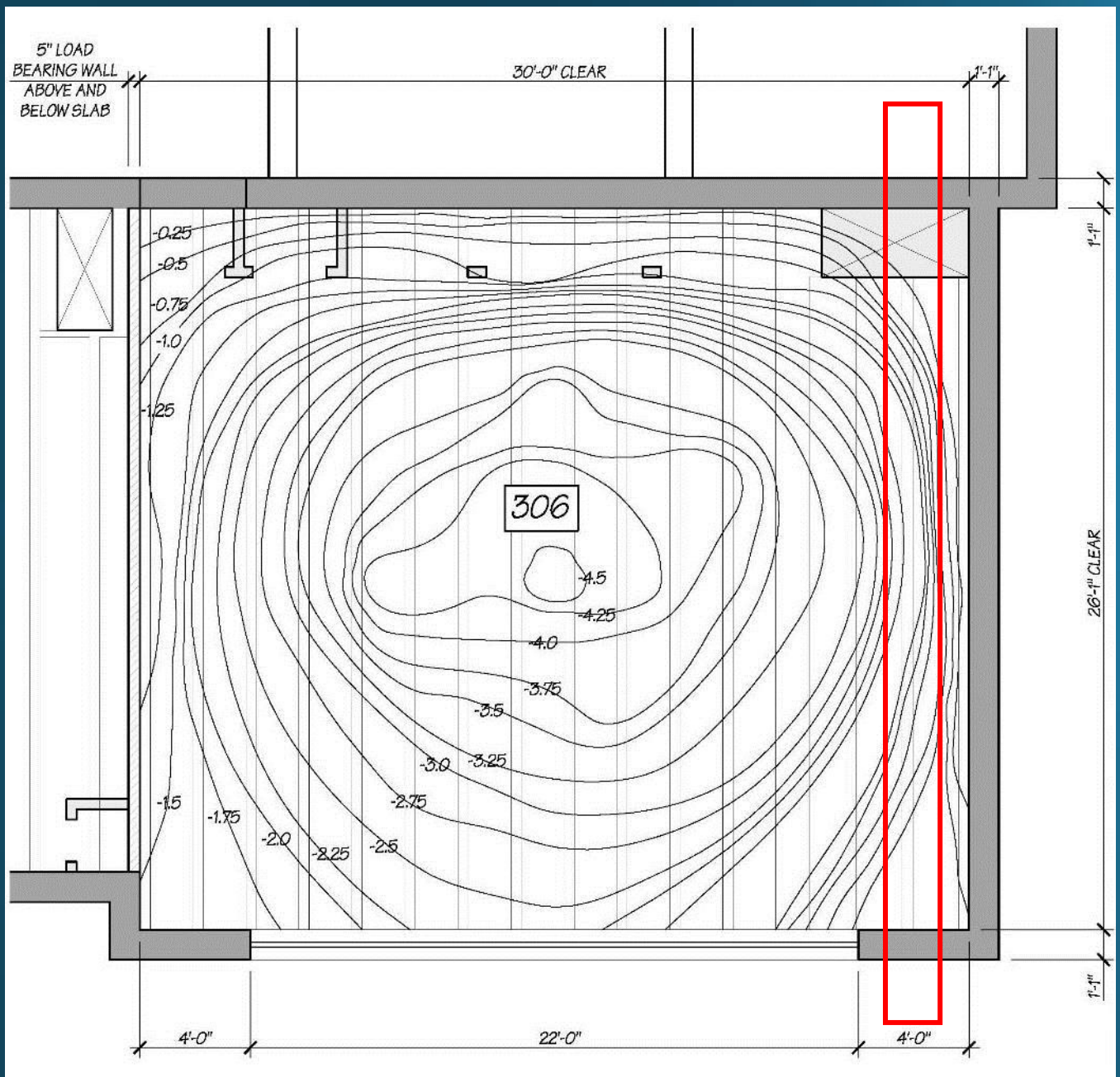
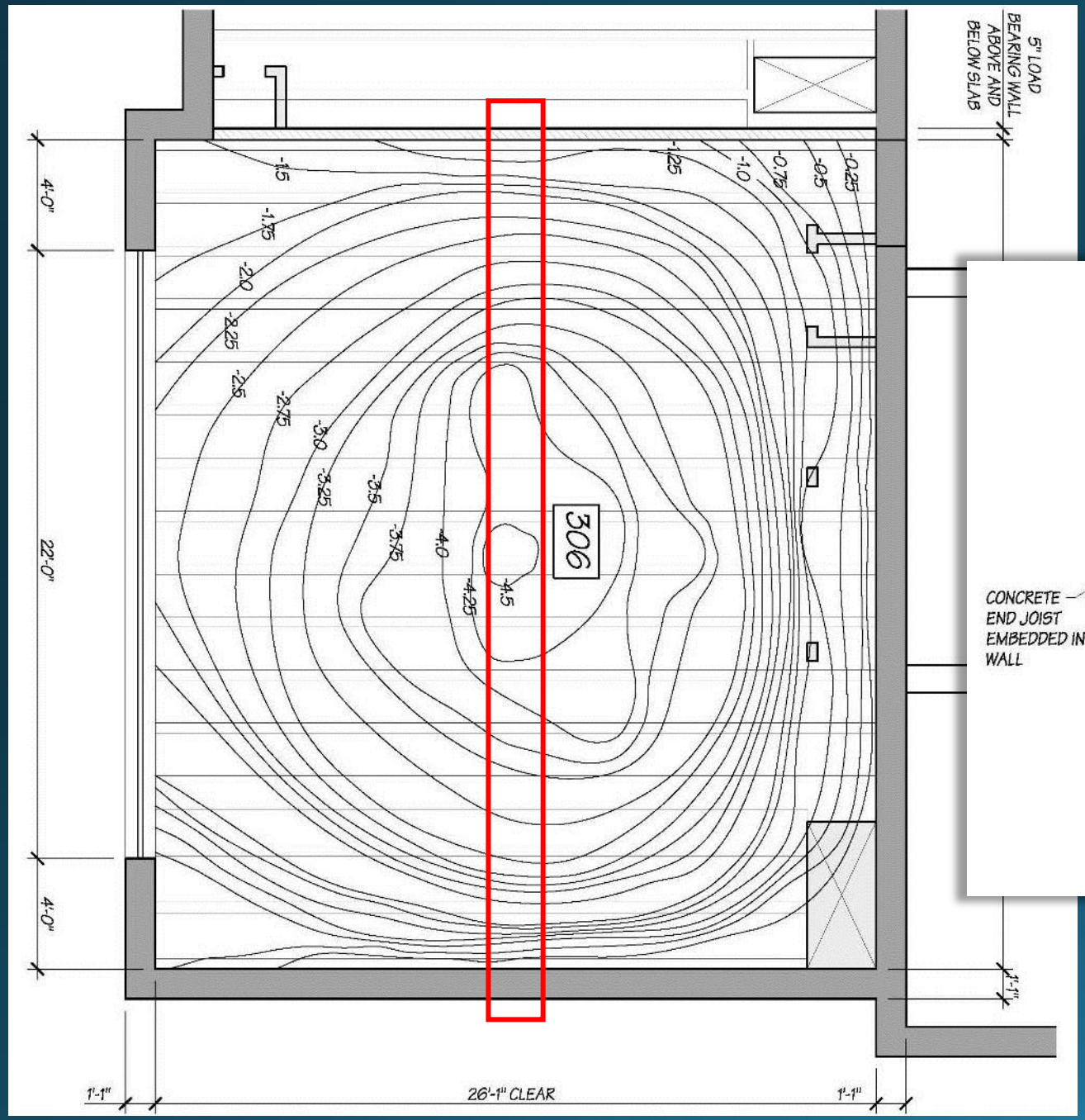
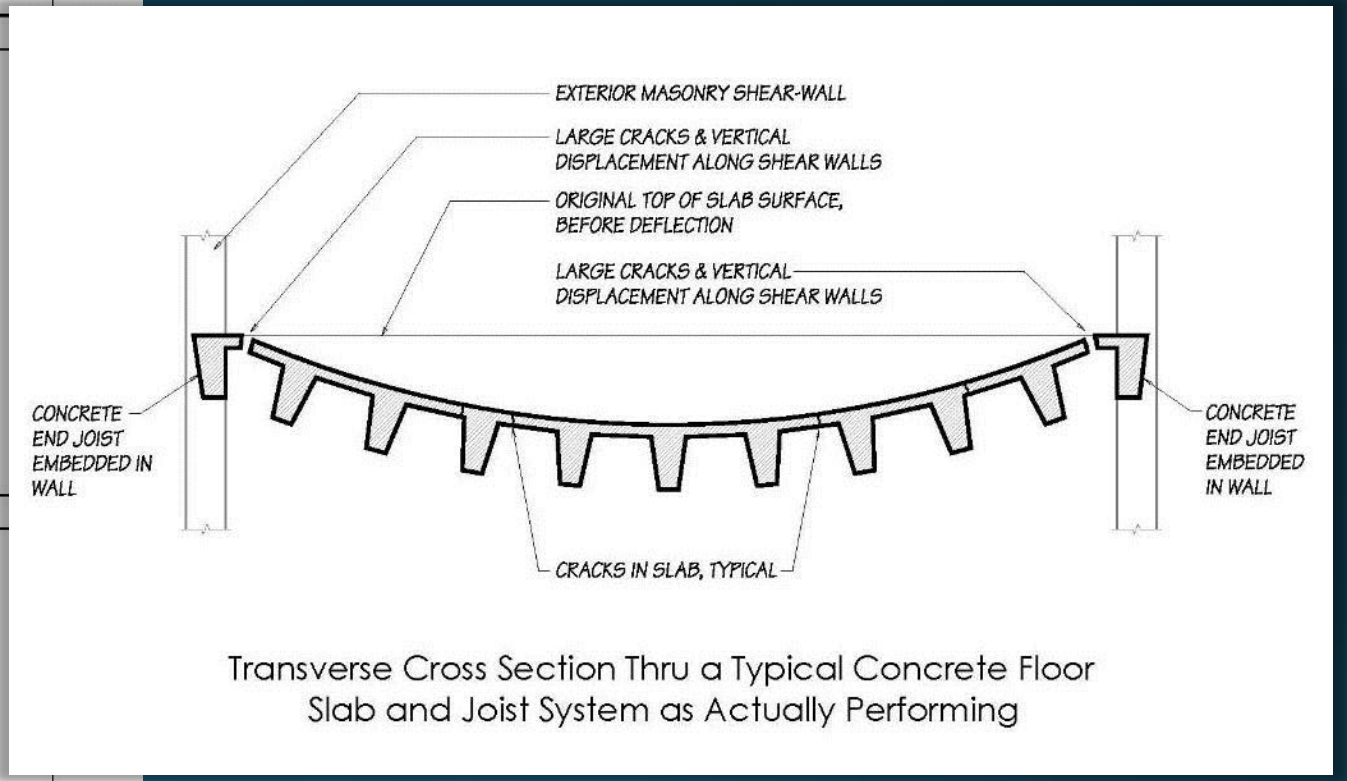
Load bearing, brick masonry and structural clay tile exterior wall



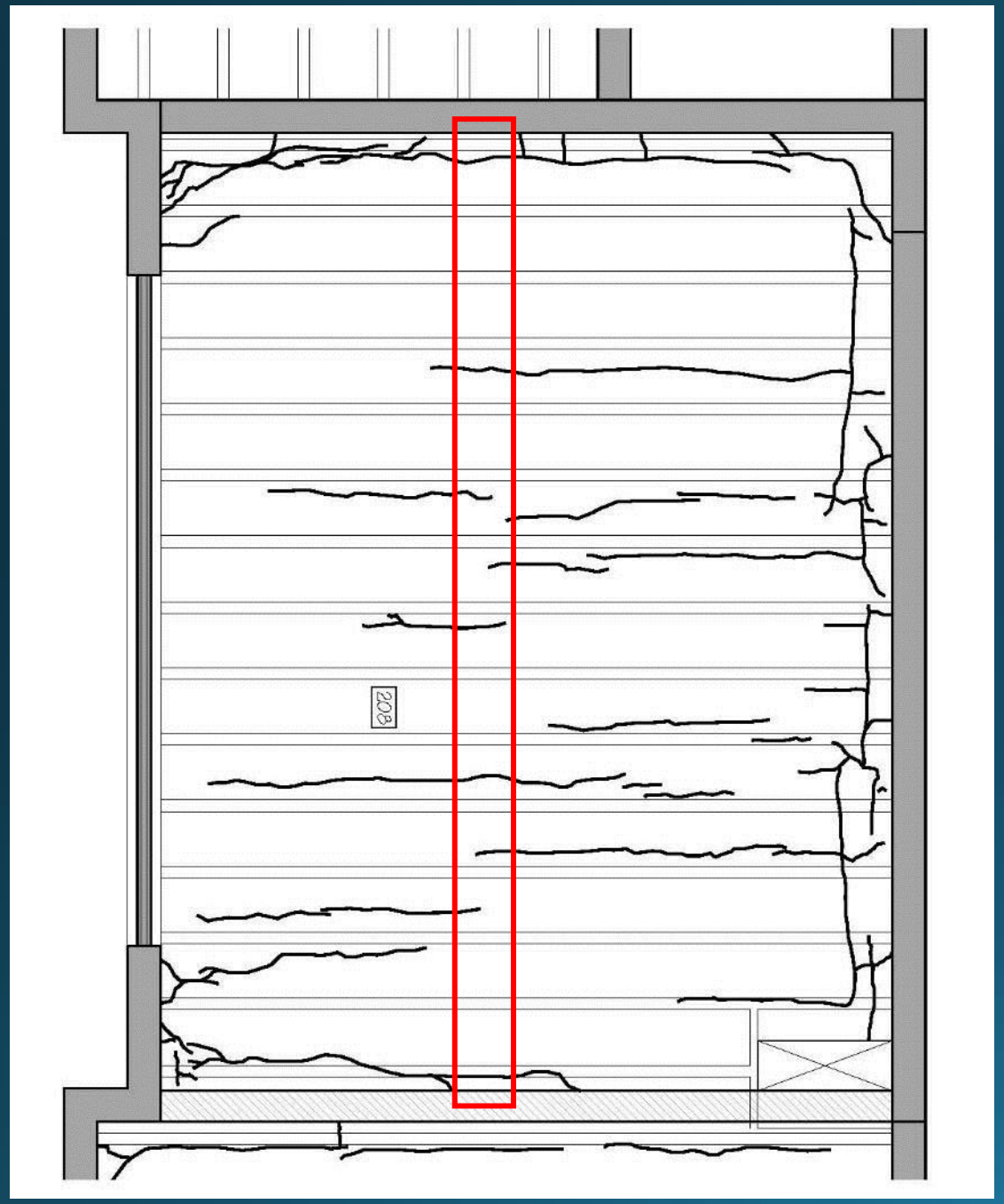
Cross Section Thru Concrete Floor Slab & Joist System Illustrating the Actual Behavior in This Building (Away From Window Locations)

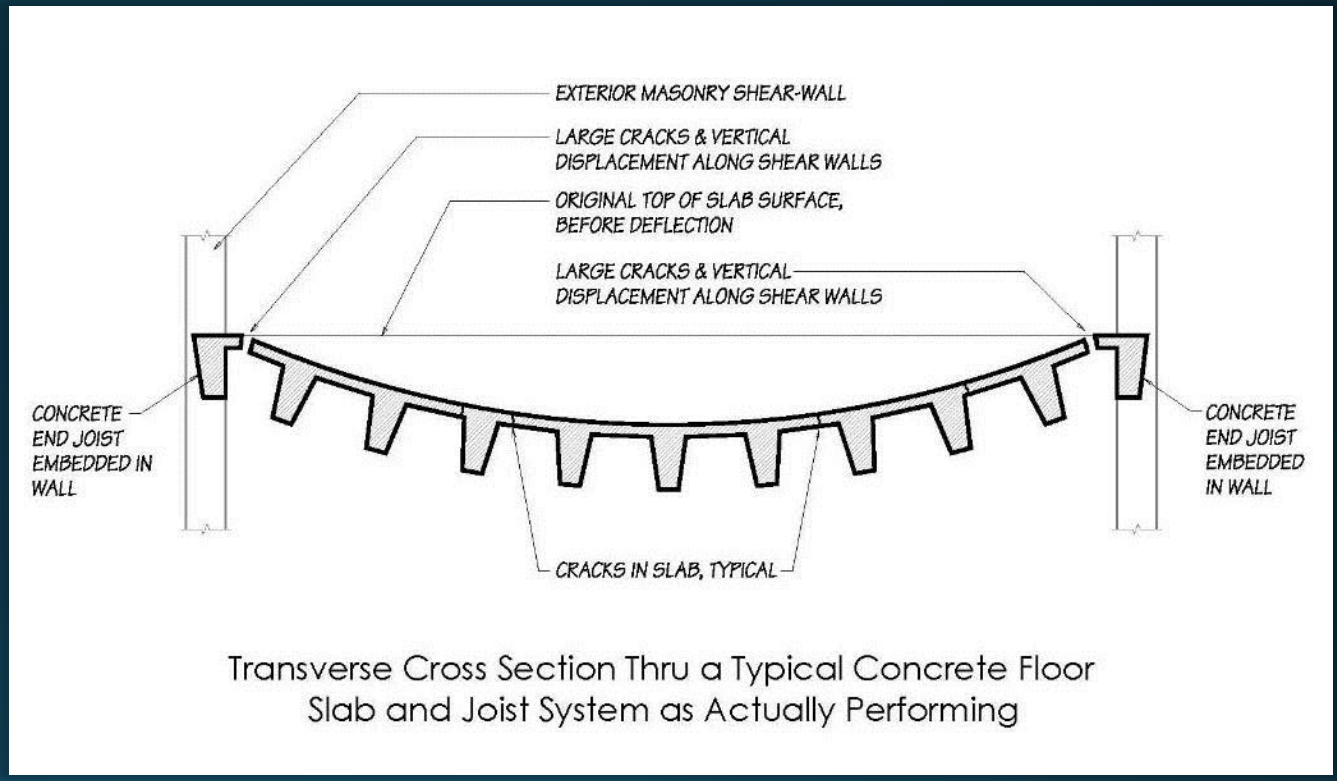

5" LOAD BEARING WALL ABOVE AND BELOW SLAB
30'-0" CLEAR
1'-1"
1'-1"
26'-1" CLEAR
1'-1"
-0.25
-0.5
-0.75
-1.0
-1.25
306
-4.5
-4.25
-4.0
-3.75
-3.5
-3.0
-3.25
-2.75
-2.5
-2.25
-2.0
-1.75
-1.5
4'-0"
22'-0"
4'-0"





Transverse Cross Section Thru a Typical Concrete Floor Slab and Joist System as Actually Performing





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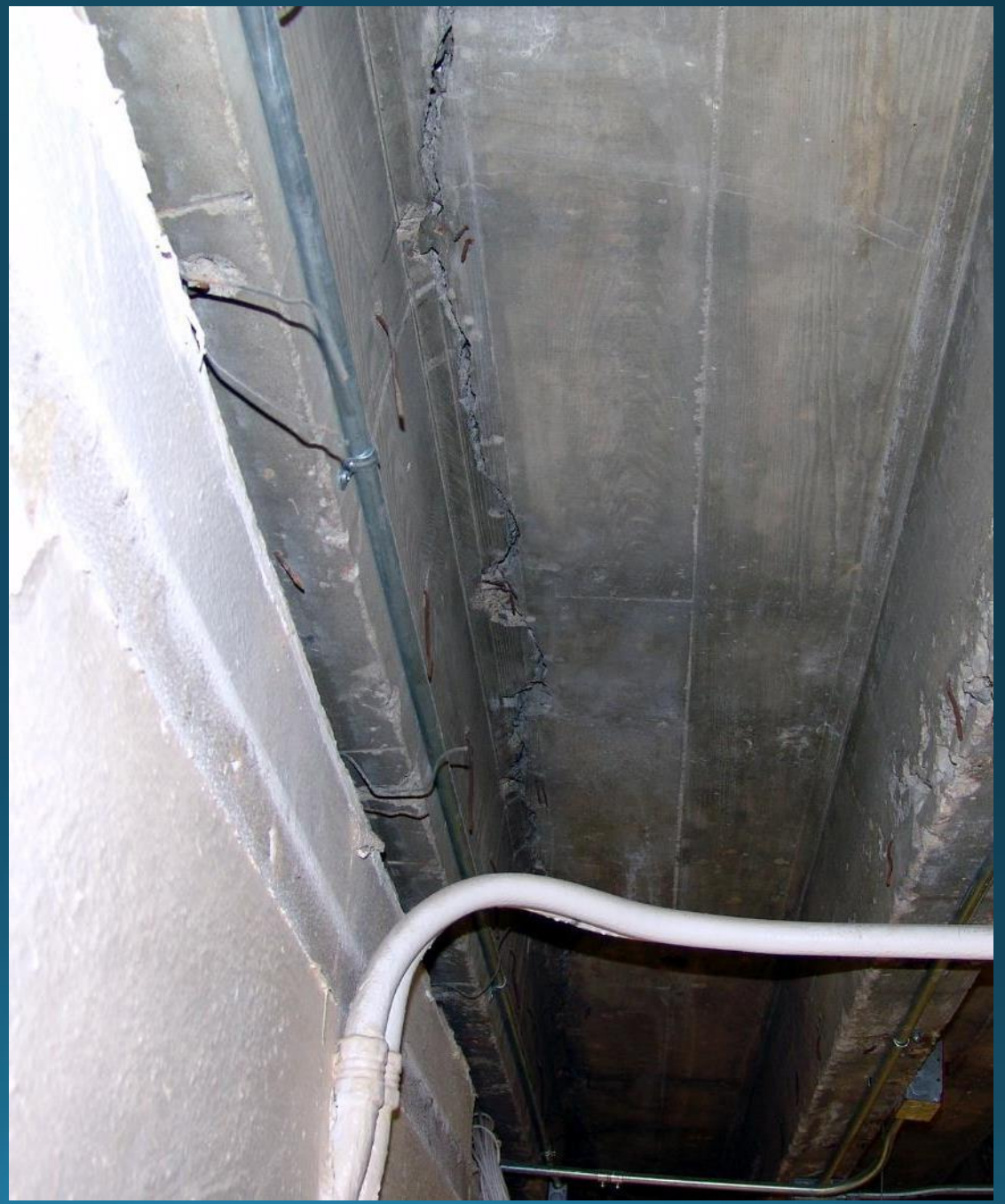

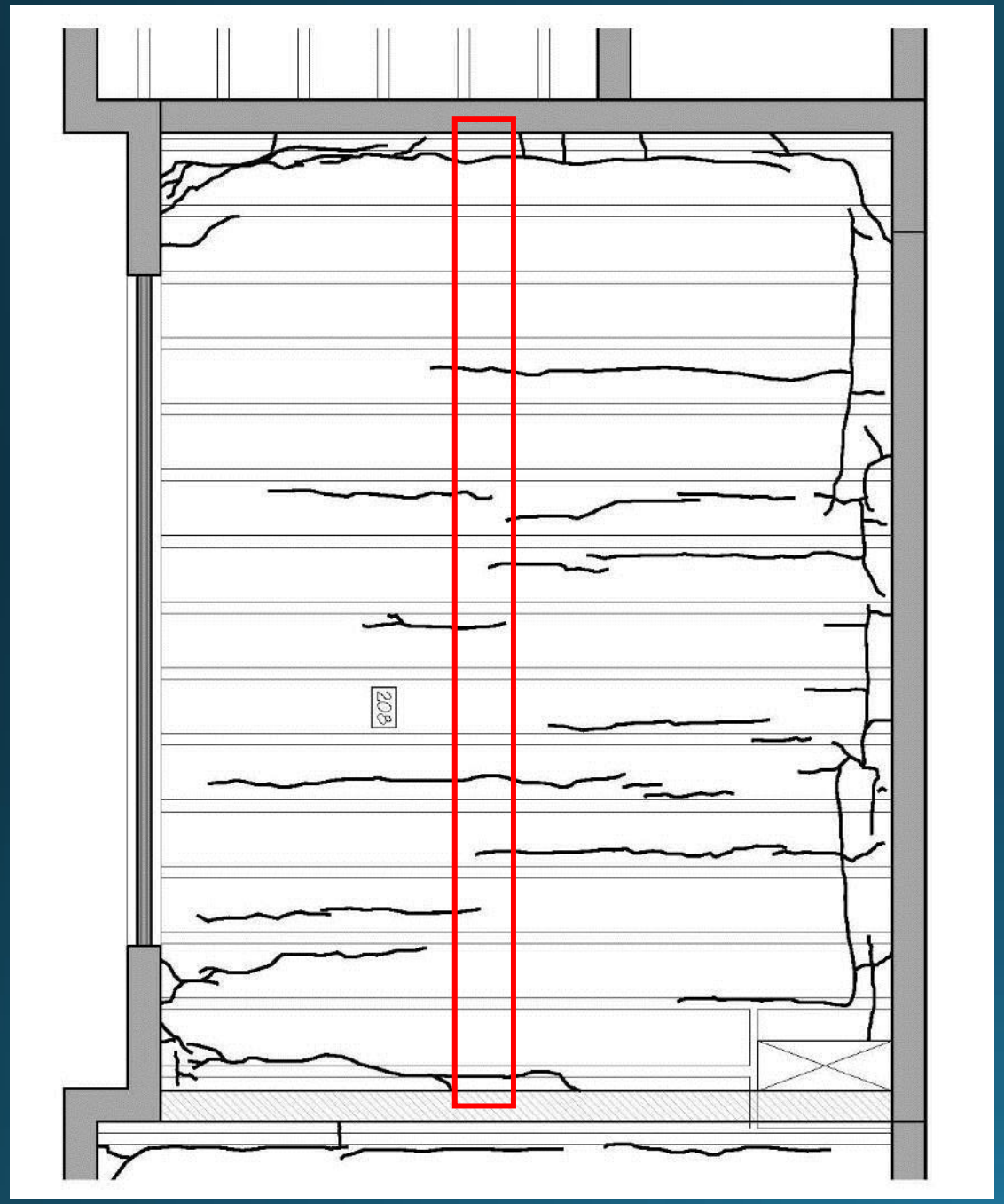

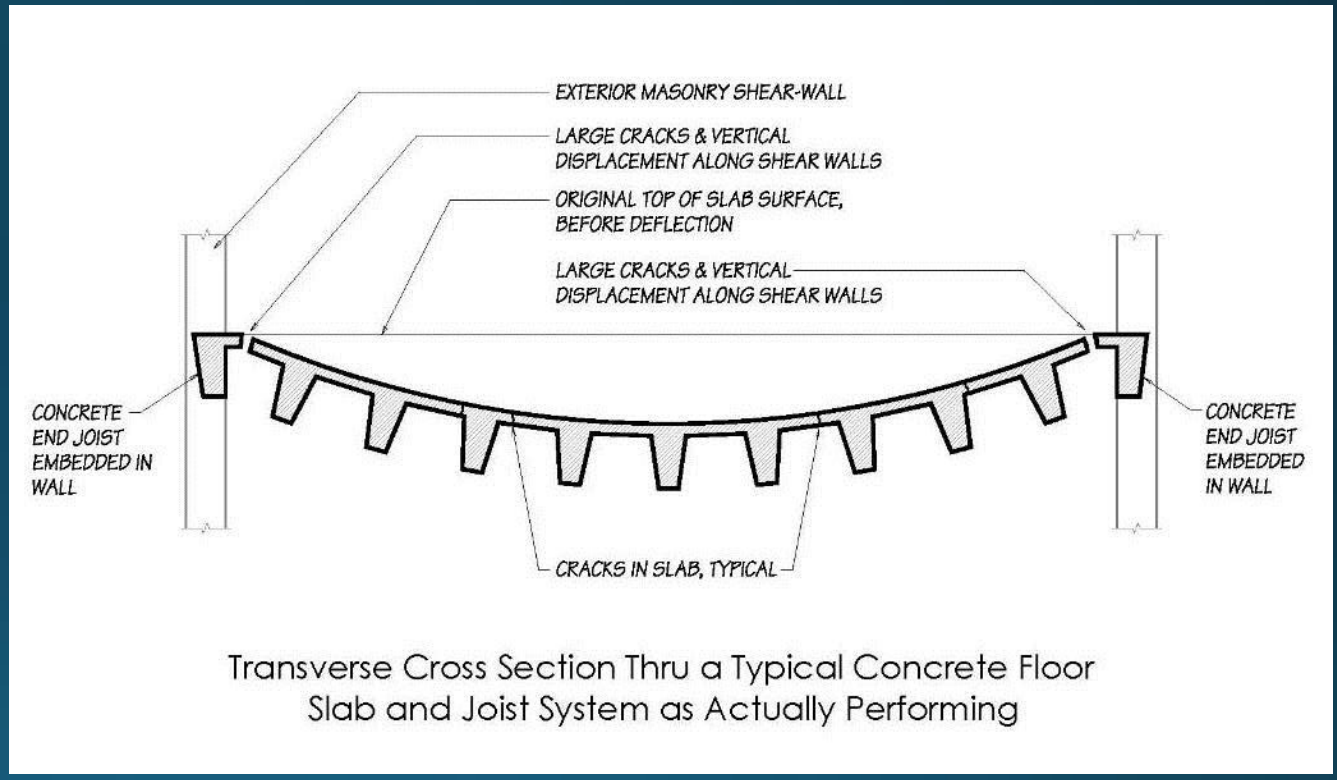

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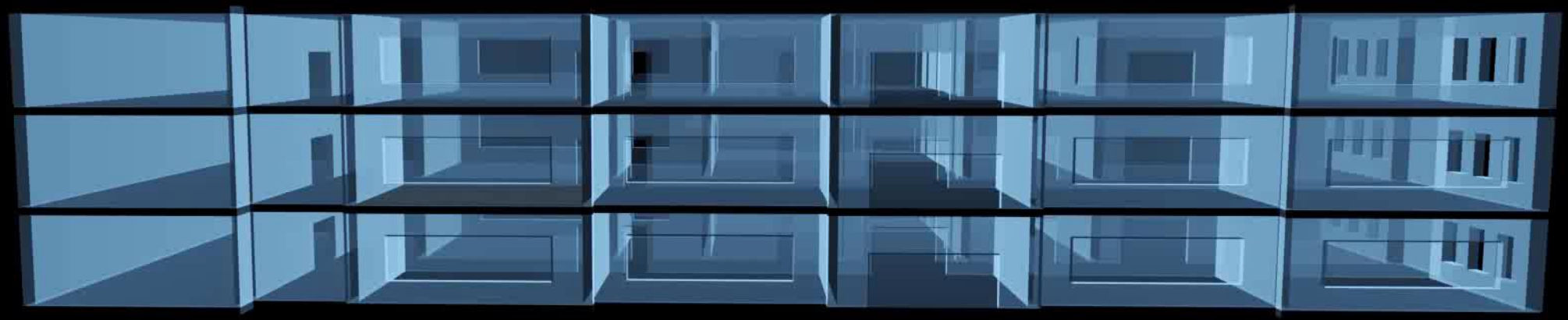
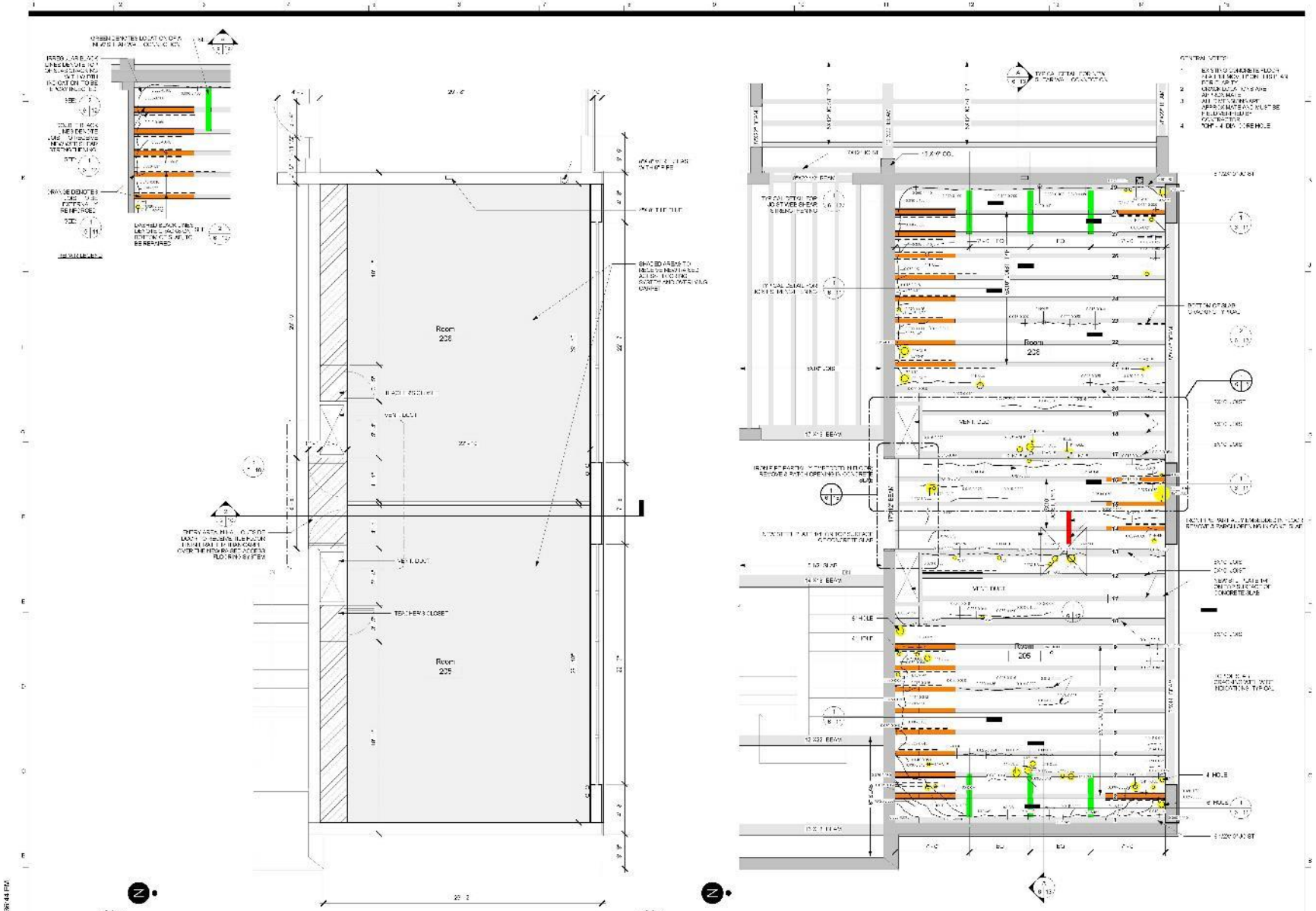




1 / 2 6 Second Floor- North Work Area
1/4" = 1'-0"

2 / 4 6 Second Floor- North Work Area- Struct Plan
1/4" = 1'-0"

THOS. REVERTS & CO., LLC
Structural Engineering
4550 Main St. Suite 216
Kansas City, MO 64111-7711
816.531.2665 Office
913.424.5130 Mobile

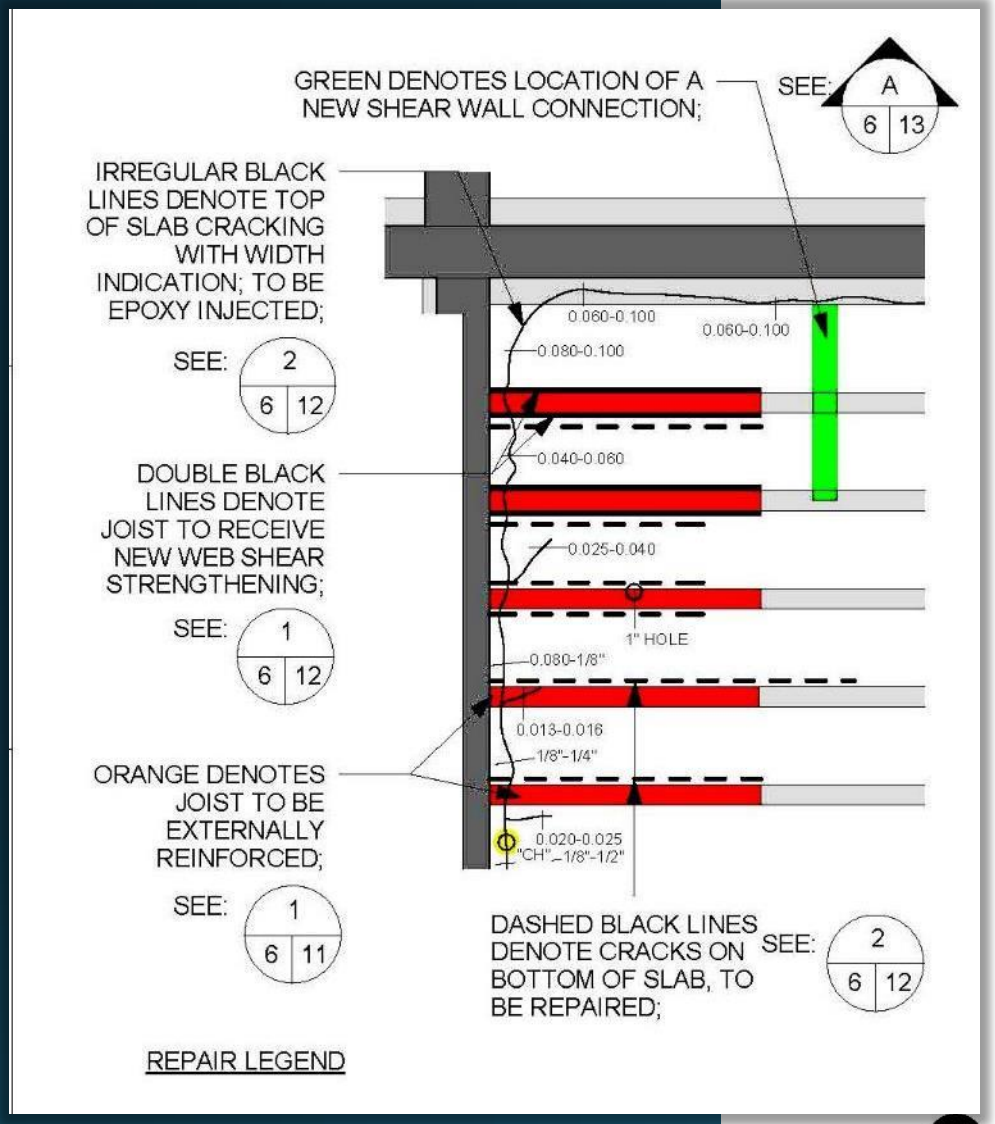
Structural Repairs
Phase II: Concrete Floor System Repairs
Allison | Traditional Magnet Middle School
221 S. Seneca - Wichita, Kansas

not for construction

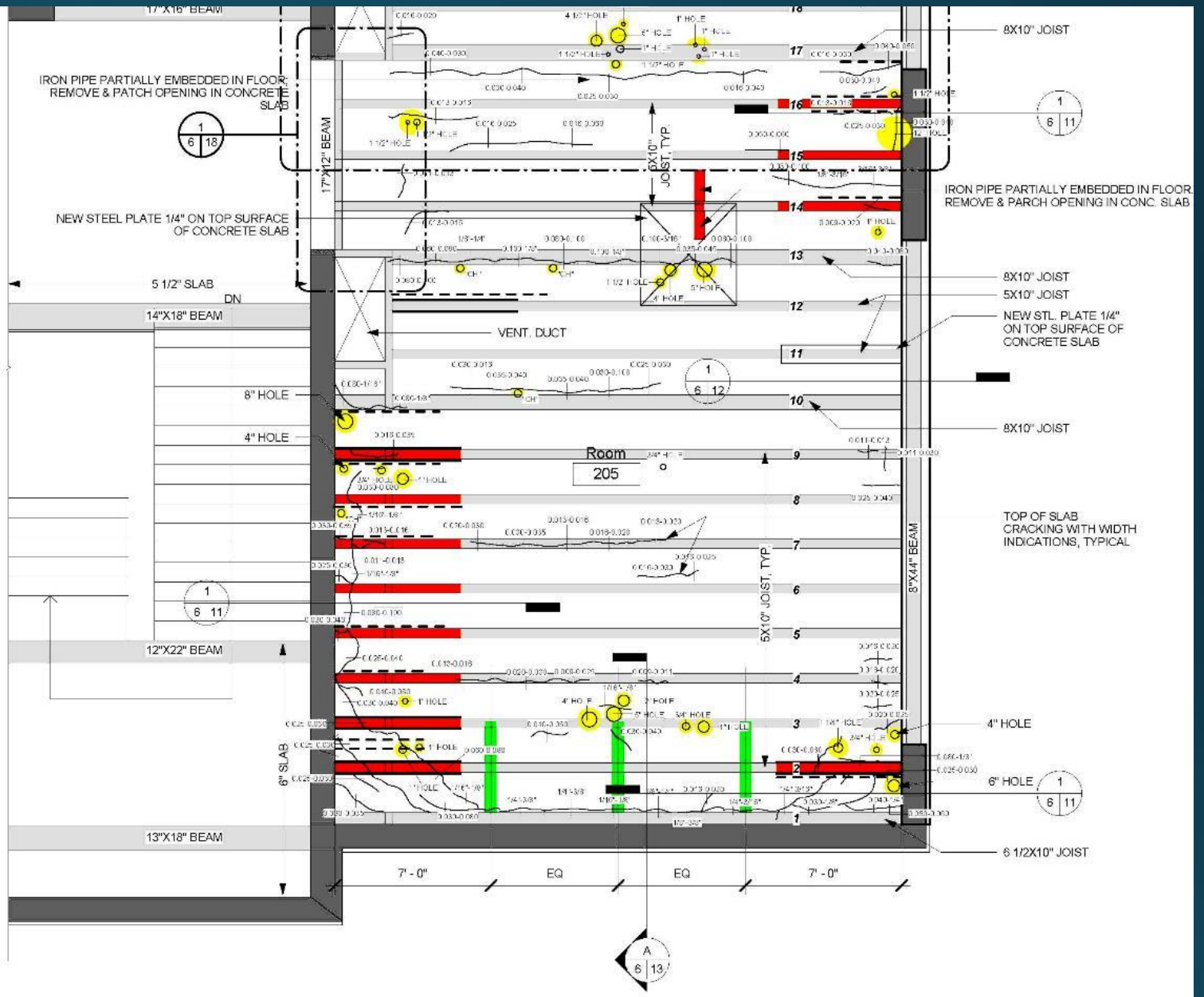
North Work Area Plans-
Second Floor

date	08/23/2010
phase	Phase II Structural Repairs
issued for	For Bid Only
project number	TRC1010-08

S-6



REPAIR LEGEND



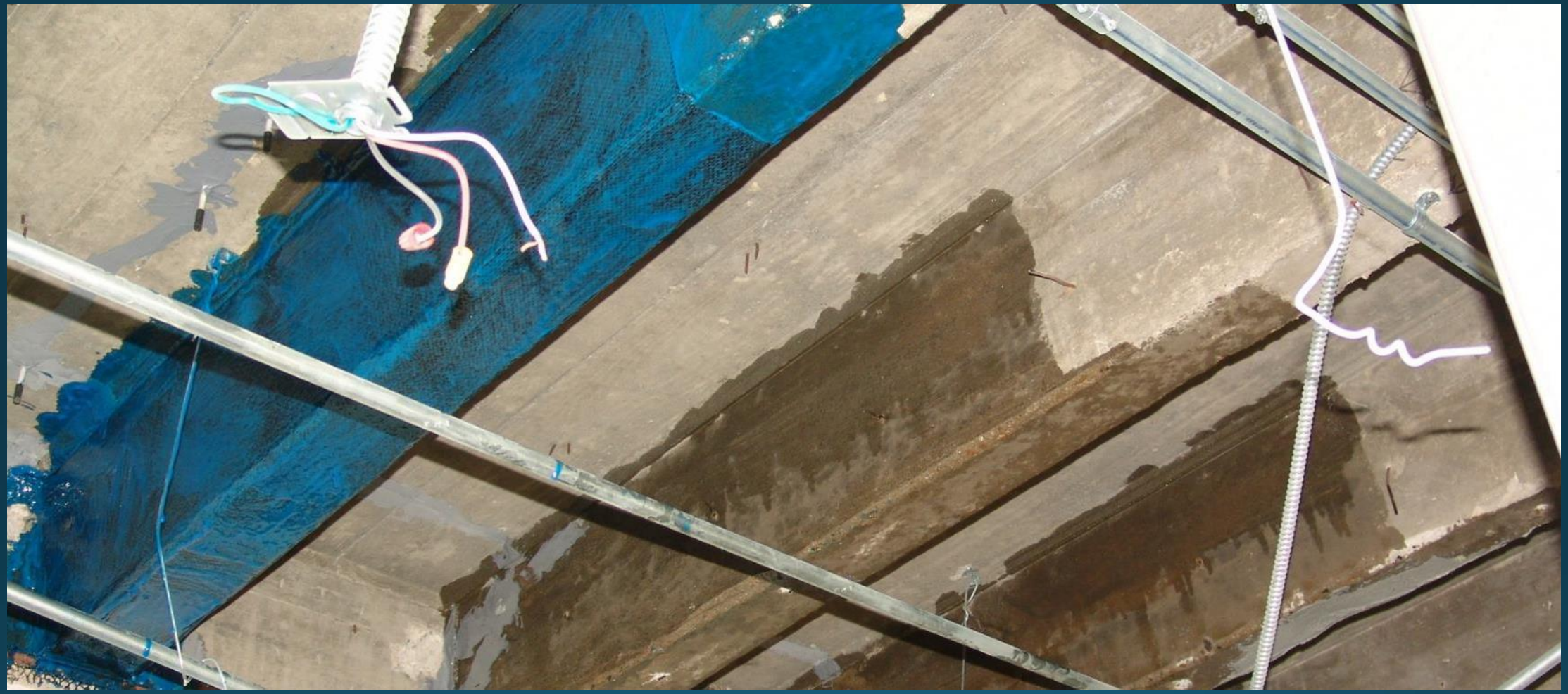
2 4 6 Second Floor- North Work Area- Struct Plan

1/4" = 1'-0"

The initial portion of the repair program provided load relief to the severely distressed slab systems through careful removal of the concrete topping that had been added in the renovation program.

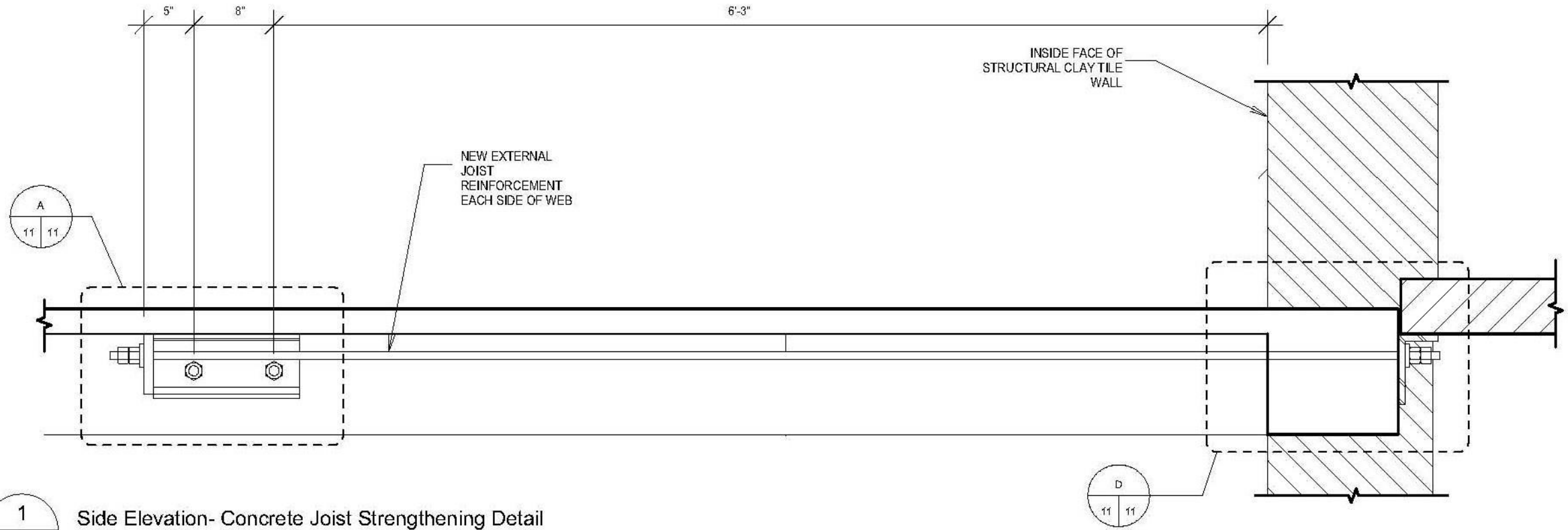
That was followed extensive structural epoxy injection of cracks throughout the floor slab and joists.


.007-.013
.016-.030
.035-.040
.020-.025
.030-.040
.020-.025



The structural repairs included use of carbon fiber reinforcing to provide additional shear strength to the ends of the historic concrete floor joists.

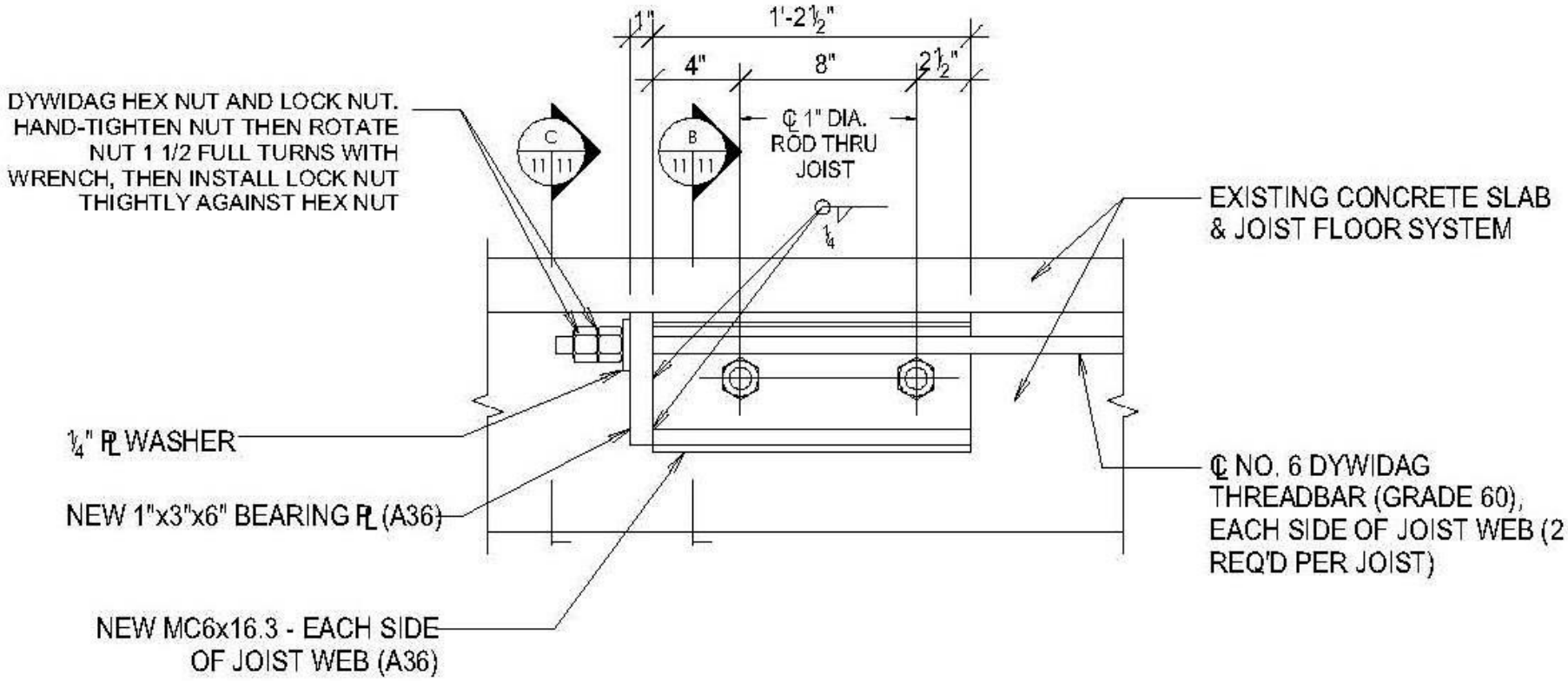
The most important aspect of the repair of the floor slab systems included use of external post-tensioned reinforcement to strengthen the ends of the floor joists in the negative moment regions.



1
6 | 11

Side Elevation- Concrete Joist Strengthening Detail

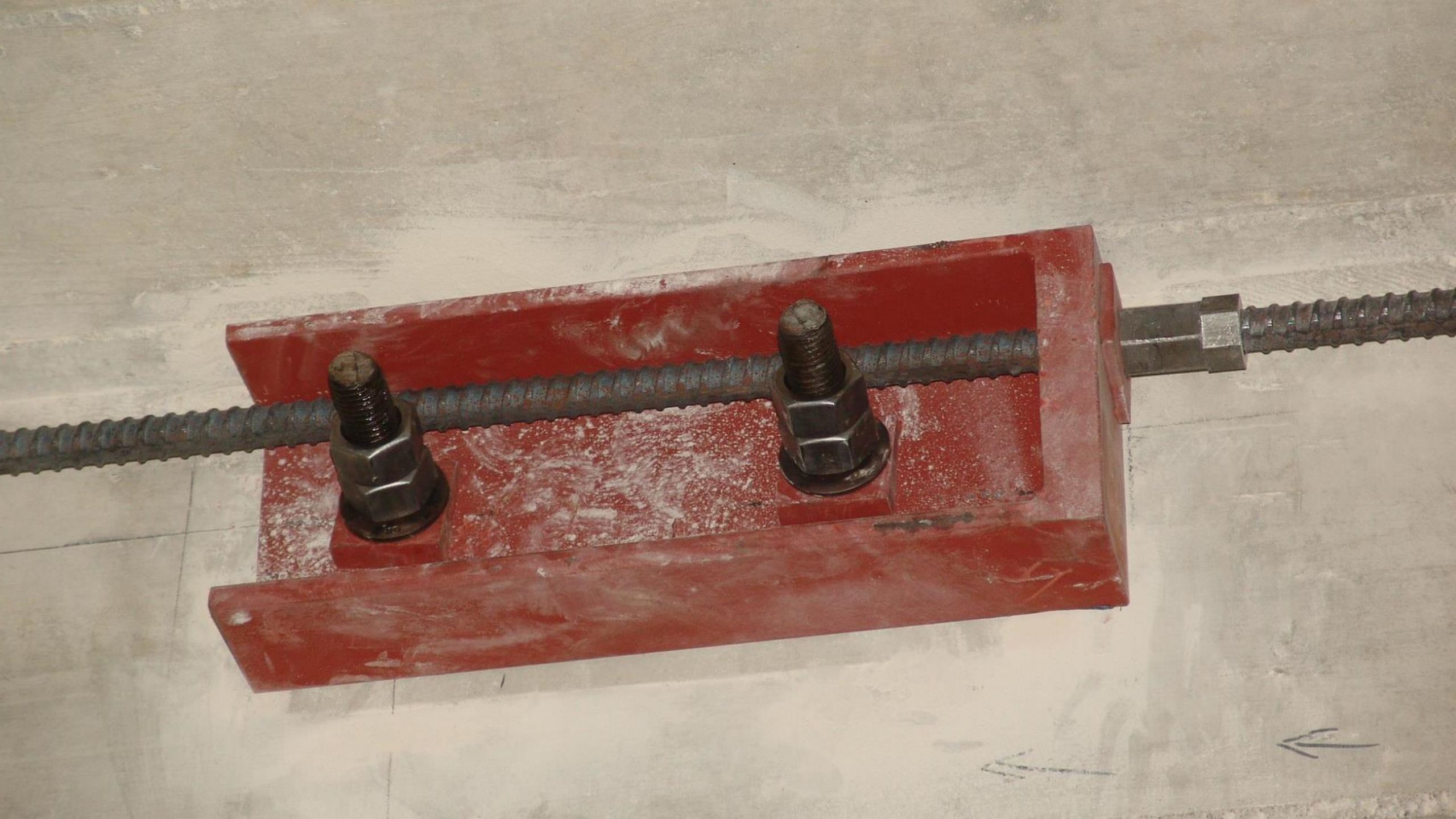
1 1/2" = 1'-0"

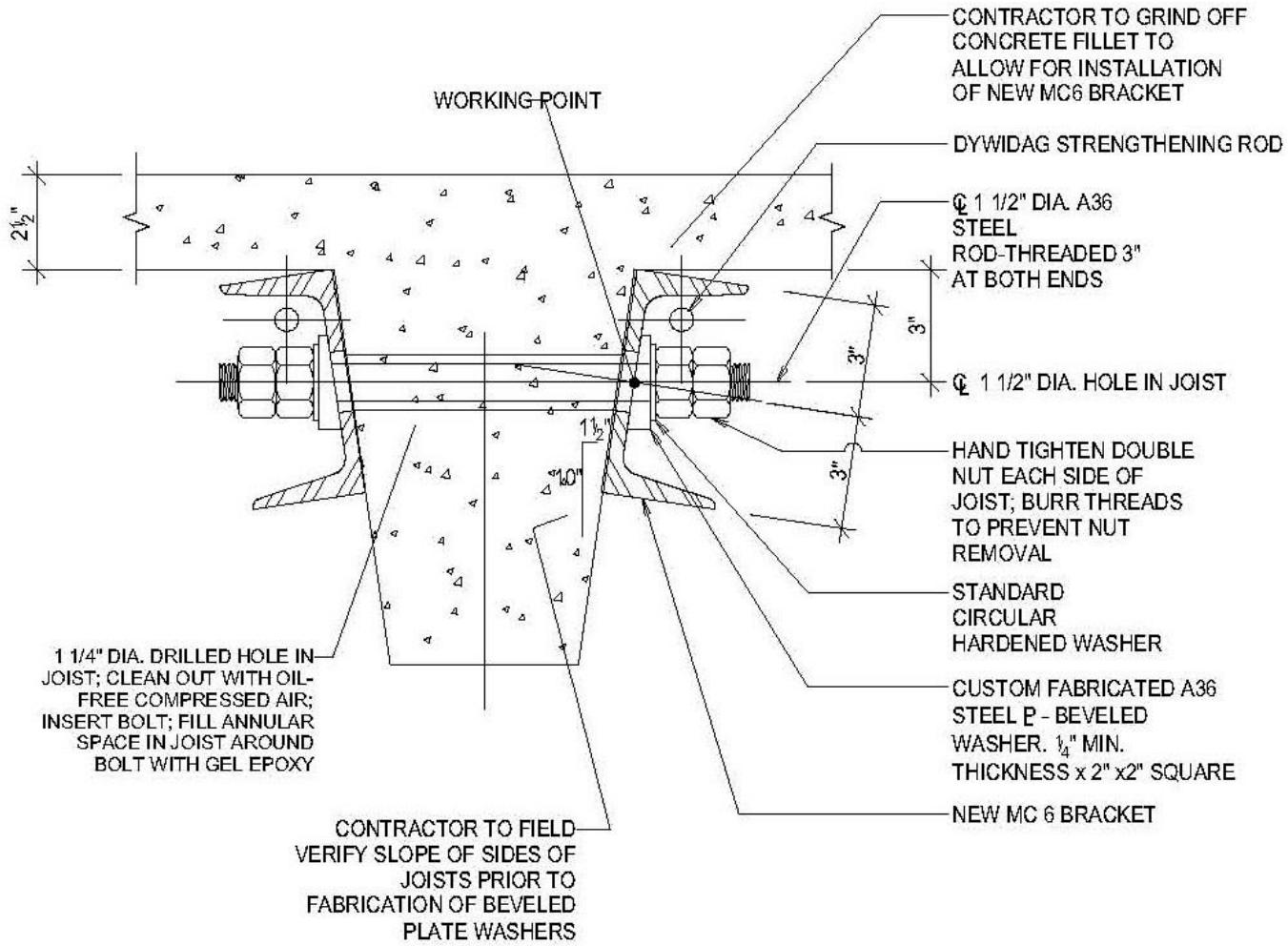


A
11 11

Partial Side Elevation of Concrete Joist- Showing New Channel Anchorage for Strengthening Rods

1 1/2" = 1'-0"



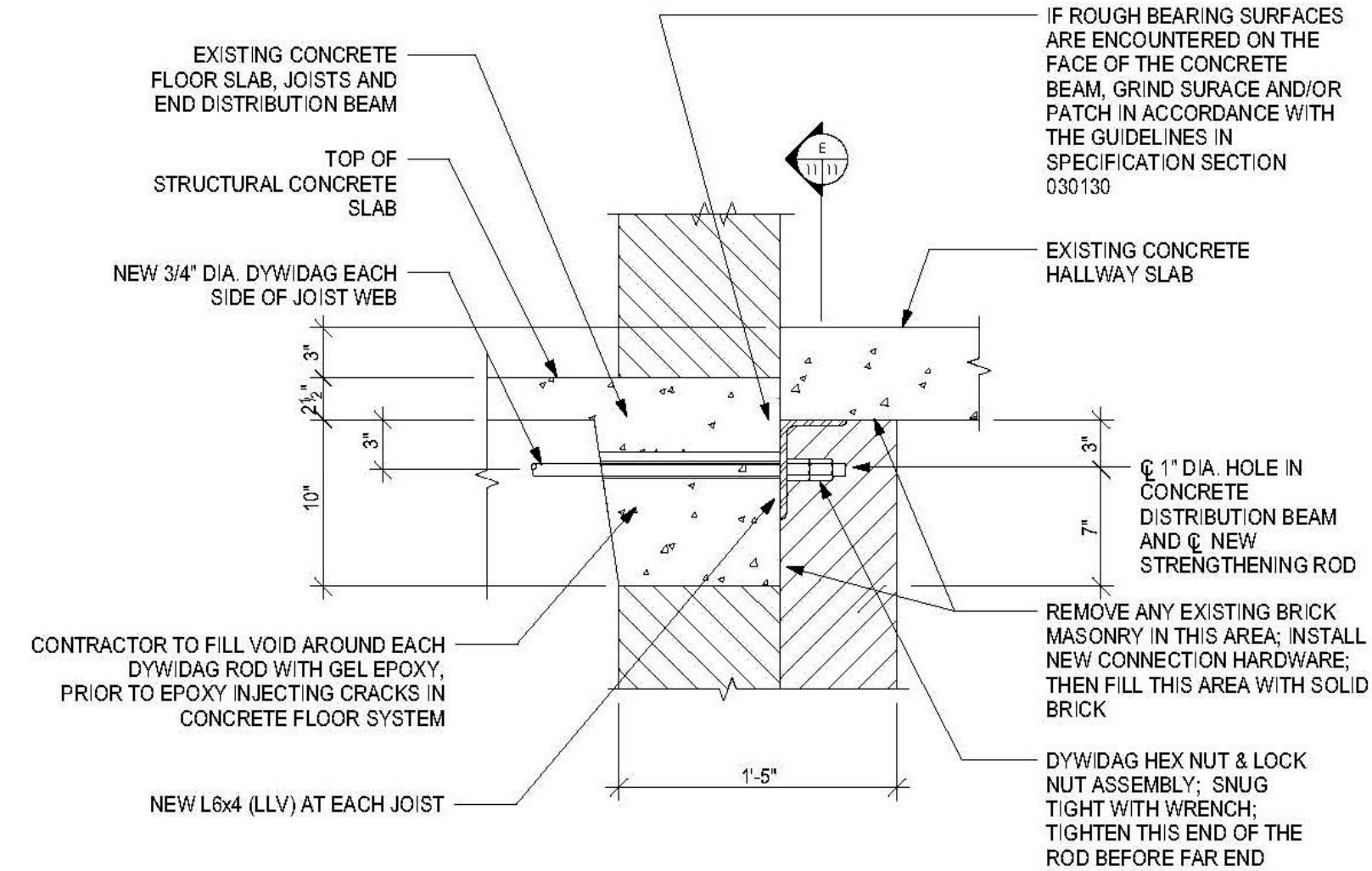


B
11 | 11

Vertical Section Showing Bolted Connector Detail for Channel Anchorage Assembly

3" = 1'-0"


PORTER-CABLE



D
11 | 11

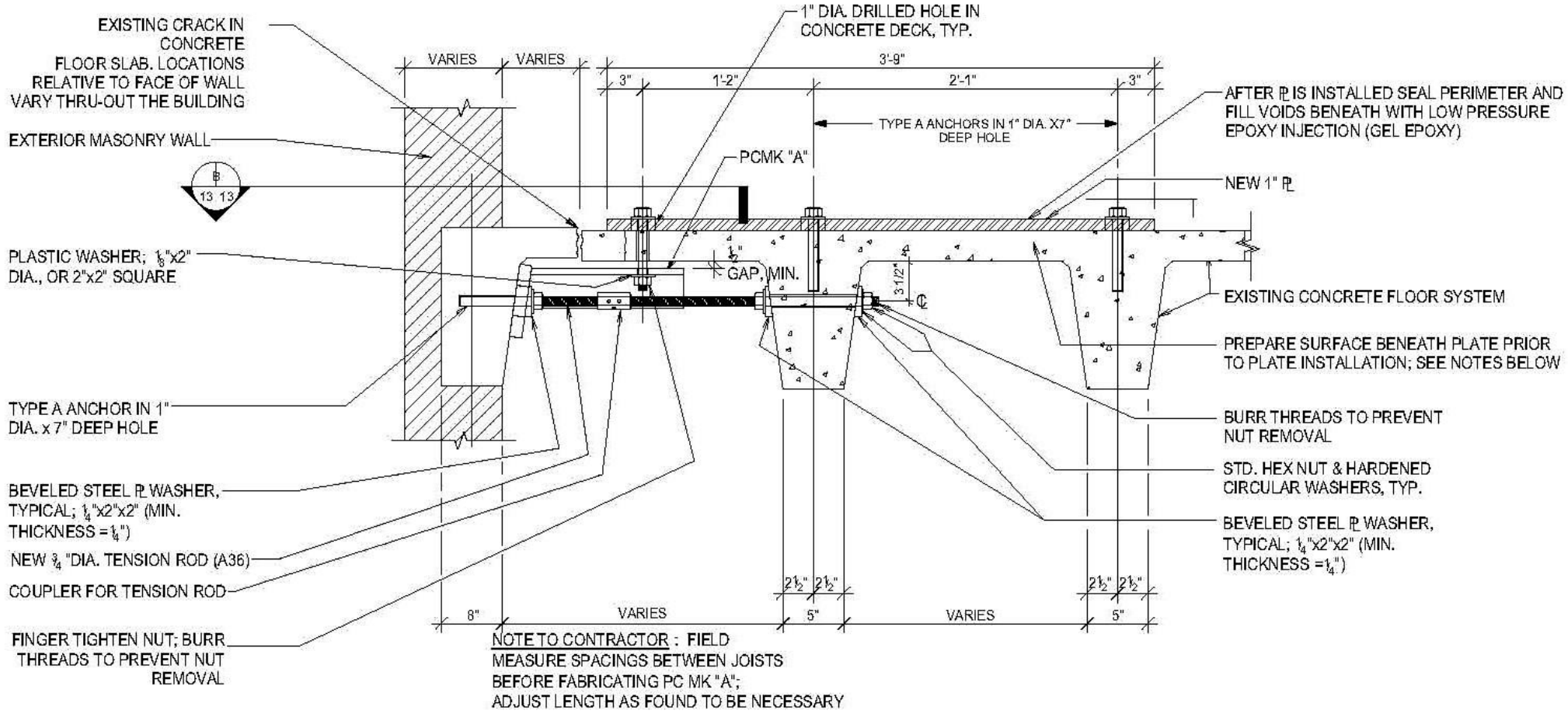
Vertical Section thru Distribution Beam at 2nd Floor Level

1 1/2" = 1'-0"

℄ JOIST


8x8
OCT 29 2009

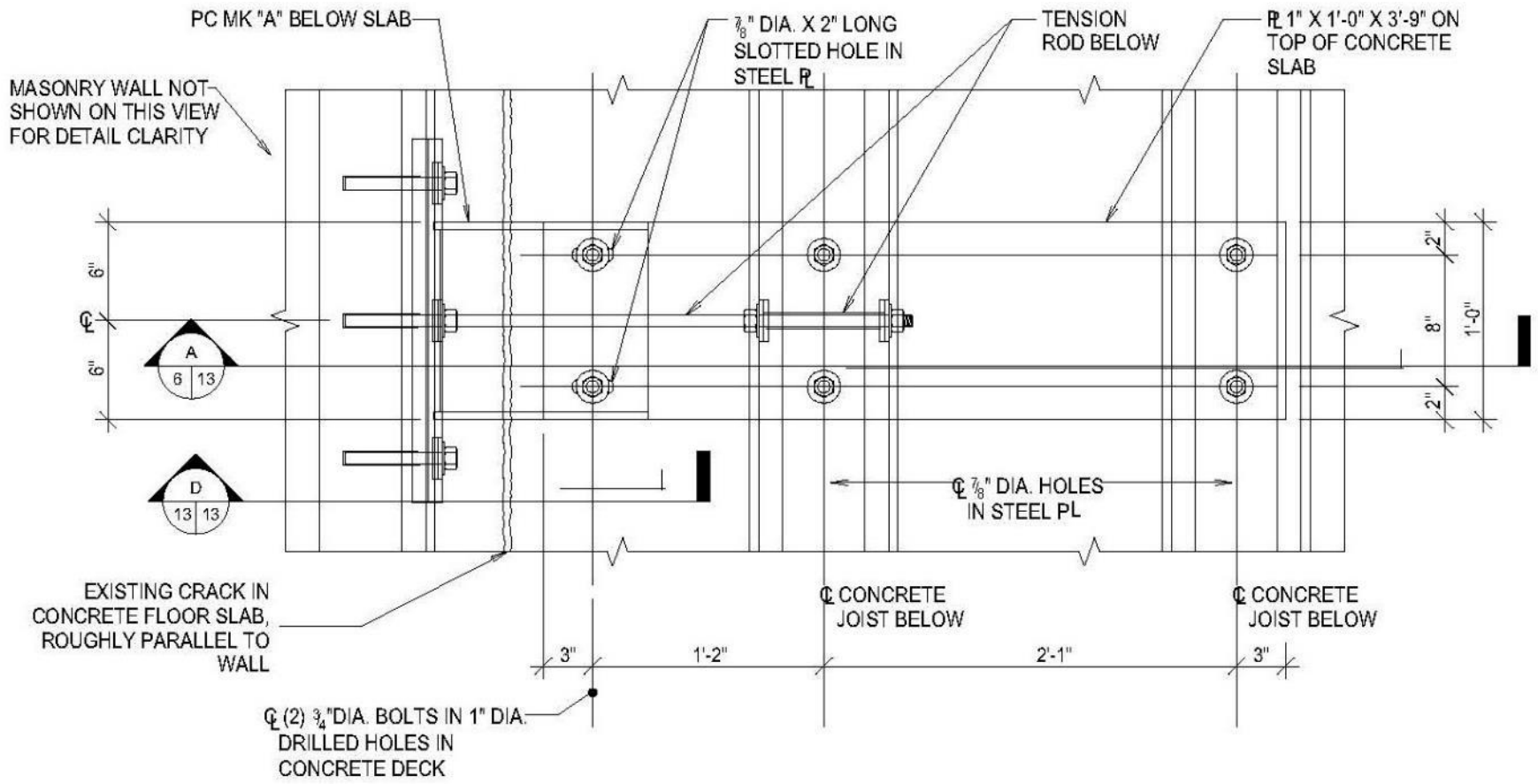
The repairs included installation of mechanical shear connections between the damaged concrete floor systems and the internal and external shear walls, to restore the horizontal shear transfer capacity.



A
13 13

Vertical Section- Lateral Support and Shear Transfer Detail- Exterior Wall-to-Floor Interface

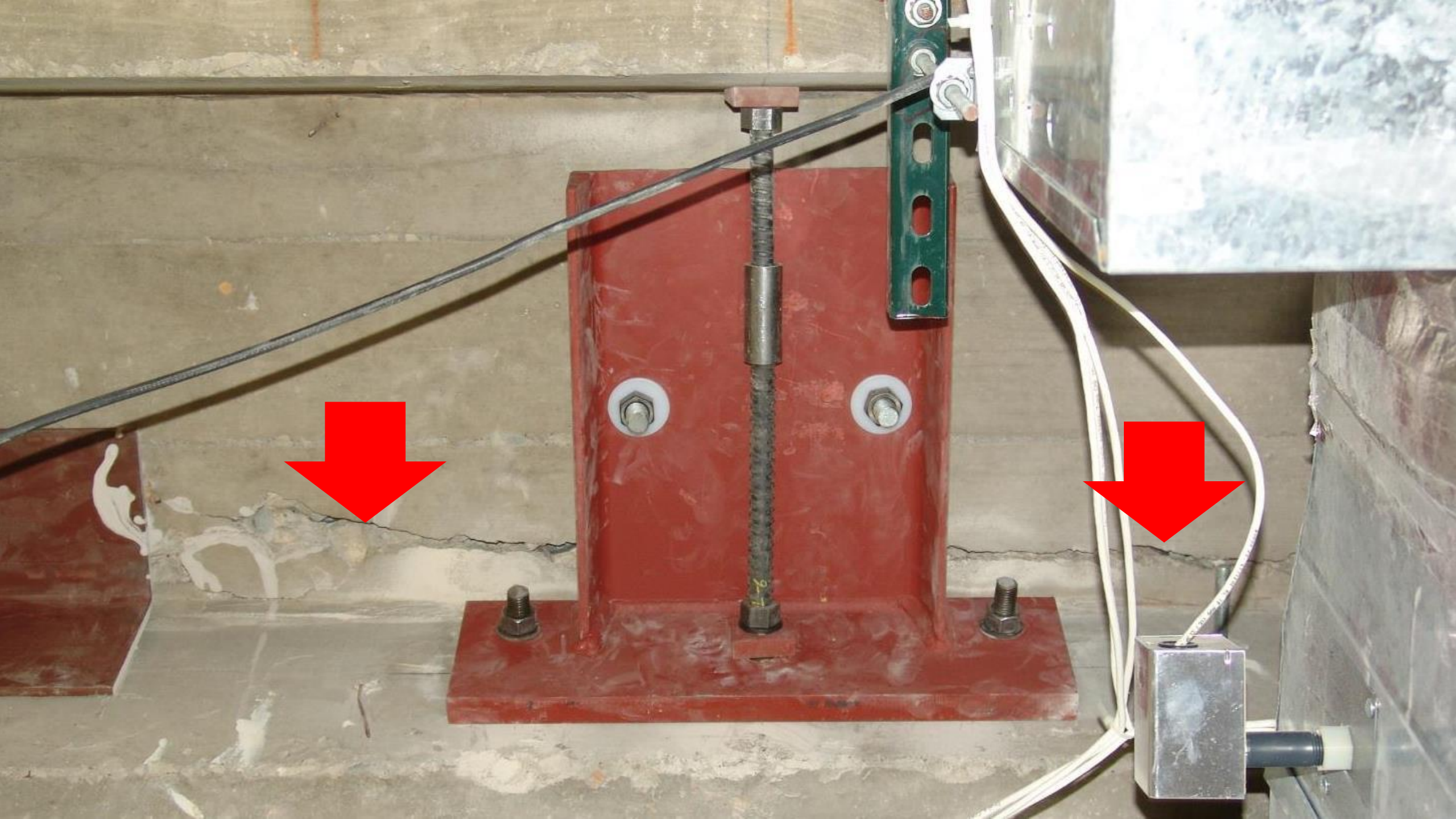
1 1/2" = 1'-0"



B
13 13

Plan

1 1/2" = 1'-0"

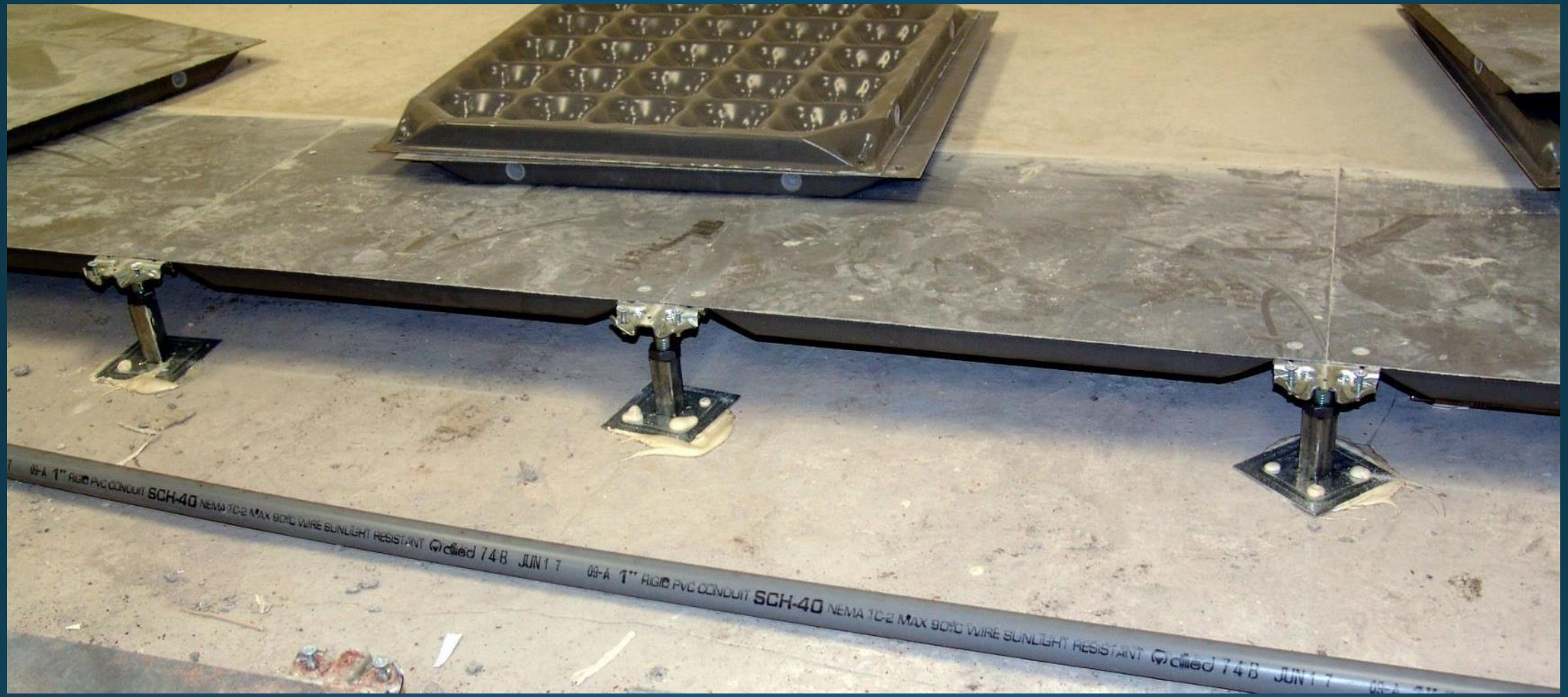



CORROSIVE
BULL

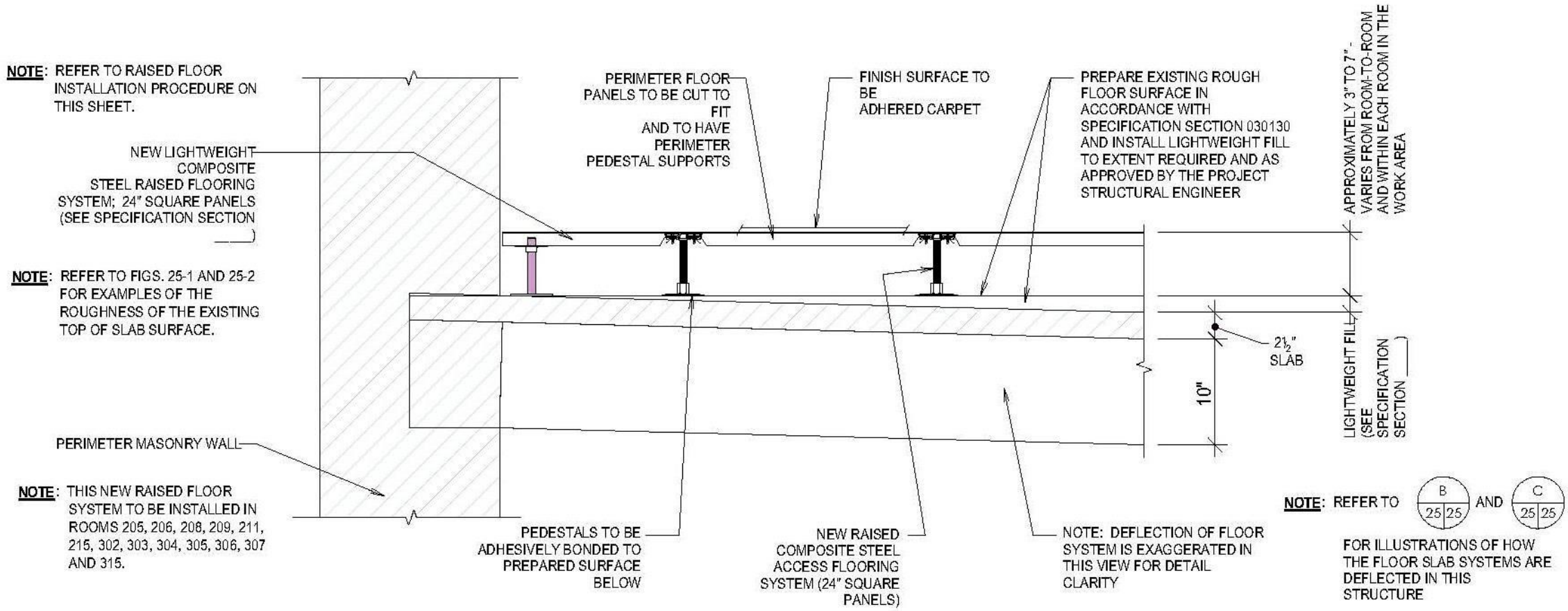
Selected areas of the existing concrete floor slab were in such bad condition, steel plates had to be installed to bridge between the joists below to prevent punching shear failures through the slab.


STANLEY
35ft
ft
in


MONARCH



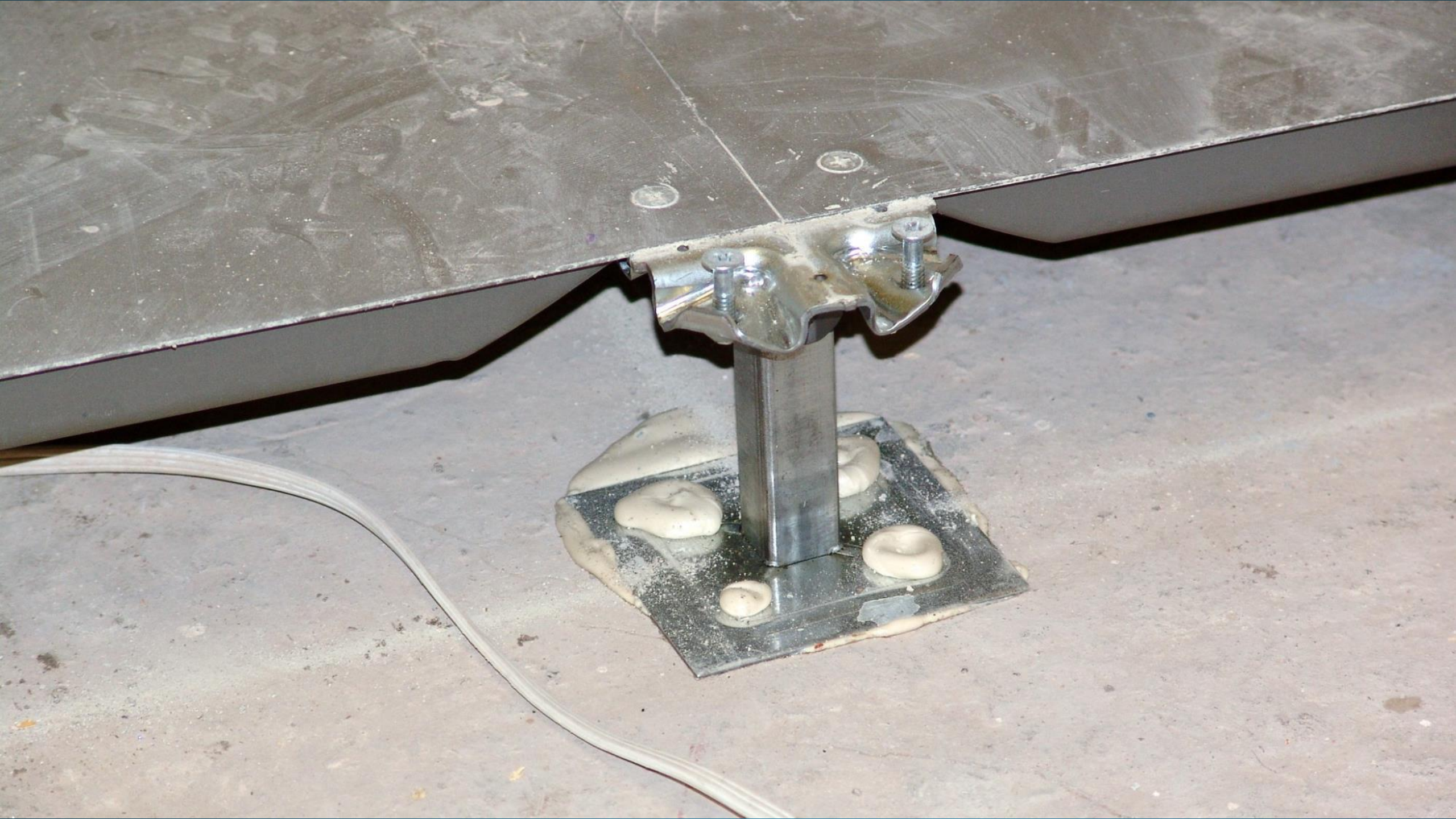
Finally, a new, lightweight, raised ceramic and metal flooring system was installed on the concrete floor slab systems to replace the concrete fill that had overloaded those floor systems during the renovation.



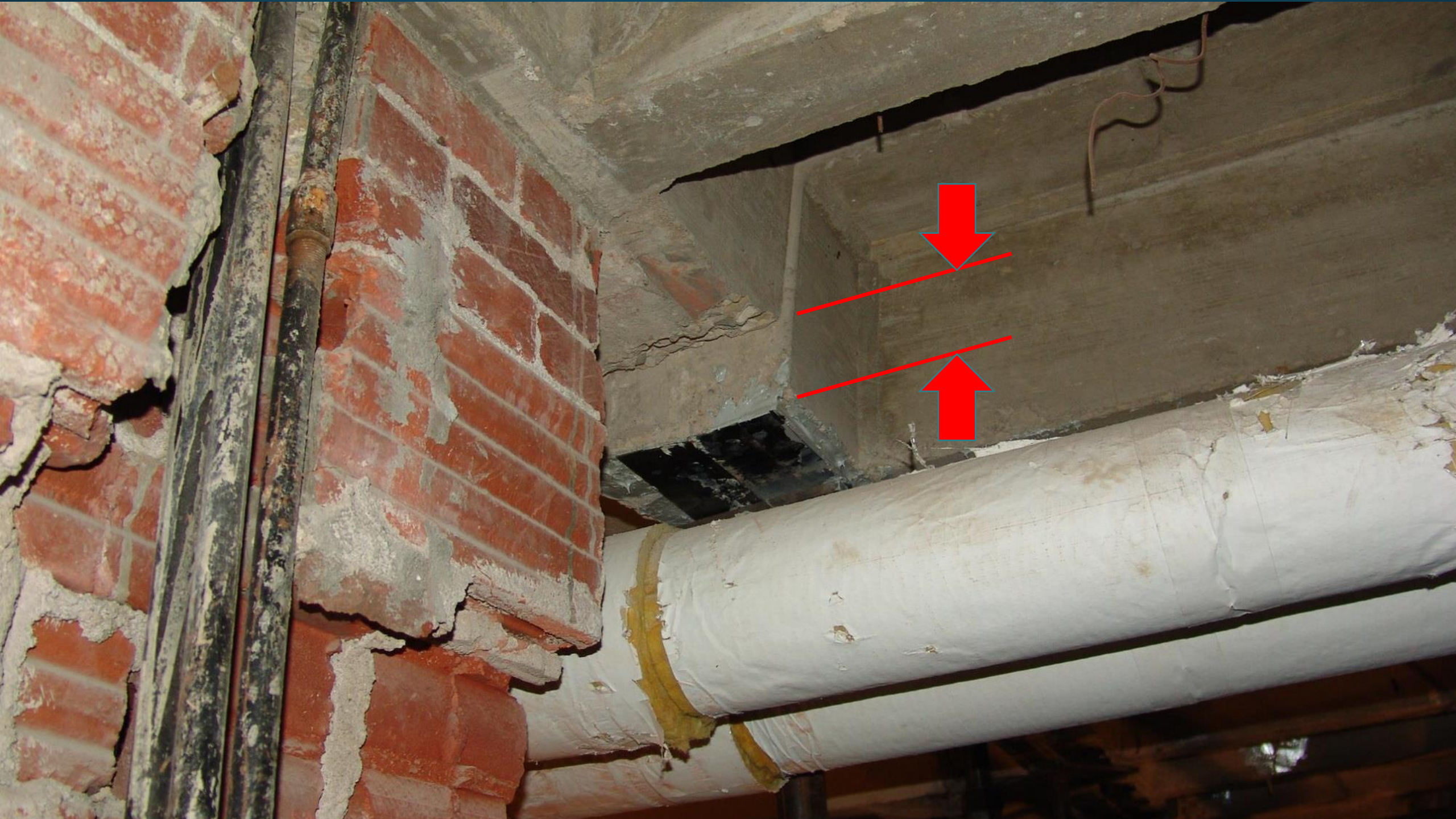
C
18 18

Vertical Section Thru New Lightweight Raised Floor System

1 1/2" = 1'-0"



Installation of large banks of new HVAC ducts through interior load-bearing structural clay tile walls caused serious vertical displacement and near collapse of a section of the concrete floor system in one area of one of the buildings.




INSPECTED
CONDUIT

The partially collapsed floor system was raised back into its original orientation with a system of hydraulic jacks, and a new concrete masonry wall constructed to replace the severely damaged structural clay tile wall that originally supported the displaced floor slab section.


OCT 31 2009

Thank you!

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