Chapter 9—Construction
Chapter 10—Quality Assurance

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Construction/Quality Assurance

- This code assigns certain responsibilities to the licensed design professional
- This presentation will focus on those responsibilities

Chapter 9-Construction

- 9.1 - Stability and temporary shoring requirements

Shoring and bracing during construction

- Typically the design of shoring and bracing is the responsibility of the Contractor.

Shoring and bracing during construction

- AIA Document A201 states in Section 3.3.1:

  The Contractor shall supervise and direct the Work. The Contractor shall be solely responsible for, and have control over, construction means, methods, techniques, sequences and procedures and for coordinating all portions of the Work under the Contract, unless the Contract Documents give other specific instructions concerning these matters.

9.1 - Stability and temporary shoring requirements

- Section 9.1.1 states that the "Contract documents for repair shall define the temporary shoring and bracing requirements for all phases of the repair project.

9.1 - Stability and temporary shoring requirements

- Section 9.1.1C states that the "Load, spacing, and placement requirements for temporary shoring and bracing at all phases of a repair should be conveyed to the contractor."

Possible language to put in General Notes:

- The contractor is solely responsible for all methods and means of construction and for job site safety.

Possible language to put in General Notes:

- The contractor is responsible for the design, installation, and performance of all shoring and bracing.
- Design all shoring and bracing to meet the required provisions and regulations of the local prevailing codes and of all other applicable regulatory agencies.

Possible language to put in General Notes:

- Provide and install all shoring and bracing prior to the removal of concrete for any structural or nonstructural components whose strength may be affected during the repair process resulting in conditions that reduce capacities below code required limits.

9.1 - Stability and temporary shoring requirements

- Temporary shoring and bracing shall be designed by a licensed design professional.

  -The contractor usually hires their own licensed design professional for this task

  -Sometimes the licensed design professional for the project performs this task

9.1 - Stability and temporary shoring requirements

- Adequate temporary shoring and bracing of affective members shall be provided during evaluation and repair construction.

Punching shear concerns discovered during initial evaluation

Temporary shoring was immediately installed by the contractor assisting with the evaluation

9.1 - Stability and temporary shoring requirements

- Temporary shoring shall be designed to accommodate in-place conditions in the structure and expected superimposed loads
- Temporary shoring shall be reviewed by the licensed design professional for the repair project to assess the impact of the shoring on the existing structure.

LDP must check capacity of framing to support shoring

9.1.2 – Global structural stability

- Global stability shall be maintained prior to and during all stages of the repair project

  -Defined as the stability of the overall structure with respect to uplift, sway instability, or sliding failure.

9.1.3 – Existing member stability

- "Existing member stability, including the effect of modifications or repairs to existing lateral bracing members shall be evaluated and maintained at all times."

9.1.3C – Existing member stability

- Indicates that a lateral force of 2 percent of the axial load in member being braced is commonly used.

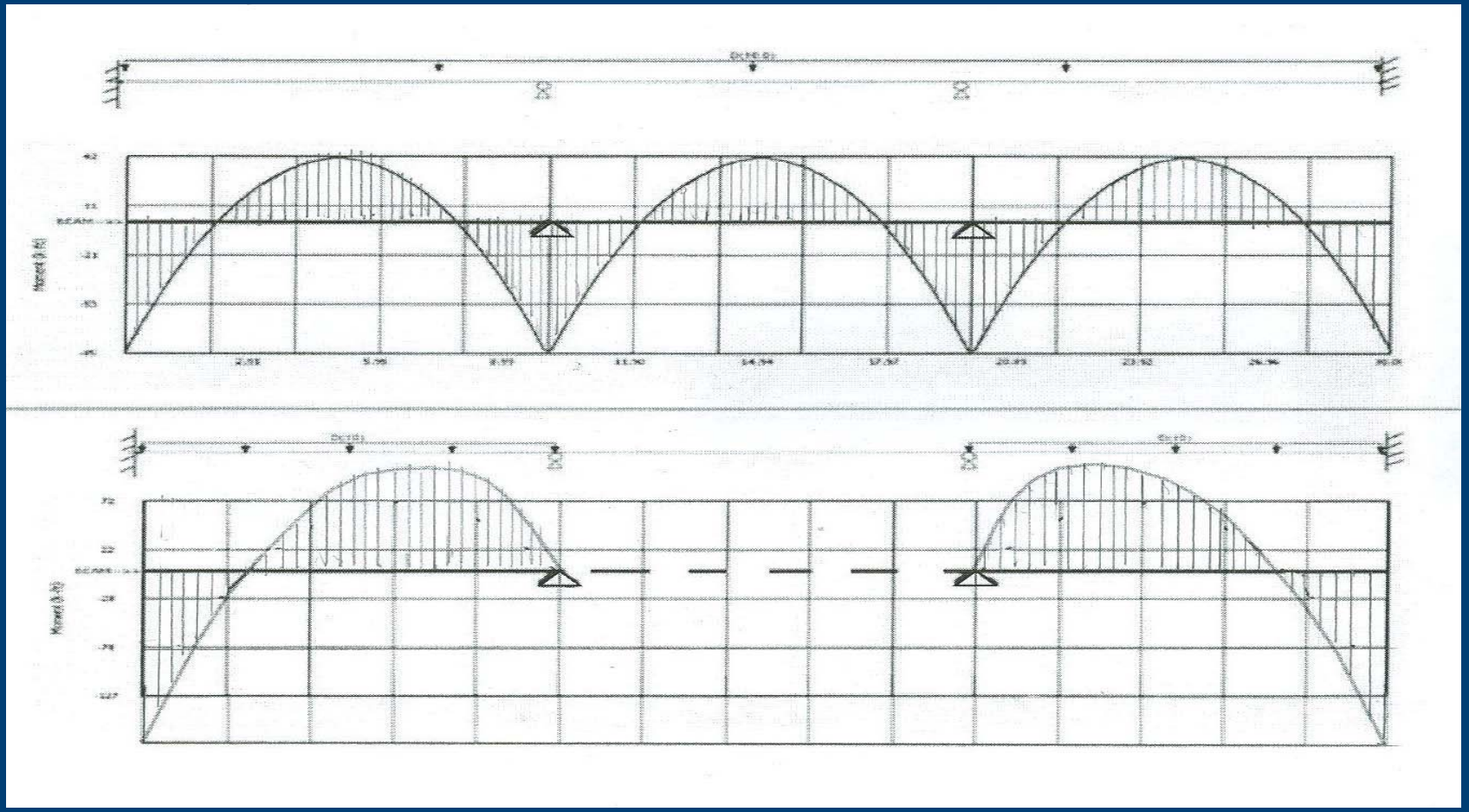
Global Stability

Temporary bracing of columns

9.1.4 Design of shoring and bracing

- The design of shoring and bracing members during the repair or removal of existing adjacent framing shall consider changes in load paths and unbraced lengths, and the redistribution of loads and internal forces…

9.1.4 Design of shoring and bracing—redistribution of loads due to removal of member



9.1.5 Support of construction loads

- Where existing structural members support the structure and loads generated during the evaluation and repair construction, the design strength of those shall be evaluated and shall exceed the temporary required strength due to construction loads.


89
208
GOLF

9.2.1 Load and load factors

- Load and load factors during the evaluation and repair construction process shall be in accordance with 5.1.4.

9.2.1 Load and load factors

- Section 5.1.4 indicates:
  - If the building is occupied during the construction loading shall be in accordance with ASCE/SEI 7.
  - If the building is unoccupied during the construction, loads shall be in accordance with ASCE/SEI 37.

9.3.1 Contract documents requirements

- Contract documents prepared by the licensed design professional shall instruct the contractor or other designated party to be responsible for all specified environmental remediation measures….

9.3.1 Contract documents requirements

- Contract documents shall also indicate that the contractor report any new conditions encountered, and for the control of all construction debris, including environmentally hazardous materials.

AIA Document A201

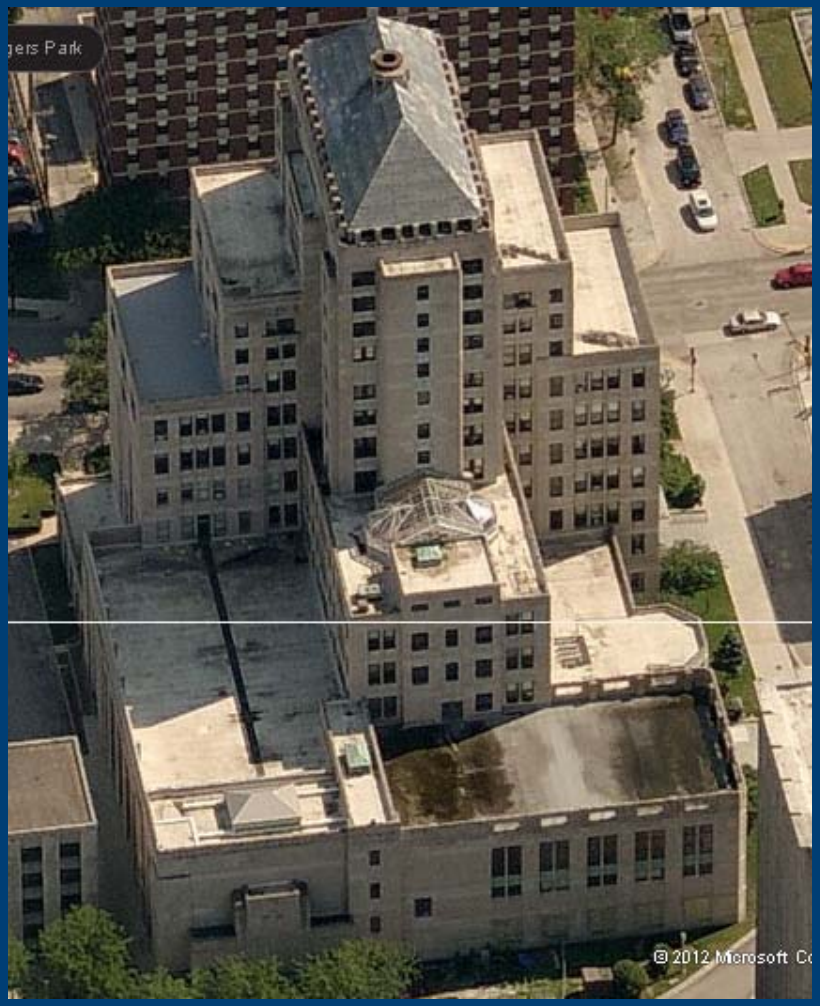
- 10.3.1 The Contractor is responsible for compliance with any requirements included in the Contract Documents regarding hazardous materials

AIA Document A201

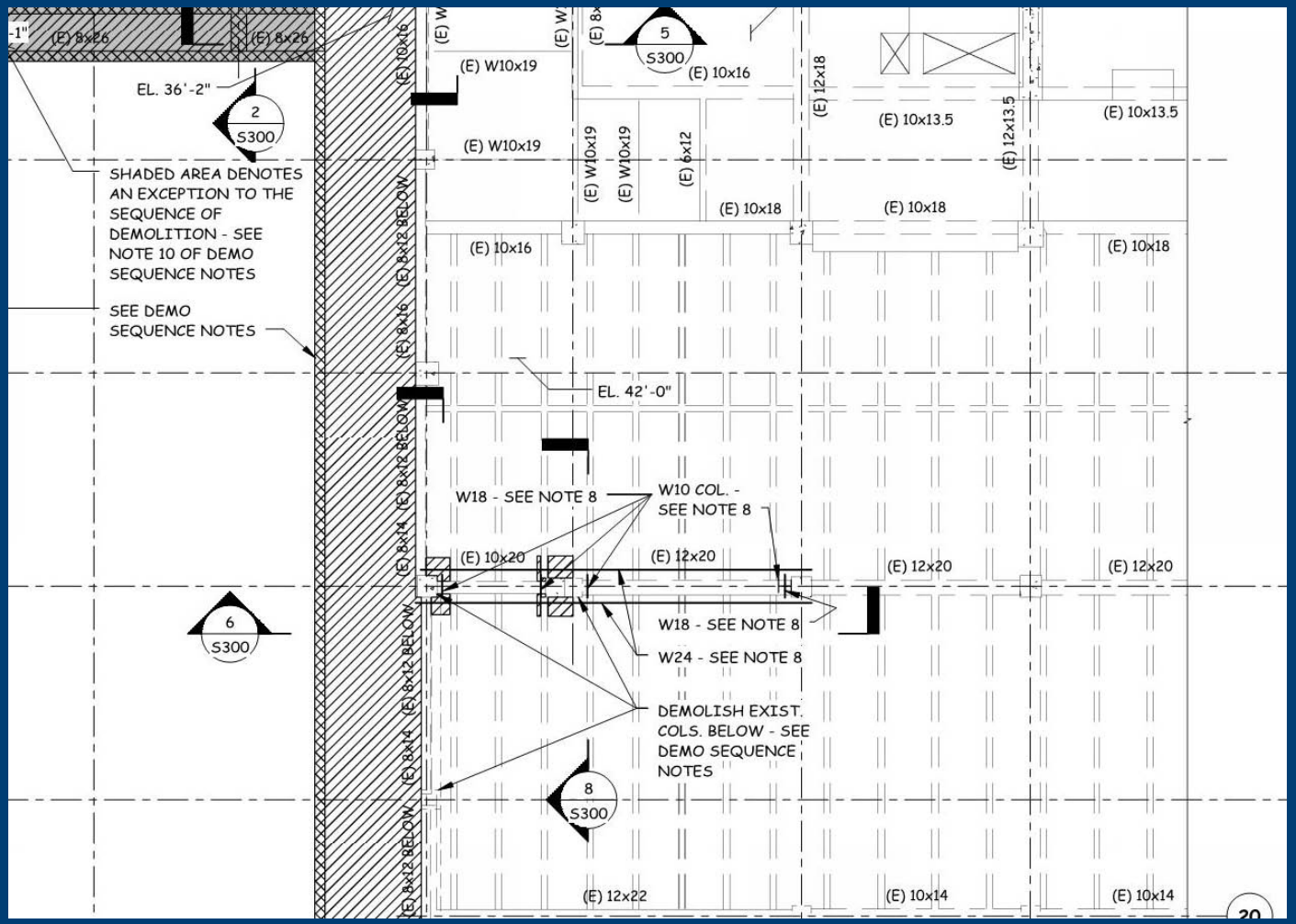
- 10.3.1 If the Contractor encounters a hazardous material or substance not addressed in the Contract Documents….the Contractor shall, upon recognizing the condition, immediately stop the Work in the affected area and report the condition to the Owner and Architect in writing.

Case study illustrating Contract Documents defining temporary shoring and bracing requirements

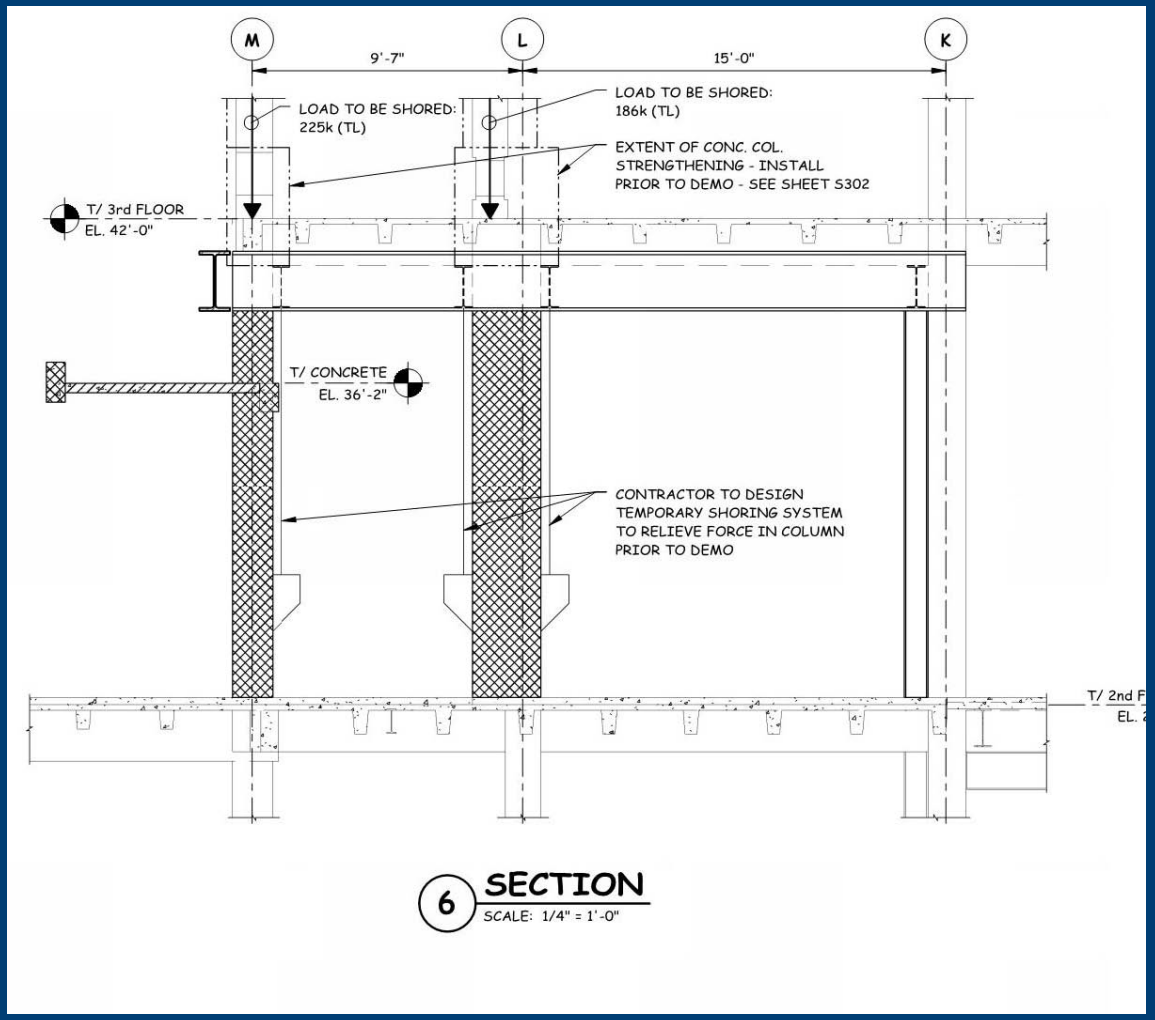
Addition to University Midrise Building



Case study-defining of temporary shoring and bracing requirements



Case study-defining of temporary shoring and bracing requirements



Case study-defining of temporary shoring and bracing requirements

DEMOLITION SEQUENCE NOTES:

PRIOR TO DEMOLITION OF THE EXIST. THIRD FLOOR PERIMETER RUNNING TRACK FRAMING, EXIST. BALCONY AND EXIST. COLUMNS AT M17, K17 AND M19 (2nd TO 3rd FLOOR) THE FOLLOWING MUST BE COMPLETED:

1. PHASE 5E FOUNDATION AND COLUMN WORK BELOW 2nd FLOOR.
2. NEW STEEL COLUMNS AND CONNECTIONS ALONG COLUMN LINE R.
3. NEW STEEL COLUMNS AT P10 AND P12.
4. NEW COLUMNS AT M14, M21 & K17.
5. 3rd FLOOR CONCRETE TRANSFERS AT EXIST. COLUMNS L17 & M17.
6. NEW TRANSFER TRUSS BETWEEN M14 & M21.
7. NEW DOUBLE TRANSFER BEAMS BETWEEN M17 & K17.
8. 4th FLOOR COMPOSITE FLOOR TRUSS FRAMING WITH HANGERS TO 3rd FLOOR BELOW.
9. ALL NEW 3rd FLOOR STEEL FRAMING INCLUDING COMPOSITE DECKING
10. EXCEPTION: AREA OF EXIST. BALCONY MAY BE DEMOLISHED PRIOR TO THE ABOVE STEPS - SEE DEMO PLAN FOR SHADED AREA.

Case study-defining of temporary shoring and bracing requirements

- Contractor decided to hire our firm (Engineer of Record) to design shoring and bracing for column removal phase of project

Case study-defining of temporary shoring and bracing requirements

Proposed Construction Sequencing

Columns M 17 and L 17

1. Remove masonry, limestone, and clay tile walls to expose the columns as required.
2. Roughen all four sides of the existing columns to ¼" amplitude in the areas receiving new column strengthening concrete. Provide 1-1/2" notches as shown on sheet S302.
3. Install transfer truss, girders, and columns as shown on structural drawings. Do not attach truss members to column at M19 per 14/S404 & 10/S404.
4. Install deflection gages and load cells to measure acutely the load transfer from columns to the framing.
5. Install steel framing on sheet S2 above 3rd floor.
6. Install concrete jacket and encase steel framing above 3rd floor per S2 and S302. Leave gap at base for installation of jacks.
7. Install 60 ton hydraulic jacks with lock nut (ENERPAC CLL-5010 OR CLL-504 OR EQUAL) as shown on S2. Verify fit before ordering. Use manifold to load the jacks at the same pace. Hydraulic jacks are to be loaded to 225 kips (M17) and 186 kips (L17) in increments of 10 after the column new concrete strengthening has attained a minimum 3000 psi compressive strength. EOR will compare actual deflection to calculated deflection.
8. EOR to watch the behavior of the new framing and transfer girder for a minimum of 15 minutes at each incremental loading and record readings of the gages.
9. Increase to next load increment only after satisfying the stability of the framings and existing structure. If there are sign of distress or excessive deflection observed, unload the jacks gradually.
10. After successful transfer of the column dead load to the new framing, watch the behavior of the framing for 24 hours.
11. Attach transfer truss at M19 per M19 per 14/S404 & 10/S404.
12. Pour the remaining bottom portion of the concrete transfer jacket per S302. The hydraulic jacks will be encased in concrete and left in place.
13. Demolish the existing columns flush with the new framing bottom chord between second floor and third floor.
14. Weld cover plate to protect jack left in place on transfer truss at M17.

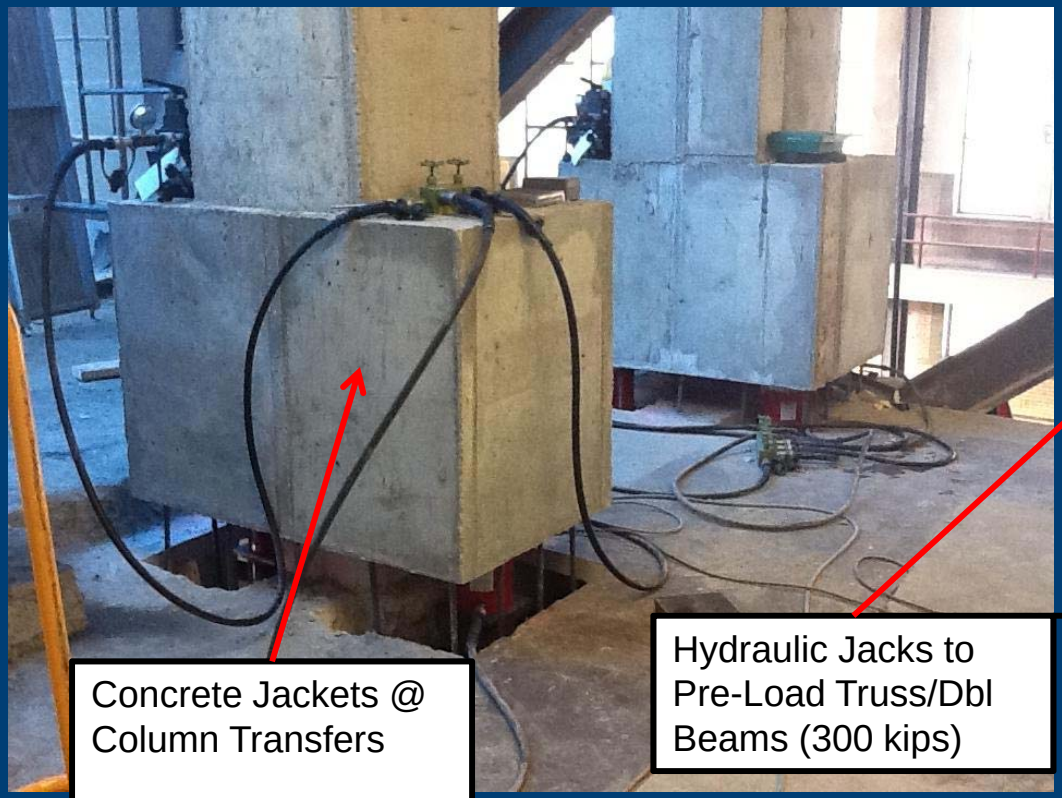
Case study-defining of temporary shoring and bracing requirements

New 13 ft deep, 42 ft long transfer truss

Columns to be removed

Case study-defining of temporary shoring and bracing requirements

- New Theatre – Column Removal



Case study-defining of temporary shoring and bracing requirements

Chapter 10-Inspection requirements

10.1- Inspection

10.1.1 Concrete repair and rehabilitation construction shall be inspected as required by the general existing building code or as required by the local jurisdiction

10.1.1C Inspection requirements

In the absence of such inspection requirements the licensed design professional should recommend to the owner that concrete repair and rehabilitation should be inspected during the various work stages by a licensed design professional, a qualified inspector, or a qualified individual.

Reasons why inspections should be performed include:

- It is the owner's best assurance that the work will be done in accordance with the contract documents
- Verify quality of work
- Better control of quantities of work required
- Document quantities

Reasons why inspections should be performed include:

- Existing conditions vary throughout project requiring modifications to details on drawings
- Assist contractor to solve problems found during the course of the work
- Verify that required quality control procedures and tests are performed

10.1.2 Testing and inspection requirements

- The licensed design professional shall include in the contract documents testing and inspection requirements applicable to project.
- These requirements are usually included in the project specifications.

10.1.2C Testing and inspections may include:

- Delivery, placement, and testing reports
- Concrete removal and surface preparation
- Placing of reinforcement and anchors
- Mixing, placing, and curing of repair materials
- General progress of work
- Other testing and inspections pertinent to the work

10.1.2C Testing and inspections may include:

- Inspections should be performed by either repair inspectors or the licensed design professional.

10.1.2C Testing and inspections may include:

- The findings during the inspections should be documented and reported as required by the contracted documents.

10.1.2C Testing and inspections may include:

- If the inspections shows readily correctable issues and the issues are corrected by the contractor, then the inspected work should be documented and reported.
- Nonconforming or deficient components, processes, and procedures should be reported to the licensed design professional for review and actions should be made to correct these deficiencies.

Klein and Hoffman, Inc.
Structural and Restoration Engineers

150 South Wacker Drive, Suite 1900
Chicago, Illinois 60606
Tel: 312-251-1900
Fax: 312-251-1960

55 East Monroe

Field Report No. 21

To: GlenStar Properties, LLC
55 East Monroe Street
Chicago, IL 60660

Attn: Mr. Steve Smith

Present: Francisco Castro (K&H), Ted Chakos, Dan Data, work crew (GC)

Project No. 6585.005
Date: 09/27/06
Project: Parking Garage Rehabilitation
Location: 55 E. Monroe St., Chicago IL
Contractor: Golf Construction (GC)
Owner/Agent: GlenStar Properties (O/A)

Temperature: 60's **at:** 7:00AM
Weather: Partly cloudy

General:

K&H conducted two site visits (09/26/06 and 09/27/06) to review work in progress and placement of new concrete material of Phase 1 on P4 level. The 09/26 pour was from pass column line D to the middle bay of column lines J-K. The 09/27 pour was the middle bay of column lines J-K to the middle bay of column lines M-N. Universal Construction Testing (UCT) provided concrete quality control services. Ozinga provided the concrete material.

Observations:

- Shoring for Phase 1 P4 level was in place at both P3 and P2 levels.
- Final reviews of areas to receive new concrete were performed just prior to the start of the concrete pours. Exposed reinforcing bars were cleaned, additional reinforcing steel bars were installed, galvanic anodes were installed, and substrate was saturated surface dry. Prior to placement of new concrete material, Sika Armatec 110 (bonding agent) was spray applied. No deficiencies in the preparation were noted.
- The first Ozinga concrete trucks arrived on site at about 9:00AM for the 09/26 pour and at about 8:00AM for the 09/27 pour. UCT performed the required on site concrete tests. UCT obtained cylinder samples for the required laboratory tests. Additional test were performed on every other truck. No deficiencies were identified in the concrete.
- New concrete material was placed in a continuous operation until prepared section was completed. New concrete was float finished and broom. Finished concrete elevation provided required coverage of existing reinforcing steel bars.
- Finished concrete surface was covered with wet burlap to protect and provide curing of new concrete.
- No deficiencies were noted in the installation of the new concrete.

Notes:

- Approximately a total of thirty eight (38) full depth slab repairs were required for the combine length of both pours.
- During K&H site visits, It was noted large amount of demolition concrete debris accumulated at P3. GC was advised to remove periodically the concrete debris to prevent overload of the floor slab.

10.1.2C Nonconforming repair construction may include:

- Existing construction that differs from the repair documents
- Existing construction deterioration, distress, or levels of distress beyond those anticipated in the design of the repairs
- Deficiencies in construction processes and procedures

10.1.3 Concealment of work

- The licensed design professional shall require that existing conditions and reinforcement shall not be concealed with materials that obscure visual inspection before completion of inspection unless the licensed design professional determines that it is only necessary to inspect representative locations rather than every repair location.

10.1.3C Concealment of work

This includes:

- Existing reinforcement
- Embedded items such as anodes
- New reinforcement
- Anchors

10.1.3 Concealment of work

10.2.1 Material Tests

- Repair material tests and test frequencies shall be specified by licensed design professional in the contract documents.
- Shall be reported as required by contract documents and general existing building code.

10.2.1C Material Tests

- The licensed design professional usually must rely on the manufacturers data for proprietary repair materials.
- If necessary, have the manufacturer perform testing to confirm that their material achieves published values that they have provided for project.

10.2.1C Material Tests

- Testing of conventional cast-in-place concrete should comply with testing and frequency for new construction

10.3.1 Construction observation

- Construction observation shall be performed as required by the contract documents.

Case study illustrating the importance of quality assurance testing

Installation of a lightweight concrete bonded overlay in a parking garage

at the lower levels of a 50 story building

American Concrete Institute

Always advancing

Inspection, testing and construction observation

Inspection, testing and construction observation

- Prior to the start of the production work a mockup was installed which was extensively tested.
- The testing would include:

  -Tensile bond tests of the overlay concrete to the substrate

  -Cores were removed so that the lightweight aggregate of the substrate and the repair concrete could be compared

Inspection, testing and construction observation

Inspection, testing and construction observation

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Inspection, testing and construction observation

Table 1. Bond Test Data

Test No.	Test Location	Test Parameters		
		Reading, kN	**Bond Strength, psi**	Separation Plane
A1	Level P8, Floor slab Mock-up area A, Slurry	4	**126**	Structural concrete
A2	Level P8, Floor slab Mock-up area A, Slurry	3.5	**110**	Surface of the structural concrete
A3	Level P8, Floor slab Mock-up area A, Slurry	3.5	**110**	Surface of the structural concrete
B1	Level P8, Floor slab Mock-up area B, Armitage	5.0	**157**	Structural concrete
B2	Level P8, Floor slab Mock-up area B, Armitage	4.5	**142**	Surface of the structural concrete
B3	Level P8, Floor slab Mock-up area B, Armitage	4.5	**142**	50% Structural concrete 50% Surface of the structural concrete

Inspection, testing and construction observation

- Extensive testing of the repair construction work was performed throughout the duration of the project.
- Pull-off testing was performed to confirm the adequacy of the bond of the overlay to the substrate concrete.

Inspection, testing and construction observation

Inspection, testing and construction observation

Inspection, testing and construction observation

Inspection, testing and construction observation

Inspection, testing and construction observation

Table 2. Bond Test Data

Test No.	Test Area and Location	Date of Placement	Test Parameters		
			Reading, kN	Bond Strength, psi	Separation Plane
BT-1	Level P9, on Column Line 2 between Column Lines G & H	6-29-06	2.5	79	Parent Concrete
BT-2	Level P9, on Column Line 2 between Column Lines K & L	6-29-06	3.0	95	Parent Concrete
BT-3	Level P9, West of Column Line 2 between Column Lines N & P	7-08-06	1.0	32	75% Interface, between parent concrete & overlay, 25% within parent concrete
BT-4	Level P9, between Column Lines 8 & 9 and J & K	7-14-06	6.0	190	Test Epoxy Media
BT-5	Level P9, between Column Lines 8 & 9 and F & G	7-14-06	6.0	190	Parent Concrete

Inspection, testing and construction observation

55 East Monroe, Chicago, Illinois
August 14, 2006

UCT No. 06054

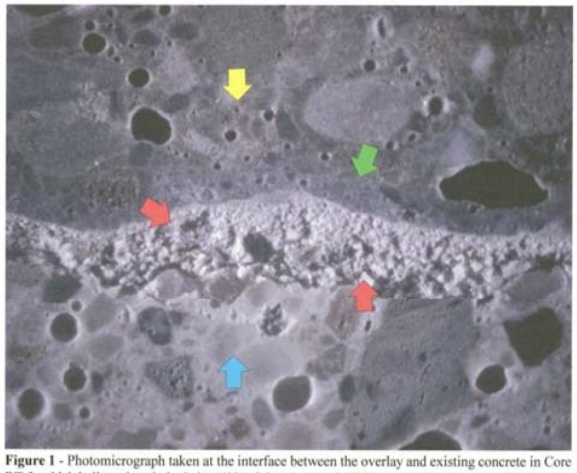

Figure 1 - Photomicrograph taken at the interface between the overlay and existing concrete in Core BT-3, which indicated a relatively low (32 psi) bond strength. This cross section shows a high porosity (loose) material between the bonding agent layer (green arrow) and the original concrete (blue arrow). Note the layer of loosely compacted material on top of the existing concrete (red arrows). This material is soft and friable, and represents a zone of weakness that ultimately becomes the failure plane.

UCT

Inspection, testing and construction observation

- Actions taken to improve bond strength:

  -Contractor improved methods to clean surface of substrate and to remove all residue resulting from hydro demolition

  -K&H inspectors more closely examined surface of substrate for suitability to receive bonded overlay

Inspection, testing and construction observation

Table 5. Bond Strength Test Data

Test No.	Test Area and Location	Date of Concrete Placement	Test Parameters		
			Reading kN	Bond Strength, psi	Separation Plane
BT-16	Level P9, NWC	not provided	5.5	**174**	Interface zone
BT-17	Level P9, SWC	not provided	2.5	**79**	Parent concrete
BT-17A	Level P9, SWC, 9' N. of Core BT-17	not provided	3.5	**100**	Interface zone
BT-17B	Level P9D, West, 3' N of Core BT-17	not provided	3.5	**100**	Interface zone
BT-18	Level P8D, West	not provided	6.5	**206**	Interface zone
BT-19	Level P8D, West, column 2 between N & P	not provided	6.0	**190**	Interface zone

Inspection, testing and construction observation

Mrs. Homa Ghaemi, S.E.
August 23, 2006

UCT Project No. 06054

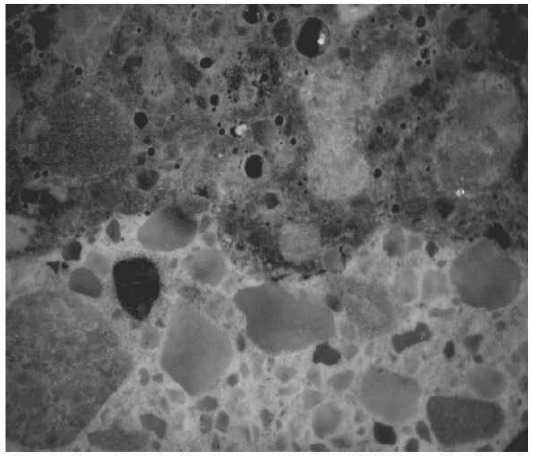

Figure 3 - Photomicrograph of interface concrete in Core BT-13. It is noted that the repair concrete is well bonded to the existing parent concrete and represents a sound bond. No debris, microcracking or poor consolidation is present. Length of view is approximately 0.35".

Conclusions

- The construction phase of the work must be done with high quality workmanship and materials that satisfy the intent of the construction documents.

Conclusions

- This code assigns certain responsibilities to the licensed design professional during construction regarding quality assurance that they must understand and follow.

Thank you very much!

Questions?