ANDERSON ENGINEERING, INC
EMPLOYEE OWNED

March 23, 2010

Mr. Dave Hunt
602 S. Main Street
Joplin, MO 64801

Ref: Joplin Parking Garage
6th and Virginia
Joplin, MO 64801

In accordance with our meeting this morning, we have prepared this cost proposal to perform a structural evaluation of the corroded steel brackets supporting the upper level parking deck over the south side of 6th Street.

Our initial evaluation found the steel severely deteriorated from the long-term effects of water seeping through the expansion joint, which has caused significant rusting of the bracket and at least one steel tube column. There are portions of the bracket that were not visible, which may also be in a severely corroded condition; therefore, we have recommended closing this area of deck and location of 6th Street. We are recommending no vehicular traffic be allowed on top of the parking deck and no vehicular or pedestrian traffic be allowed below the deck on 6th Street.

We further recommend an immediate structural evaluation of the slab and bracket to determine the most appropriate method of stabilizing this deck by using temporary shoring to allow the street and deck to re-open as soon as possible. To perform this evaluation, we will be using our land surveyors and technicians to dimension the deck and our lab to core the deck to determine slab thickness to enable a structural design of the temporary shoring.

Please see attached our cost proposal to perform this work. We will begin work immediately upon your approval of this proposal. We anticipate completion of this evaluation within 14 calendar days from your notice to proceed.

We will forward to you a full proposal to evaluate the entire garage in the near future.

John T. Snider, P.E.
Engineering Manager

Charles E. Powell, P.E.
Manager CEPCO, LLC

Example photos illustrating significant distress









ANDERSON ENGINEERING, INC
EMPLOYEE OWNED

April 5, 2010

Mr. Dave Hunt
602 S. Main Street
Joplin, MO 64801

Ref: Joplin Parking Garage
Temporary Shoring Details
6th and Virginia, Joplin, MO 64801
Anderson Engineering Project Number 70009-10

In accordance with our letter and email of March 23, 2010, same subject, attached are Temporary Shoring Details to support the south side of the upper level parking deck over 6th Street. Below are additional notes that are to be included with the attached Temporary Shoring Details and are an integral part of the details.

1. Sheets 1 through 3, dated 4-2-10, are calculations sheets for the design and are not included.
2. Minimum compressive strength of non-shrink grout is 5,000 psi minimum at 28 days. Minimum set time is 24 hours or manufacturer's recommendations.
3. Top horizontal brace to be bearing on bottom of joist, as shown in sketch. Bottom horizontal brace to be as close to screw jack as possible, subject to constructability, but no more than 12 inches from bottom of 6X6 post. Cross bracing to begin and end at horizontal braces.
4. The Engineer of Record or designated representative should perform an initial inspection of temporary shoring for compliance to details and notes.
5. On satisfactory completion of an initial inspection of temporary shoring, the subject parking deck can be re-opened to 3 ton vehicular traffic and below (including pedestrian traffic), as shown on signage on the upper deck. This 3 ton limit should be enforced by the City. Also 6th Street, under the parking deck, can be re-opened to vehicular traffic and pedestrian traffic.
6. After temporary shoring has been installed and initially inspected by Engineer, the City should inspect temporary shoring weekly for two weeks, and then quarterly for one year.
7. After one year, the Engineer of Record or designated representative should perform an annual inspection of temporary shoring.

Any questions please contact the undersigned. Thank you.




John T. Snider, P.E.
Engineering Manager

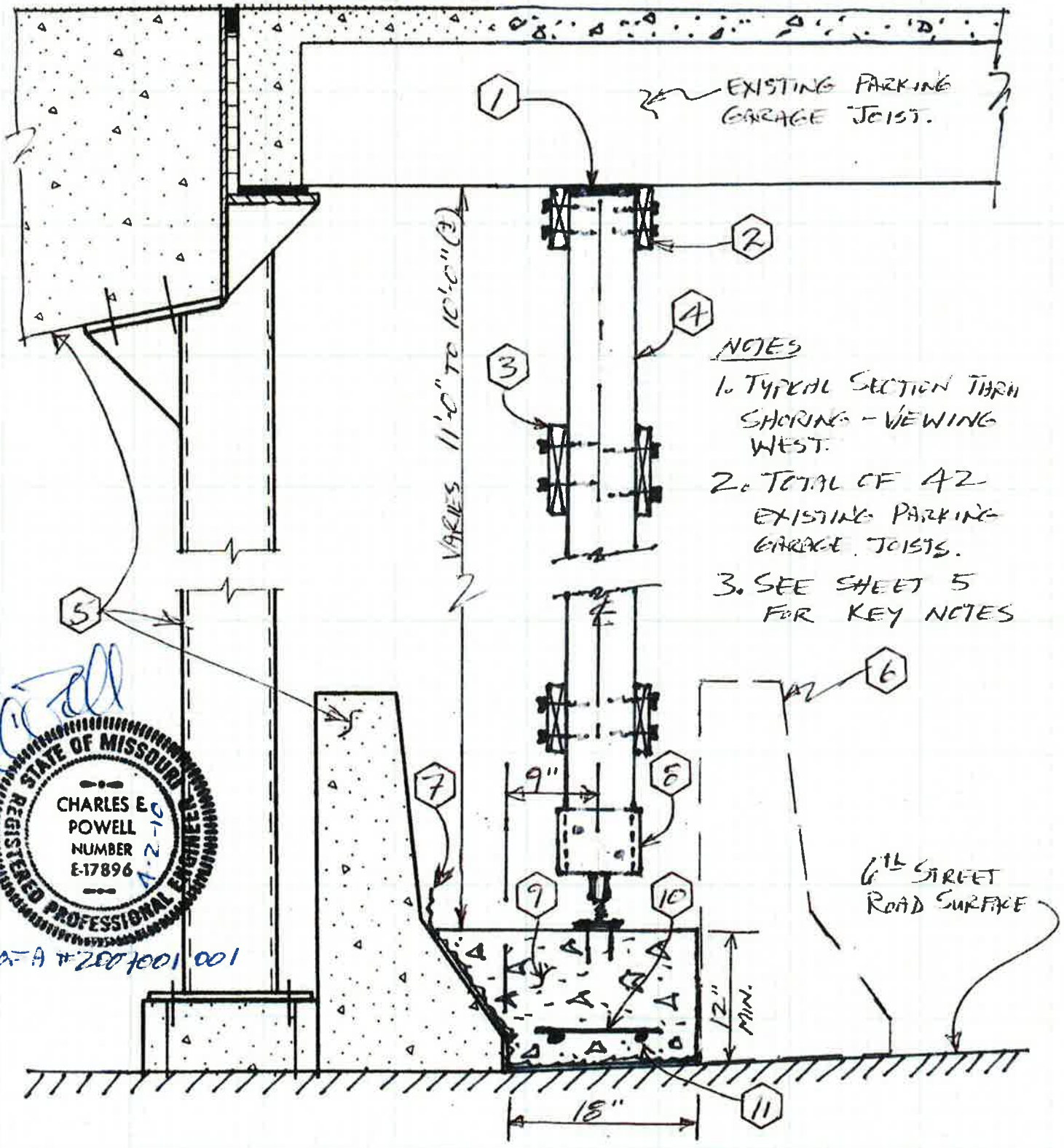
Enclosures - Sheets 4 through 7 dated 4-2-10 and Ellis Screw Jack information sheets (4 pages).

Copy - Charles E. Powell, P.E., budpow@hotmail.com, Manager CEPCO, LLC

**CEPCO, LLC** PO BOX 800 OZARK, MISSOURI 65721-0800
Phone: 417.838.9622 Fax: 417.485.8503
Structural • Forensic • Airports

Computations by: CEP
Project No: CP10-1001
Description of Work: ANDERSON - JOPLIN PARKING GARAGE

Sheet 4 of 9
Date: 4-2, 2010




NOTES

1. TYPICAL SECTION THRU SHORING - VIEWING WEST.
2. TOTAL OF 42 EXISTING PARKING GARAGE JOISTS.
3. SEE SHEET 5 FOR KEY NOTES

STATE OF MISSOURI
CHARLES E. POWELL
NUMBER E-17896
REGISTERED PROFESSIONAL ENGINEER
12-2-10

COA #2007001001

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Computations by: CEP
Project No: CEPCO-1001
Description of Work: ANDERSON-JOPLIN PARKING GARAGE

Sheet 5 of 9
Date: 4-2, 20 15

KEY NOTES COMMENTS

(1) — ESTABLISH 1" GAP BETWEEN TOP OF WOOD POST AND BOTTOM OF CONCRETE JOIST. PACK WITH STIFF NON-SHRINK GROUT WITH HIGH EARLY STRENGTH PROPERTIES. JACK, POST, AND BRACING SHALL ALL BE IN PLACE BEFORE PACKING WITH GROUT. AFTER GROUT HAS SET, LOAD JACK "(E)" TO PRE-LOAD 6X6 POSTS.

(2) — 2X6 HORIZONTAL BRACE CONTINUOUS EACH SIDE OF POST - TOP & BOTTOM. SECURE TO EACH 2X6 WITH 2-1/2" ϕ LAG BOLTS AND WASHERS UNDER EACH HEAD. PRE-DRILL PILOT HOLE FOR EACH BOLT PER MANUFACTURER'S RECOMMENDATIONS. WOOD TO BE KD #2 SYP OR BETTER. IF WATER BOURNE TREATED WOOD IS USED, WOOD MUST BE ADEQUATELY AIR DRIED SO THAT MEMBERS DO NOT WARP, BOW, ~~AND~~ OR TWIST AFTER SHORING IS CONSTRUCTED.

STATE OF MISSOURI
CHARLES E POWELL
NUMBER E-17896
REGISTERED PROFESSIONAL ENGINEER
4-2-15

COA #2007001001

(3) — 2X6 DIAGONAL BRACE EACH SIDE OF POST. SEE ELEVATION SKETCH FOR PLACEMENT. LANGUAGE IN KEY NOTE "(2)" ALSO APPLIES TO THESE DIAGONAL BRACES.

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Computations by: CEP Sheet 6 of 9
Project No: CPO-1001 Date: 4-2, 2010
Description of Work: ANDERSON-JOPLIN PARKING GARAGE

KEY NOTES (CONT.) COMMENTS

(4) — 6X6 POST AT EACH EXISTING GARAGE JOIST (42 TOTAL). POST SHALL BE VERTICAL WITH NO MORE THAN 1/2" OUT-OF-PLUMB OR BOW. GRADE AND NOTES ON WOOD SHALL BE IDENTICAL TO KEY NOTE "(2)".

(5) — EXISTING GARAGE STRUCTURE AND BARRIER

(6) — CITY CREWS TO PLACE CITY OF JOPLIN JERSEY BARRIERS AGAINST SIDE OF CONCRETE FOOTING AFTER SHORING IS CONSTRUCTED, BUT BEFORE 6TH STREET IS OPENED TO TRAFFIC.

(7) — 30# ROOFING FELT OR OTHER SUITABLE MATERIAL TO ACT AS A "BOND BREAK" BETWEEN NEW CONCRETE FOOTING AND BARRIER/STREET.

STATE OF MISSOURI
CHARLES E. POWELL
NUMBER E-17896
REGISTERED PROFESSIONAL ENGINEER
4-2-10

COA 2007001001

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Computations by: CEP
Project No: CP10-1001
Description of Work: ANDERSON - JOPLIN PARKING GARAGE

Sheet 7 of 9
Date: 4-2, 2010

KEY NOTES (CONT.) COMMENTS

(8) — "ELLIS" ITEM #ST-6 OR EQUIVALENT SCREW JACK. JACK SHALL HAVE A MINIMUM WORKING CAPACITY OF 20,000 POUNDS WITH A FACTOR OF SAFETY OF AT LEAST 2.5. SECURE JACK TO WOOD POST AND CONCRETE FOOTING IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS. JACK SHALL LOAD POSTS TO BE TIGHT AGAINST GARAGE JOIST WITHOUT DAMAGE TO POST.

(9) — NEW CONCRETE FOOTING SHALL HAVE A 28 DAY MINIMUM COMPRESSIVE STRENGTH OF 4,000 PSI. DO NOT LOAD SCREW JACK UNTIL CONCRETE HAS A MINIMUM COMPRESSIVE STRENGTH OF 3,000 PSI. A "HIGH EARLY" CONCRETE MAY BE USED. CONCRETE SHALL NOT BE AIR ENTRAINED. FOOTING SHALL HAVE A FORMED SURFACE ON NORTH SIDE.

STATE OF MISSOURI
CHARLES E. POWELL
NUMBER E-17896
REGISTERED PROFESSIONAL ENGINEER
4-2-10

COFA #2007001001

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Computations by: CEP
Project No: CP10-1001
Description of Work: ANDERSEN - JOPLIN PARKING GARAGE

Sheet 8 of 9
Date: 4-2, 2010

KEY NOTES (CONT) COMMENTS

(10) — #4 BAR 12" LONG AT 24" ON CENTER TIED TO #5 BARS TO STABILIZE BARS DURING CONCRETE PLACEMENT.

(11) — 2#5 BARS CONTINUOUS ON 2" CHAIRS.

GENERAL NOTE: COMMENTS AND/OR RECOMMENDATIONS BY CONTRACTOR TO MODIFY SHORING OR TO USE DIFFERENT SHORING THAT IS AVAILABLE TO CONTRACTOR IS WELCOMED. EACH POST MUST CARRY A MINIMUM OF 10,850 POUNDS AT THE END OF EACH GARAGE JOIST. ONLY THE ENDS OF JOISTS AT THE SOUTH SIDE OF 6TH STREET ARE REQUIRED TO BE SUPPORTED.

STRUCTURAL ENGINEER MUST APPROVE ANY MODIFIED OR DIFFERENT TYPE OF SHORING BEFORE IT IS INSTALLED.

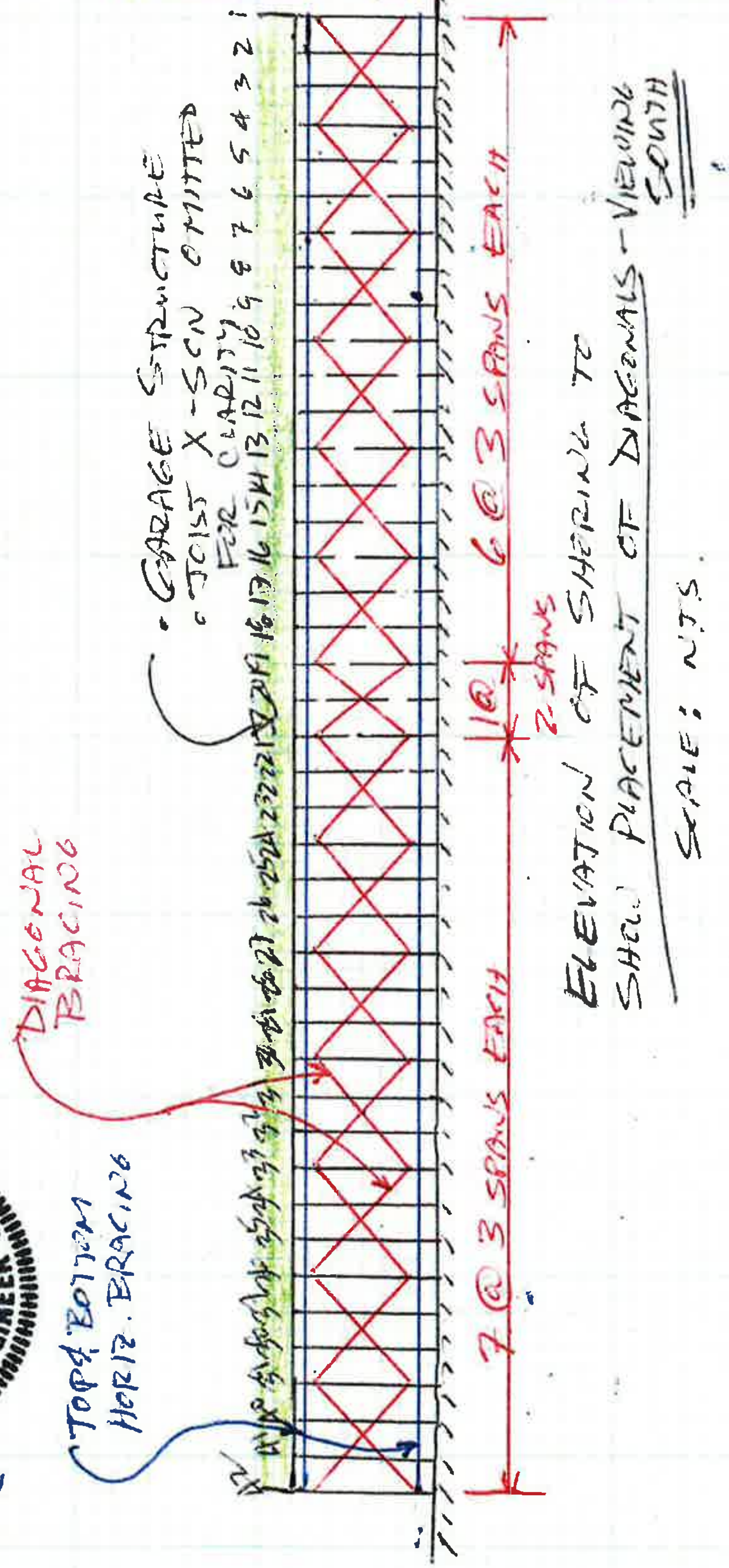
STATE OF MISSOURI
CHARLES E. POWELL
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Date: 4-2, 2010




STATE OF MISSOURI
CHARLES E. POWELL
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4-2-10

C of A # 2007001001







## Products

checkout | view cart

**Ellis Screw Jacks** - [Back to Main Products Page]

| Item # | Item Name | Weight | List Price | Add to Cart |
|---|---|---|---|---|
| SJ-4 | Screw Jack 4x4 **(Painted Finish)** | 12 lbs. | $40.00 Ea. | ADD TO CART |
| SJ-4G | Screw Jack 4x4 **(Galvanized Finish)** | 12 lbs. | $46.00 Ea. | ADD TO CART |
| SJ-6 | Screw Jack 6x6 **(Painted Finish)** | 22 lbs. | $54.00 Ea. | ADD TO CART |
| SJ-6G | Screw Jack 6x6 **(Galvanized Finish)** | 22 lbs. | $60.00 Ea. | ADD TO CART |
| TJ-4 | Timber Jack (15,000 Lb. Capacity) | 10 lbs. | $32.00 Ea. | ADD TO CART |
| TJ-6 | Timber Jack (30,000 Lb. Capacity) | 10 lbs. | $38.00 Ea. | ADD TO CART |
| BJ-6 | Bridge Jack 6" Adjstmt. | 60 lbs. | $150.00 Ea. | ADD TO CART |
| BJ-12 | Bridge Jack 12" Adjstmt. | 70 lbs. | $200.00 Ea. | ADD TO CART |
| STL-36 | STEEL Shore Screw Jack | 30 Lbs. | $60.00 Each | ADD TO CART |

**HOW TO OPERATE THE ELLIS SCREW JACK VIDEO**




***4X4 SCREW JACK***

- *15,000 LB Load Capacity!*
- *Choose either **Galvanized or Painted Finish***
- *For Standard Dressed 4x4 Lumber*

MAXIMUM SAFE WORKING LOAD (LBS.)
Douglas Fir Dimensional Lumber (3-1/2" Square).

| Total Shore Height Including Jack | Maximum Load Capacity |
|---|---|
| 4' | 15,000 |
| 6' | 12,000 |
| 8' | 7,200 |
| 10' | 5,000 |
| 12' | 3,000 |
| 14' | 2,600 |



- *Use For Vertical Or Horizontal support*
- *4"x 4"x5" Square Tubing*
- *1-1/2" x 6-1/2" Pipe*
- *1-1/4" Acme Threads*
- *14.25" Overall Length Screwed Down*
- *Full 6" Adjustment*
- *Inner Pipe is Greased To Prevent Rusting*
- *Turn "U" Shaped Handle At Bottom Of Screw To Adjust Height*




- *Base Plate Will Not Turn With Screw and 4 Holes Are Provided To Secure It To A Solid Foundation*
- *Lift Up To 1800 LBs By Hand*
- *Lift Up To 4000 lLbs W/ 2 x 4 x 6' Piece Of Lumber Placed Between Screw & Handle Used For Extra Leverage*
- *Always secure to a flat and solid foundation.*
- *Proper Bracing required to prevent shifting.*
- *Caution, the acme screw of the 4x4 Screw Jack will completely separate from the acme nut if screwed out too far. Do not extend the acme screw past the maximum adjustment of 6". This will insure that the threads of the acme nut will be used to support a heavy load.*









***6x6 SCREW JACK SPECIFICATIONS:***

- *30,000 LB Load Capacity!*
- *For Standard Dressed 6x6 Lumber*
- *Use for Vertical / Horizontal support*
- *6" x 6" x 5" Square Tubing*
- *2" x 6-1/2" Pipe*
- *1-3/4" Acme Threads*
- *15-1/2" Overall Length Screwed Down*
- *Full 6" Adjustment*
- *Inner Pipe is Grease To Prevent Rusting*
- *Adjust Height by Turning "U" Shaped Handle*

MAXIMUM SAFE WORKING LOAD (LBS.)
Douglas Fir Dimensional Lumber (5-1/2" square)

| Total Shore Height Including Jack | Max Load Capacity |
|---|---|
| 6' | 30,000 |
| 8' | 30,000 |
| 10' | 27,000 |
| 12' | 20,000 |
| 14' | 15,000 |
| 16' | 11,500 |
| 18' | 8,800 |
| 20' | 6,000 |



Screw Jack is included in Shore Height Calculations.

Load Capacity Based on Actual Test Results of Douglas Fir # 1 6x6 Dressed Lumber (5-1/2" Square).

Capacities Include a Standard 2-1/2 to 1 Safety Factor.

Lumber Must Be Cut Square On Both Ends.

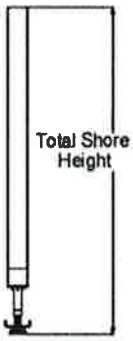


This product is also offered with a GALVANIZED finish to prevent rusting.

Select SJ-6G to add this product to your shopping cart.

DO NOT EXCEED RECOMMENDED ALLOWABLE LOAD FOR DOUGLAS FIR AS SHOWN IN THE ABOVE CHARTS.

- *Base Plate Will Not Turn With Screw and 4 Holes Are Provided To Secure It To A Solid Foundation*




- *Lift Up To 1800 lbs By Hand*
- *Lift Up To 4000 Lbs W/ 2 x 4" x 6' Piece Of Lumber Placed Between Screw & Handle, Used For Extra Leverage*
- *Always secure to a flat and solid foundation.*
- *Proper Bracing required to prevent shifting.*
- *Caution, the acme screw of the 6x6 Screw Jack will completely separate from the acme nut if screwed out too far. Do not extend the acme screw past the maximum adjustment of 6". This will insure that the threads of the acme nut will be used to support a heavy load.*

***OTHER ELLIS SCREW JACKS***

BRIDGE JACK STEEL SHORE TIMBER JACK





## Need more LIFTING Power?

Try the Ellis Hydraulic Bottle Jack.

*When **shoring a multi-story building**, and your shores have to be the same height, the Ellis Screw Jack is the way to keep you on the level. Contractors young and old enjoy using the Ellis Screw Jack for shoring at near uniform story heights. Their versatility allows them to be quickly erected, taken down, or adjusted at a distance of 6 inches. Our Screw Jacks have Acme threads which guarantee the kind of strength needed for heavy construction.*

***Re-leveling house floors** are also made easy with Ellis Screw Jacks. If your home contains a crawl-space, Ellis Screw Jacks fit easily underneath for re-leveling floors to their original status. This is a great alternative for floor re-leveling in a home.*

***Search and Rescue Operations** can put Ellis Screw Jacks to the test in horizontal applications as well. They are perfect for trench shoring in wide as well as tight spaces. Ellis Screw Jacks fit in areas such as downed buildings or enclosures with little space for leverage. Power in a small package, it's ideal for jacking or bracing large sections of concrete and steel.*

Screw Jack | Lifting Jack | Support Jacks | House Floor Leveling | Support Jack | House Jacks | Sagging Floors | Basement Jacks | Screw Jacks | Lifting Jacks | Link Resources



ANDERSON ENGINEERING, INC
EMPLOYEE OWNED

June 30, 2011
Mr. Dave Hunt
602 S. Main Street
Joplin, MO 64801

Ref: Report for Structural Condition Assessment
Joplin Parking Lot "B" and "Deck over 6th Street"
6th and Virginia
Joplin, MO 64801

Dave,

This is the Report of Limited Structural Evaluation for the Parking Lot B and Deck over 6th Street to determine an appropriate method of rehabilitating structurally damaged components of the parking deck, primarily joists, pans, and end beams and to repair the expansion joint between Parking Lot B and the Deck over 6th Street.

**Background**

The parking deck as referenced above is located at the intersection of 6th Street and Virginia Ave in Joplin, Missouri. Construction of Parking Lot B was conducted in the mid 1960s. Shortly after construction of Parking Lot B, the deck over 6th Street and the sidewalk south of the current State Beauty Supply were constructed to serve the building for the then Joplin Enterprises, Inc. (See attached drawings for locations). Repairs to the parking deck over 6th Street, which included the repair of the end beam located at the expansion joint at column line G, were completed in the late 1960s. Additional repairs and strengthening of Parking Lot B were conducted in the early 1990's. The following construction plans for the above referenced phases were provided to us for review:

- Plans of Joplin Parking Lot "B" Structure, Allgeier-Martin & Associates, May 1964
- A Building for Joplin Enterprises, Inc., Located at 6th Street & Virginia Avenue, Joplin, Missouri, Allgeier-Martin & Associates, April 1965
- Repairs to Parking Deck Over 6th Street, Allgeier-Martin & Associates, February 1968
- Repair & Strengthening of Municipal Parking Lot "B", Harrington & Cortelyou, Inc., May 1991

In March of 2010, Anderson Engineering was retained to perform a structural evaluation of the corroded steel brackets supporting the upper level parking deck over the south side of 6th Street. The deck over 6th Street and the street below were closed to traffic at that time to provide the time necessary to evaluate the corroded brackets and prepare plans for temporary shoring. Plans for temporary shoring

were completed in early April of 2010 and construction of the temporary shoring was completed shortly after. The deck over 6th Street and 6th Street were then reopened to traffic.

In early April of 2011, Anderson Engineering was retained to conduct a structural evaluation of Parking Lot B and Deck over 6th Street as reported below.

**Scope of Work and Exploration Methods**

From our visits and in discussion with you, it was determined for the purpose of the proposal and limited structural assessment, that the most significant damage to the structures was at the following areas:

- Expansion joint at column line G (between Parking Lot B and the Deck over 6th Street)
- Concrete joist and deck/pan deterioration on the upper deck of Parking Lot B and Deck over 6th Street
- Concrete end beams deterioration between the upper deck of Parking Lot B and Deck over 6th Street (End Beams: EB 1 and EB 2)

There were others areas that have minor damage at cursory observation, but they are not nearly as significant as those areas described above.

For ease of investigations and reporting the parking deck was divided into four sections:

- Area A, Repair of expansion joint between Parking Lot B and the Deck over 6th Street.
- Area B, Rehabilitation of Parking Lot B.
- Area C, Rehabilitation of deck over 6th Street.
- Area D, Rehabilitation of deck over north sidewalk of 6th Street (deck in front of Beauty Supply).

The following tasks were included in the scope for phase of the project:

- **Mark the underlying web joists, beams, and columns on the top surface of the deck to aid in recording and analysis of the deterioration.** Prior to beginning the limited structural analysis, the top and underside of the parking deck was scanned with a 3D laser lidar scanner. The top and underside scans were overlaid on each other and critical components were selected. Using survey equipment the column locations were located and painted on the top deck and other components were painted on the top deck by taking measurements from the column locations.

- **Perform a delamination and visual crack survey of the top surface of the deck.** The delamination survey was conducted for the entire top of deck by first locating areas for further investigation with a chain drag apparatus using ASTM methods. While dragging the chain drag apparatus, technicians listened for tone changes in the ringing of the metal chains, from a sharp ring to a dull ring. The areas of the deck that were identified as delaminated were investigated further and the limits of each area was determined by tapping the concrete surface with a metal rod. Limits of the delaminations were painted on the deck surface. The cracks located during

the visual crack survey were also painted.

- **Collect concrete cores from the deck in various locations to aid in analyzing the types of deterioration that are occurring.** Coring locations were chosen based on the delamination surveys, visual observations, and tests that were conducted on the parking deck. Cores were taken in areas that both appeared and tested to be in good condition (good being in a relative term), areas that appeared to be in good condition but tested to be deteriorated, and areas that appeared and tested to be deteriorated. Coring was conducted with a 4 inch diameter, diamond tipped core barrel and coring machine.

- **Field confirm dimensions and spacing of selected structural components.** This was completed with a tape measure and man lift.

- **Field confirm the presence and orientation of reinforcing bars of selected structural components.** This was completed with a tape measure, calipers, and a man lift. Confirmation of reinforcing bars was generally completed in areas were the rebar had been previously exposed due to concrete deterioration or vehicular impact. In areas that the concrete was not previously exposed, generally in areas of no deterioration, the reinforcing steel was exposed with an electric hammer drill and chisel bit, and or a pachometer/rebar locator was used to identify presence and orientation of metal in concrete.

- **Perform a delamination and visual crack survey of the underside of the deck to include the pans, joists, and end beams.** Using man lifts, delamination wheels and metal rods, technicians investigated each pan beneath the parking deck using ASTM methods. Delaminations were initially located with the delamination wheel and the limits of the delaminations were then determined using the metal rod.

- **Perform Schmidt Rebound Hammer testing on accessible concrete structural components.** A Schmidt rebound hammer was used to determine likely ranges of unconfined compressive strength of tested structural components.

- **Perform carbonation and chlorination tests on selected structural components to check for signs of corrosion potential.** Carbonation and chlorination testing was often conducted in conjunction with investigative tasks such as while exposing rebar, on concrete core, etc. For carbonation, the concrete was exposed to a phenolthalein solution at various depths. When exposed to the phenolthalein solution, if the concrete changed to a pink color the concrete was recorded as not carbonated. No color change in the concrete was an indication of carbonated concrete. For chlorination testing, concrete powder was collected from various discrete depths in the concrete utilizing a masonry bit and impact hammer. The concrete powder samples were returned to analytival lab for chlorination testing.

**Findings**

*Top of Deck*

Tone changes in the concrete indicating delamination of the upper deck was found to exist in many

locations. For the upper deck on Parking Lot B and the deck over 6th Street delaminations are estimated at less than 25 percent of the deck area. For the sidewalk at State Beauty Supply, the entire upper deck is believed to be delaminated. Locations and sizes of delaminations of the upper deck can be found on Sheet 1 of 4 of drawing number JOP-100-2457.

Delaminations on Parking Lot B are generally near expansion joints, tensile cracks, and tend to straddle column lines 2.5 and 5.5. See Photo #1. It must be remembered that the repairs completed to the parking deck in the early 1990s included a bonded concrete overlay over the existing concrete deck. However, area D in front of Beauty Supply was not addressed for repair at that time.

Cores taken in areas determined to not be delaminated were examined and no corrosion or delamination of the wire mesh was noted in the upper concrete layer (i.e. in the concrete that was placed after milling in the early 1990's). Also, cores taken in areas of the upper deck that were determined to be delaminated were examined and no corrosion or delamination of the wire mesh was noted in the upper concrete layer. However in these areas the upper and lower concrete layers had separated from one another. Again this was not from corrosion, but likely due to differential expansion and contraction and resultant tensile forces breaking the bond layer between upper overlay and lower concrete deck layers. See Photo #2. For a summary of the findings and test results from the concrete cores, see *Table #1 – Core Inspections: Carbonation and Reinforcing Steel.*

Cracks in the overlay (i.e. upper deck) are generally tensile cracks and tend to be located between web joists (i.e. in the pan area) and on top of web joists. The cracks are generally 1mm width and smaller. The cracks also tend to be associated in the areas between column lines 2 to 3 and 4 to 5. Cracking of the sidewalk in front of State Beauty Supply appeared to be more severe. See Photo #3.

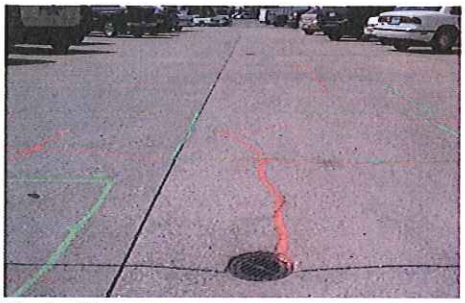


Photo #1
Green indicates delamination
Pink highlights cracks




Photo #2
C-1 from non-delaminated area
C-2 from delaminated area

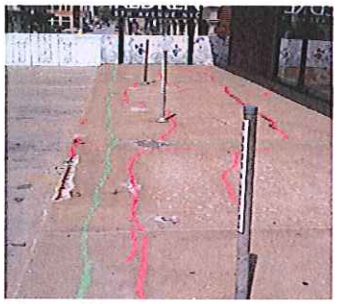


Photo #3
Green indicates delamination
Pink highlights cracks

During the investigation of the upper deck, it was noticed that many of the storm water drains were partially or completely plugged with silt and debris. To assist in evaluation of the investigation findings, the upper deck was observed during a rain event. The draining and non-draining locations were noted and the areas of ponding water were roughly located. The drains, their condition, and the locations of ponded water can be seen on sheet 2 of 4 of drawing JOP-100-2457.



Photo #4



Photo #5



Photo #6

*Bottom of Deck*

Investigations of the bottom of the deck began with the visual survey and delamination survey. Pans were assessed based on three conditions: no delamination, minor delamination, and major delamination. Minor delaminations were those where only a minor tone change was noted, the pan was not visually delaminated and the concrete did not come loose during the investigation by striking with metal bars and or hammers. Major delaminations were determined to be areas where a major tone change was noted, the pan was visually delaminated, or the concrete came loose during the investigation. In some cases a pan with a major dull tone (i.e. an indicator of delamination) would not appear to be visually delaminated but after further investigation, it was discovered that there was a void between the concrete and the welded wire mesh. The pan delamination locations, type, and size can be seen on sheet 3 of 4 of drawing JOP-100-2457.

The joists were investigated for delaminations at the same time as the pans. The joists delaminations were classified by severity in the same manner as the pans. A summary of joist delaminations can be found in *Table #2 – Delaminations on Joists*.

Visual observations of the joists also revealed three key types of damage to the joists. The first type of joist damage occurred at the location where the concrete joists rested on the metal beams at column lines 2.5 and 5.5 (from the early 1990's rehabilitation repairs). The stresses added to the bottom of the joists from the metal beams appears to be crushing the concrete from the bottom of the metal joists. A summary of locations where this occurs can be found in *Table #3 – Joist Damage at Metal Beams.*

The second type of damage was cracks in the concrete joist, often beginning at the top and continuing diagonally to the bottom of the joists. We attempted to differentiate these cracks from cracks that were caused by delaminations. A summary of locations where this occurs can be found in *Table #4 –Cracked Joists.*

The third type of damage to the joists appeared to be from vehicle impacts due to low clearance. This type of damage was only noted in Area C, the deck over 6th Street. A summary of locations where this occurs can be found in *Table #5 –Joists Damaged by Vehicle Impact.* Joist delaminations and damage can also be seen on sheet 4 of 4 of drawing JOP-100-2457.

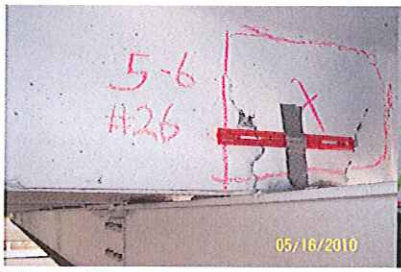



Photo #7
Joist Damage at Metal Beam

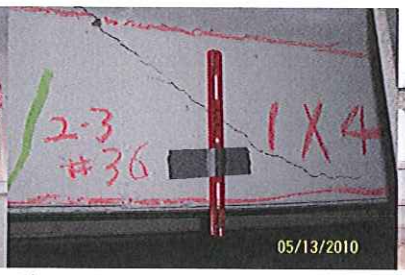



Photo #8
Joist Crack

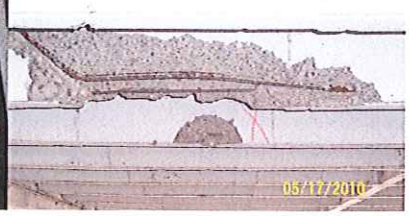


Photo #9
Joist Damage by Vehicle Impact

Field testing for carbonation, Schmidt Rebound Hammer, and reinforcing steel observations can be found on *Table #6 – Field Inspection: Carbonation and Reinforcing Steel.* Test results for Chloride Ion sampling and testing can be found on *Table #7 – Chloride Ion Results.* Testing locations can be found on sheet 3 of 4 of drawing JOP-100-2457.

Though not explicitly included in the proposed scope of work, there were two locations on the metal beams that show signs of corrosion and were investigated. At the metal beam to column connection at column F-6, a leaking drain pipe has caused some corrosion of the bolted angle bracket. Further inspection revealed that, with the exception of the metal spacer plate between the beam and angle bracket, the corrosion was surface rust only. The spacer plate was beginning to become more severely corroded. Also between columns F-2 and F-3, a leaking drain pipe is causing corrosion to begin on the top of the metal beam. Upon further investigation, this area was also discovered to be surface rust only.




Photo #10 – Column F-6
Overall of Beam to Angle Bracket



Photo #11 – Column F-6
Close-up of Spacer Plate.



Photo #12 – Between F-2 &F-3
Surface Corrosion on Metal Beam
(Bottom of photo)
Leaking Pipe (top of photo)

Investigation of the concrete columns was not included in the detailed investigation of the parking deck because of generally good condition. However, the reinforcing steel at the base of column D-2 had been exposed at the corner by an impact from a vehicle. Further exposing of the steel was not conducted, but it was noted that the steel was corroded.



Photo #13
Exposed reinforcing steel at Column D-2

**Expansion Joint**
The expansion joint will be cleaned out by City of Joplin at later date and then observed by us prior to completion of plans. An addendum to this report will be prepared for that observation. Based on work done to date our conclusions are not expected to change.

**Conclusions**

Overall, the indications are that the items investigated appeared to be built and or repaired as designed with the exception of the lower welded wire mesh in the original 1960's deck/pan is often less than specified (i.e. less than one inch).

Overall the damage to the parking deck appears to be concentrated in three areas: Area A near the expansion joint from column line F to G, Area B between the Frisco Building (column line) and column line 4, and Area D the deck over the sidewalk on the north side of 6th Street between column line G and X. Other areas of the parking deck show signs of damage and distress to a lesser extent.

Carbonation of the concrete deck does not currently appear to be a major contributor to the corrosion-based damage and distress of the parking deck. Carbonation of the concrete was generally found to be at a depth of 1 inch or less. Reinforcing steel that had sufficient concrete cover (per plan cover) and was generally located deeper than the depth of carbonation generally showed no signs of corrosion. Based on Chloride Ion testing, chlorides are present in varying amount throughout the parking deck likely from the application of ice melting salts on the surface during the winter months. The chloride ion content is generally higher than permitted by ACI for new construction, but is near threshold limits used by other countries referenced by ACI in their literature. It should be noted that chloride concentrations in the upper half of the concrete deck (i.e. the 1990's overlay) is likely to be much less than the chloride concentration in the lower half of the deck due to younger age (about 20 years versus about 50 years). Once present in the concrete, chloride ions can move within the concrete and cannot readily be removed from the concrete and will continue to move deeper into the concrete.

The use of salt-less ice melt products and improving deck storm water drainage could be utilized to prevent introducing additional chloride ions in to the parking deck system. The good news is that where concrete cover over reinforcing steel is as specified and concrete cover has not been compromised by cracking or exposure, the high chloride content does not appear to have significantly corroded the reinforcing steel yet; this comment however does not apply to Area D pans and web joist which are significantly corroded.

It appears that the incorporation of the metal beams to the parking deck in the early 1990s at column

lines 2.5 and 5.5 has increased cracking in the parking deck in those areas. The metal beam at column line 5.5 does not appear to have had as large an impact as the metal beam at column line 2.5. We suspect that the additional cracks have assisted in the infiltration of chloride ions due to increased chloride ion test results in the area of column line 2.5. Also it is suspected that the amount of salts over column line 5.5 were less than 2.5 due to distance from entrance ways to buildings. Also column 5.5 received more sunlight, due to less shadow time from the Frisco building.

The repairs that were completed to the parking deck in the early 1990s were observed during this investigation. In general, the areas that were repaired or replaced as part of that repair process appear to have little or no deterioration. By comparing the 1991 repair drawings completed by Harrington and Cortelyou with our current drawing JOP-100-2457, one can see that the areas identified for repair in 1991 generally show no signs of distress. This was also confirmed through field observations. This shows that properly done repairs can be made to last about 20 years.

Readers should refer to the tables and drawing JOP-100-2457 for more detailed information regarding the information used the provide these conclusions.

**Recommendations**

The general approach for rehabilitation is to remove/replace corrosion damaged areas; and initiate measures to slow down the corrosion process. Specific repair details and plans will be prepared subsequently.

We appreciate the opportunity to assist the City with repairs to its parking deck. If you have any questions about this report, please let us know.

Very Respectfully,
Anderson Engineering, Inc.

Cody R. White, P.E.
Associate/Lab Manager

John T. Snider, P.E.
VP/Engineering Manager

Table 1 - Core Inspections: Carbonation and Reinforcing Steel

| Location | | | | | Testing Performed | | Carbonation | | Steel Inspectionn (original 1960's deck) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Core | Location | Columns | Depth From Bottom of Deck (in) | Suspected Condition of Location | Deck Lifts Separated? | Chloride Ion Sample Taken? | Present based on Phenolphtalein Reaction? | pH Indication** | Cover over Steel (inches) | Measured Size of Steel (inches) | Plan Size of Steel | Visible Corrosion of Steel? |
| C -1 | Pan B19-20 | 6-7 | 0-0.5 | top deck good: bottom deck good; joists good | No | No | Yes | < 9.0 | 1 1/8 | 3/16 | 3/16 | No |
| | Pan B19-20 | 6-7 | 0.5-1.0 | | | | Yes | < 9.0 | | | | |
| | Pan B19-20 | 6-7 | 1.0-1.5 | | | | No | ≥ 9.0 | | | | |
| C-2 | Pan B32-33 | 5-6 | 0-0.5 | top deck delaminated: bottom deck good; joists good | Yes | No | Yes | < 9.0 | None Encountered [1] | None Encountered [1] | 3/16 | N/A |
| | Pan B32-33 | 5-6 | 0.5-1.0 | | | | Yes | < 9.0 | | | | |
| | Pan B32-33 | 5-6 | 1.0-1.5 | | | | No | ≥ 9.0 | | | | |
| C-3 | Pan B34-35 | 2-3 | 0-0.5 | top deck delaminated: bottom deck delaminated; joist delaminated | Yes | No | Yes | < 9.0 | 3/4 | 1/8 | 3/16 | Yes |
| | Pan B34-35 | 2-3 | 0.5-1.0 | | | | Yes | < 9.0 | | | | |
| | Pan B34-35 | 2-3 | 1.0-1.5 | | | | Yes | < 9.0 | | | | |
| C-4 | Pan B66-67 | 5-6 | 0-0.5 | top deck delaminated: bottom deck delaminated; joist good | Yes | Yes | Yes | < 9.0 | < 1/8 | 3/16 | 3/16 | Yes |
| | Pan B66-67 | 5-6 | 0.5-1.0 | | | | Yes | < 9.0 | | | | |
| | Pan B66-67 | 5-6 | 1.0-1.5 | | | | No | ≥ 9.0 | | | | |
| C-5 | Pan C2-3 | 6-7 | 0-0.5 | top deck good: bottom deck good; joists good | No | No | Yes | < 9.0 | 3/16 | 1/8 | 1/8 | No |
| | Pan C2-3 | 6-7 | 0.5-1.0 | | | | No | ≥ 9.0 | | | | |
| | Pan C2-3 | 6-7 | 1.0-1.5 | | | | No | ≥ 9.0 | | | | |
| C-6 | Pan D2-3 | 5-6 | 0-0.5 | top deck delaminated: bottom deck delaminated; joist delaminated | N/A (no overlay done in Area D) | No | Yes | < 9.0 | 3/4 | 1/8 | 1/8 | Yes |
| | Pan D2-3 | 5-6 | 0.5-1.0 | | | | Yes | < 9.0 | | | | |
| | Pan D2-3 | 5-6 | 1.0-1.5 | | | | No | ≥ 9.0 | | | | |
| C-7 | Pan B25-26 | 1-2 | 0-0.5 | top deck good: bottom deck good; joists good | No | No | Yes | < 9.0 | None Encountered [1] | None Encountered [1] | 3/16 | N/A |
| | Pan B25-26 | 1-2 | 0.5-1.0 | | | | No | ≥ 9.0 | | | | |
| | Pan B25-26 | 1-2 | 1.0-1.5 | | | | No | ≥ 9.0 | | | | |

* Detailed results shown on subsequent table.

**Indication of pH based on American Concrete Institute, Report ACI 222R-01, Section 4.3.1.5 which states phenolphathalein reaction occurs at pH ≥ 9.0

[1] Not encountered during coring; steel sustpected in adjacent areas

[2] 10 gauge = 0.135 inches; 1/8 inch = 0.125 inches

[3] 6 gauge = 0.192 inches; 3/16 inch = 0.187 inches

| | | | |
|---|---|---|---|
| Created by: | BDB | Date: | 6/20/2011 |
| Checked by: | CRW | Date: | 6/20/2011 |

**Table 2 - Delaminations on Joists**

AREA B

| Columns | Joist # | Delamination Size (FTxFT) | North (N) or South(S) Side of Joist | East (E) or West (W) Side of Stiffener |
|---|---|---|---|---|
| 4-5 | 67 | ENTIRE JOIST | S | W |
| 4-5 | 68 | ENTIRE JOIST | S | W |
| 3-4 | 67 | ENTIRE JOIST | S | W |
| 2-3 | 68 | 1x8 | S | E |
| 2-3 | 65 | ENTIRE JOIST | S | E |
| 2-3 | 64 | ENTIRE JOIST | S | E |
| 2-3 | 68 | ENTIRE JOIST | N, S | E, W |
| 2-3 | 61 | 1X8 | N | E |
| 2-3 | 38 | 1X4 | N | E |
| 2-3 | 36 | 1X4 | N | W |
| 2-3 | 37 | 1X5 | N | W |
| 2-3 | 34 | 1X5 | N | E |
| 2-3 | 26 | ENTIRE JOIST | N | E |
| 2-3 | 34 | 1X5 | S | E |
| 2-3 | 36 | 1X4 | S | W |
| 2-3 | 37 | 1x5 | N | W |
| 2-3 | 37 | 1X2 | S | W |
| 2-3 | 38 | 1x3.5 | S | E |
| 2-3 | 43 | 1X2.5 | S | E |
| 1-2 | 40 | 1x3.5 | N | N/A |
| 1-2 | 39 | 1x2 | N | N/A |
| 1-2 | 38 | 1x3 | N | N/A |
| 1-2 | 37 | ENTIRE JOIST | N | N/A |
| 1-2 | 38 | 1x4.5 | N | N/A |
| 0.5-1 | 36 | 1x4 | N, S | N/A |
| 0.5-1 | 37 | 1X4 | N, S | N/A |
| 0.5-1 | 33 | 1X4 | N | N/A |
| 1-2 | 37 | 1X8 | S | N/A |
| 1-2 | 39 | 1X3 | S | E |
| 1-2 | 40 | 1X5 | S | N/A |

**AREA C**

| Columns | Joist # | Delamination Size (FTxFT) | East (E) or West (W) Side of Joist | North (N) or South (S) Side of Stiffener |
|---|---|---|---|---|
| 1-2 | 36 | 1X3 | E | N |
| 1-2 | 39 | 1x2 | E | S |
| 1-2 | 39 | 1x4 | E, W | Center |
| 1-2 | 40 | 1x4 | E, W | Center |
| 1-2 | 41 | ENTIRE JOIST | W | N |
| 1-2 | 39 | 1x2 | E | S |
| 2-3 | 31 | 1x2 | E | S |
| 6-7 | 7 | 1x2 | W | N |

**AREA D**

| Columns | Joist # | Delamination Size (FTxFT) | East (E) or West (W) Side of Joist | North (N) or South (S) Side of Stiffener |
|---|---|---|---|---|
| All Joists in Area D had minor or major delamination | | | | |

**Ramp to Main Street**

| Columns | Joist # | Delamination Size (FTxFT) | East (E) or West (W) Side of Beam | North (N) or South (S) Side of Stiffener |
|---|---|---|---|---|
| 1-2 | 3 | 1x1 | E | N,S |
| 1-2 | 4 | 1x3 | E | N,S |
| 1-2 | 4 | 1x2.5 | E | N |
| 1-2 | 5 | 1x6 | E | N |
| 2-3 | 5 | 1x10 | W | S |

**Table 3 - Joist Damage at Metal Beams**

| Joists Damaged at Beam | |
|---|---|
| **Columns** | **Joist #** |
| 5-6 | 8 |
| 5-6 | 10 |
| 5-6 | 11 |
| 5-6 | 12 |
| 5-6 | 13 |
| 5-6 | 14 |
| 5-6 | 16 |
| 5-6 | 21 |
| 5-6 | 22 |
| 5-6 | 23 |
| 5-6 | 24 |
| 5-6 | 25 |
| 5-6 | 26 |
| 5-6 | 49 |
| 5-6 | 50 |
| 2-3 | 62 |
| 2-3 | 57 |
| 2-3 | 56 |
| 2-3 | 50 |
| 2-3 | 51 |
| 2-3 | 52 |
| 2-3 | 53 |
| 2-3 | 54 |
| 2-3 | 47 |
| 2-3 | 41 |
| 2-3 | 38 |
| 2-3 | 22 |
| 2-3 | 23 |
| 2-3 | 18 |
| 2-3 | 15 |
| 2-3 | 9 |
| 2-3 | 8 |
| 2-3 | 7 |
| 2-3 | 6 |

Table 4 - Cracked Joists

**AREA B**

| Columns | Joist # | North (N) or South(S) Side of Joist | East (E) or West (W) Side of Stiffener |
|---|---|---|---|
| 6-7 | 1 | N | W |
| 5-6 | 1 | N | W |
| 5-6 | 66 | N | W |
| 4-5 | 67 | N | E |
| 4-5 | 66 | N | W |
| 2-3 | 14 | N | W |
| 2-3 | 22 | N | E |
| 2-3 | 26 | N | E |
| 2-3 | 34 | Thru | E |
| 2-3 | 36 | Thru | W |
| 2-3 | 37 | N | W |
| 2-3 | 38 | Thru | E |
| 3-4 | 38 | S | W |
| 3-4 | 65 | N | E |
| 3-4 | 66 | N | W |
| 3-4 | 67 | N | W |
| 2-3 | 45 | N | E |
| 2-3 | 43 | N | E |
| 2-3 | 67 | S | W |
| 2-3 | 66 | S | W |
| 3-4 | 6 | S | E |
| 4-5 | 1 | N | E |
| 4-5 | 2 | S | W |
| 4-5 | 30 | N | W |
| 1-2 | 40 | Thru | N/A |
| 1-2 | 39 | S | N/A |
| 1-2 | 38 | N | N/A |
| 1-2 | 37 | N | N/A |

**AREA C**

| Columns | Joist # | East (E) or West (W) Side of Joist | North (N) or South (S) Side of Stiffener |
|---|---|---|---|
| 6-7 | 6 | E | N |
| 6-7 | 7 | E | N |
| 4-5 | 18 | Thru | N |

**AREA D**

| Columns | Joist # | East (E) or West (W) Side of Joist | North (N) or South (S) Side of Stiffener |
|---|---|---|---|
| 6-7 | 2 | E,W | Thru |
| 6-7 | 4 | E | Thru |

| | | | |
|---|---|---|---|
| 5-6 | 1 | W | Thru |
| 5-6 | 2 | W | Thru |
| 5-6 | 4 | W | Thru |
| 4-5 | 1 | E,W | Thru |
| 4-5 | 2 | E | Thru |
| 4-5 | 4 | E | Thru |
| 3-4 | 1 | W | Thru |
| 3-4 | 2 | W | Thru |
| 3-4 | 3 | W | Thru |
| 3-4 | 4 | W | Thru |
| 2-3 | 1 | E | Thru |
| 2-3 | 3 | W | Thru |
| 2-3 | 4 | E | Thru |

**Table 5 - Joists Damaged by Vehicle Impact**

**Area C**

| Columns | Joist # | Location |
|---|---|---|
| 1-2 | 41 | Center |
| 1-2 | 40 | North, Center |
| 1-2 | 36 | North, Center |
| 2-3 | 35 | Center |
| 4-5 | 18 | North |
| 4-5 | 17 | North |

Table 6 - Field Inspections: Carbonation and Refinforcing Steel

| Location | | | | Testing Performed | | Carbonation | | Steel Inspection | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Structural Component | Location | Columns | Depth (in) | Chloride Ion Sample Taken* | Rebound Hammer Tested* | Carbonation Present based on Phenolphtalein Reaction? | pH Indication** | Measured Cover over Steel (inches) | Cover Specified in Deck Plans (inches) | Measured Size of Steel (inches) | Plan Size of Steel | Visible Corrosion of Steel? |
| End Beam | EB2 | 3-4 | 0-0.5 | Yes | No | Yes | < 9.0 | ---- | ---- | ----- | ----- | ----- |
| | EB2 | 3-4 | 0.5-1.0 | | | Yes | < 9.0 | | | | | |
| | EB2 | 3-4 | 1.0-1.5 | | | No | ≥ 9.0 | | | | | |
| Web Joist | D3 | 3-4 | 0-0.5 | Yes | Yes | Yes | < 9.0 | 1 1/2 | 1 1/2 | 5/8 | 5 | No |
| | D3 | 3-4 | 0.5-1.0 | | | No | ≥ 9.0 | | | | | |
| | D3 | 3-4 | 1.0-1.5 | | | No | ≥ 9.0 | | | | | |
| Web Joist | B44 | 5-6 | 0-0.5 | Yes | Yes | Yes | < 9.0 | 1 1/2 | 1 1/2 | 5/8 | 5 | No |
| | B44 | 5-6 | 0.5-1.0 | | | No | ≥ 9.0 | | | | | |
| | B44 | 5-6 | 1.0-1.5 | | | No | ≥ 9.0 | | | | | |
| Web Joist | B25 | 2-3 | 0-0.5 | Yes | No | Yes | < 9.0 | 1 | 1 1/2 | 5/8 | 5 | No |
| | B25 | 2-3 | 0.5-1.0 | | | Yes | < 9.0 | | | | | |
| | B25 | 2-3 | 1.0-1.5 | | | No | ≥ 9.0 | | | | | |
| Web Joist | C26 | 3-4 | 0-0.5 | Yes | Yes | Yes | < 9.0 | 1 1/2 | 1 1/2 | 7/8 | 7 | No |
| | C26 | 3-4 | 0.5-1.0 | | | Yes | < 9.0 | | | | | |
| | C26 | 3-4 | 1.0-1.5 | | | No | ≥ 9.0 | | | | | |
| End Beam | EB1 | 5-6 | 0-0.5 | No | No | Yes | < 9.0 | 5 at bottom 1 3/4 at sides | 1 1/2 | 3/8 stirrup 5/8 horiz bar | 5 | No |
| | EB1 | 5-6 | 0.5-1.0 | | | No | ≥ 9.0 | | | | | |
| | EB1 | 5-6 | 1.0-1.5 | | | No | ≥ 9.0 | | | | | |
| End Beam | EB2 | 4-5 | 0-0.5 | No | No | Yes | < 9.0 | ----- | ---- | ----- | ----- | ------ |
| | EB2 | 4-5 | 0.5-1.0 | | | Yes | < 9.0 | | | | | |
| | EB2 | 4-5 | 1.0-1.5 | | | No | ≥ 9.0 | | | | | |
| End Beam | EB1 | 4-5 | 0-0.5 | Yes | No | No | ≥ 9.0 | ----- | ---- | ----- | ----- | ------ |
| | EB1 | 4-5 | 0.5-1.0 | | | No | ≥ 9.0 | | | | | |
| | EB1 | 4-5 | 1.0-1.5 | | | No | ≥ 9.0 | | | | | |
| End Beam | EB2 | 6-7 | 0-0.5 | No | No | Yes | < 9.0 | ----- | ---- | ----- | ----- | ------ |
| | EB2 | 6-7 | 0.5-1.0 | | | Yes | < 9.0 | | | | | |
| | EB2 | 6-7 | 1.0-1.5 | | | No | ≥ 9.0 | | | | | |
| Web Joist | C40 | 1-2 | 0-0.5 | Yes | No | Yes | < 9.0 | ----- | ---- | ----- | ----- | ------ |
| | C40 | 1-2 | 0.5-1.0 | | | Yes | < 9.0 | | | | | |
| | C40 | 1-2 | 1.0-1.5 | | | Yes | < 9.0 | | | | | |
| Web Joist | B67 | 4-5 | 0-0.5 | Yes | No | Yes | < 9.0 | ----- | ---- | ----- | ----- | ------ |
| | B67 | 4-5 | 0.5-1.0 | | | Yes | < 9.0 | | | | | |
| | B67 | 4-5 | 1.0-1.5 | | | Yes | < 9.0 | | | | | |
| Web Joist | D1 | 3-4 | 0-0.5 | Yes | No | Yes | < 9.0 | Exposed | 1 1/2 | 1/2 | 5 | Yes |
| | D1 | 3-4 | 0.5-1.0 | | | Yes | < 9.0 | | | | | |
| | D1 | 3-4 | 1.0-1.5 | | | Yes | < 9.0 | | | | | |
| Web Joist | C41 | 0-1 | 0-0.5 | No | No | ----- | ----- | 1 3/4 | 1 1/2 | 7/8 | 7 | No |
| | C41 | 0-1 | 0.5-1.0 | | | | | | | | | |
| | C41 | 0-1 | 1.0-1.5 | | | | | | | | | |
| Pan | Pan B34-35 | 5-6 | 0-0.5 | No | No | ----- | ----- | 1/2 | 1 | 3/16 | 3/16 | No |
| | Pan B34-35 | 5-6 | 0.5-1.0 | | | | | | | | | |
| | PanB 34-35 | 5-6 | 1.0-1.5 | | | | | | | | | |
| Pan | Pan C13-14 | 5-6 | 0-0.5 | No | No | ----- | ----- | 1/8 | 1 | 1/8 | 1/8 | Yes rust staining bottom surface |
| | Pan C13-14 | 5-6 | 0.5-1.0 | | | | | | | | | |
| | Pan C13-14 | 5-6 | 1.0-1.5 | | | | | | | | | |
| Pan | Pan C36-37 | 2-3 | 0-0.5 | No | No | ----- | ----- | Exposed | 1 | <1/8 | 1/8 | Yes |
| | Pan C36-37 | 2-3 | 0.5-1.0 | | | | | | | | | |
| | Pan C36-37 | 2-3 | 1.0-1.5 | | | | | | | | | |

* Detailed results shown on subsequent table.

**Indication of pH based on American Concrete Institute, Report ACI 222R-01, Section 4.3.1.5 which states phenolphathalein reaction occurs at pH ≥ 9.0.

| | | | |
|---|---|---|---|
| Created by: | BDB | Date: | 6/15/2011 |
| Checked by: | CRW | Date: | 6/17/2011 |

Table 7 - Water Soluble Chloride Ion Test Results

Values Calculated Assuming Cement Content 10% by Mass Concrete 0.10

| Structural Components | Location | Columns | Depth (in) | CL by Mass Concrete (ppm) | CL by Mass Concrete (g/g) | CL by Mass Cement (g/g) | % CL by Mass Cement | Above Threshold value for concrete in WET conditions?* | Above Threshold value for concrete in DRY conditions?* | Carbonation Present based on Phenolphtalein Reaction? | pH Indication** | Visible Corrosion of Steel?*** | Visible Condition of Area of Sample Location? | Schmidt Rebound Hammer | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | Average Reading | Range of Compressive Strength (psi) | Mean Compressive Strength (psi) |
| Endbeam | EB2 | 3-4 | 0-0.5 | 2299 | 2.30E-03 | 2.30E-02 | 2.2990 | yes | yes | yes | < 9.0 | Yes | Poor | ----- | ----- | ----- |
| | EB2 | 3-4 | 0.5-1.0 | 855 | 8.55E-04 | 8.55E-03 | 0.8550 | yes | yes | yes | < 9.0 | | | | | |
| | EB2 | 3-4 | 1.0-1.5 | ND | -- | -- | -- | no | no | no | ≥ 9.0 | | | | | |
| Endbeam | EB1 | 4-5 | 0-0.5 | 1743 | 1.74E-03 | 1.74E-02 | 1.7430 | yes | yes | no | ≥ 9.0 | No | Poor | ----- | ----- | ----- |
| | EB1 | 4-5 | 0.5-1.0 | 264 | 2.64E-04 | 2.64E-03 | 0.2640 | yes | yes | no | ≥ 9.0 | | | | | |
| | EB1 | 4-5 | 1.0-1.5 | 219 | 2.19E-04 | 2.19E-03 | 0.2190 | yes | yes | no | ≥ 9.0 | | | | | |
| Web joist | B44 | 5-6 | 0-0.5 | ND | -- | -- | -- | no | no | yes | < 9.0 | no | Good | 45.5 | 5400-6750 | 6250 |
| | B44 | 5-6 | 0.5-1.0 | ND | -- | -- | -- | no | no | no | ≥ 9.0 | | | | | |
| | B44 | 5-6 | 1.0-1.5 | ND | -- | -- | -- | no | no | no | ≥ 9.0 | | | | | |
| Web joist | C26 | 3-4 | 0-0.5 | ND | -- | -- | -- | no | no | yes | < 9.0 | no | Good | 49.5 | 6400-7700 | 7100 |
| | C26 | 3-4 | 0.5-1.0 | ND | -- | -- | -- | no | no | yes | < 9.0 | | | | | |
| | C26 | 3-4 | 1.0-1.5 | ND | -- | -- | -- | no | no | no | ≥ 9.0 | | | | | |
| Web joist | B67 | 4-5 | 0-0.5 | 4220 | 4.22E-03 | 4.22E-02 | 4.2200 | yes | yes | yes | < 9.0 | no | Poor | ----- | ----- | ----- |
| | B67 | 4-5 | 0.5-1.0 | 1766 | 1.77E-03 | 1.77E-02 | 1.7660 | yes | yes | yes | < 9.0 | | | | | |
| | B67 | 4-5 | 1.0-1.5 | 1488 | 1.49E-03 | 1.49E-02 | 1.4880 | yes | yes | yes | < 9.0 | | | | | |
| Web joist | B25 | 2-3 | 0-0.5 | ND | -- | -- | -- | no | no | yes | < 9.0 | no | Good | ----- | ----- | ----- |
| | B25 | 2-3 | 0.5-1.0 | ND | -- | -- | -- | no | no | yes | < 9.0 | | | | | |
| | B25 | 2-3 | 1.0-1.5 | ND | -- | -- | -- | no | no | no | ≥ 9.0 | | | | | |
| Pan | B Pan(66-67) | 5-6 | 0-0.5 | 1711 | 1.71E-03 | 1.71E-02 | 1.7110 | yes | yes | yes | < 9.0 | Yes | Poor | ----- | ----- | ----- |
| | B Pan(66-67) | 5-6 | 0.5-1.0 | 671 | 6.71E-04 | 6.71E-03 | 0.6710 | yes | yes | yes | < 9.0 | | | | | |
| | B Pan(66-67) | 5-6 | 1.0-1.5 | 511 | 5.11E-04 | 5.11E-03 | 0.5110 | yes | yes | no | ≥ 9.0 | | | | | |

**NOTES:**

ND = Below detection level

Cement content assumed 10% by mass concrete; similar to concrete strength of 3000 psi

*Reference: American Concrete Institute, Report ACI 222R-01, Section 2.2.4.1.c

**Indication of PH based on American Concrete Institute, Report ACI 222R-01, Section 4.3.1.5 which states phenolphathalein reaction occurs at pH ≥ 9.0

***Visible corrosion of steel taken from nearest location of exposure if not inspected at the same location as chloride ion sample collection

Table 3.1 Chloride Limits for New Construction

| Category | CL, Chloride limit for new construction (% by mass of cement) | | | | |
|---|---|---|---|---|---|
| | Test Method | | | | |
| | Acid-Soluble | Water-soluble | | Percent Water-Soluble to Acid-Soluble**** | |
| | ASTM C 1152 | ASTM C 1218 | Soxhlet | | |
| Reinforced concrete in wet conditions | 0.1 | 0.08 | 0.08 | 0.08/0.10 | 80% |
| Reinforced concrete in dry | 0.2 | 0.15 | 0.15 | 0.15/0.20 | 75% |

| | | | |
|---|---|---|---|
| Created by: | BDB | Date: | 6/9/2011 |
| Checked by: | JTS | Date: | 6/9/2011 |

Building Code fo Chloride Limits (International)*

| International Code | CL, Chloride limit for new construction (% by mass of cement) | |
|---|---|---|
| | Test Method | |
| | Acid-Soluble | Water-Soluble (based on 75% of Acid-Soluble Limit) |
| British Code CP 110 | 0.35 | 0.26 |
| Norwegian Code NS 3420-L | 0.60 | 0.45 |

Table 7 - Water Soluble Chloride Ion Test Results



Values Calculated Assuming Cement Content 15% by Mass Concrete 0.15

| Structural Components | Location | Columns | Depth (in) | CL by Mass Concrete (ppm) | CL by Mass Concrete (g/g) | CL by Mass Cement (g/g) | % CL by Mass Cement | Above Threshold value for concrete in WET conditions?* | Above Threshold value for concrete in DRY conditions?* | Carbonation Present based on Phenolphtalein Reaction? | pH Indication** | Visible Corrosion of Steel?*** | Visible Condition of Area of Sample Location? | Schmidt Rebound Hammer | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | Average Reading | Range of Compressive Strength (psi) | Mean Compressive Strength (psi) |
| Endbeam | EB2 | 3-4 | 0-0.5 | 2299 | 2.30E-03 | 1.53E-02 | 1.5327 | yes | yes | yes | < 9.0 | Yes | Poor | ----- | ----- | ----- |
| | EB2 | 3-4 | 0.5-1.0 | 855 | 8.55E-04 | 5.70E-03 | 0.5700 | yes | yes | yes | < 9.0 | | | | | |
| | EB2 | 3-4 | 1.0-1.5 | ND | -- | -- | -- | no | no | no | ≥ 9.0 | | | | | |
| Endbeam | EB1 | 4-5 | 0-0.5 | 1743 | 1.74E-03 | 1.16E-02 | 1.1620 | yes | yes | no | ≥ 9.0 | No | Poor | ----- | ----- | ----- |
| | EB1 | 4-5 | 0.5-1.0 | 264 | 2.64E-04 | 1.76E-03 | 0.1760 | yes | yes | no | ≥ 9.0 | | | | | |
| | EB1 | 4-5 | 1.0-1.5 | 219 | 2.19E-04 | 1.46E-03 | 0.1460 | yes | no | no | ≥ 9.0 | | | | | |
| Web joist | B44 | 5-6 | 0-0.5 | ND | -- | -- | -- | no | no | yes | < 9.0 | no | Good | 45.5 | 5400-6750 | 6250 |
| | B44 | 5-6 | 0.5-1.0 | ND | -- | -- | -- | no | no | no | ≥ 9.0 | | | | | |
| | B44 | 5-6 | 1.0-1.5 | ND | -- | -- | -- | no | no | no | ≥ 9.0 | | | | | |
| Web joist | C26 | 3-4 | 0-0.5 | ND | -- | -- | -- | no | no | yes | < 9.0 | no | Good | 49.5 | 6400-7700 | 7100 |
| | C26 | 3-4 | 0.5-1.0 | ND | -- | -- | -- | no | no | yes | < 9.0 | | | | | |
| | C26 | 3-4 | 1.0-1.5 | ND | -- | -- | -- | no | no | no | ≥ 9.0 | | | | | |
| Web joist | B67 | 4-5 | 0-0.5 | 4220 | 4.22E-03 | 2.81E-02 | 2.8133 | yes | yes | yes | < 9.0 | no | Poor | ----- | ----- | ----- |
| | B67 | 4-5 | 0.5-1.0 | 1766 | 1.77E-03 | 1.18E-02 | 1.1773 | yes | yes | yes | < 9.0 | | | | | |
| | B67 | 4-5 | 1.0-1.5 | 1488 | 1.49E-03 | 9.92E-03 | 0.9920 | yes | yes | yes | < 9.0 | | | | | |
| Web joist | B25 | 2-3 | 0-0.5 | ND | -- | -- | -- | no | no | yes | < 9.0 | no | Good | ----- | ----- | ----- |
| | B25 | 2-3 | 0.5-1.0 | ND | -- | -- | -- | no | no | yes | < 9.0 | | | | | |
| | B25 | 2-3 | 1.0-1.5 | ND | -- | -- | -- | no | no | no | ≥ 9.0 | | | | | |
| Pan | B Pan(66-67) | 5-6 | 0-0.5 | 1711 | 1.71E-03 | 1.14E-02 | 1.1407 | yes | yes | yes | < 9.0 | Yes | Poor | ----- | ----- | ----- |
| | B Pan(66-67) | 5-6 | 0.5-1.0 | 671 | 6.71E-04 | 4.47E-03 | 0.4473 | yes | yes | yes | < 9.0 | | | | | |
| | B Pan(66-67) | 5-6 | 1.0-1.5 | 511 | 5.11E-04 | 3.41E-03 | 0.3407 | yes | yes | no | ≥ 9.0 | | | | | |

**NOTES:**

ND = Below detection level

Cement content assumed 15% by mass concrete; similar to concrete strength of 4000 psi

Results based on water-soluble chloride ion content

*Reference: American Concrete Institute, Report ACI 222R-01, Section 2.2.4.1.c

**Indication of pH based on American Concrete Institute, Report ACI 222R-01, Section 4.3.1.5 which states phenolphathalein reaction occurs at pH ≥ 9.0

***Visible corrosion of steel taken from nearest location of exposure if not inspected at the same location as chloride ion sample collection

**Table 3.1 Chloride Limits for New Construction (United States)**

| Category | CL, Chloride limit for new construction (% by mass of cement) | | | | |
|---|---|---|---|---|---|
| | Test Method | | | | |
| | Acid-Soluble | Water-soluble | | Percent Water-Soluble to Acid-Soluble | |
| | ASTM C 1152 | ASTM C 1218 | Soxhlet | | |
| Reinforced concrete in wet conditions | 0.1 | **0.08** | 0.08 | 0.08/0.10 | 80% |
| Reinforced concrete in dry conditions | 0.2 | **0.15** | 0.15 | 0.15/0.20 | 75% |

**Building Code fo Chloride Limits (International)***

| International Code | CL, Chloride limit for new construction (% by mass of cement) | |
|---|---|---|
| | Test Method | |
| | Acid-Soluble | Water-Soluble (based on 75% of Acid-Soluble Limit) |
| British Code CP 110 | 0.35 | 0.26 |
| Norwegian Code NS 3420-L | 0.60 | 0.45 |

| | | | |
|---|---|---|---|
| Created by: | BDB | Date: | 6/9/2011 |
| Checked by: | JTS | Date: | 6/9/2011 |

MAIN STREET

GRID

GRAPHIC SCALE

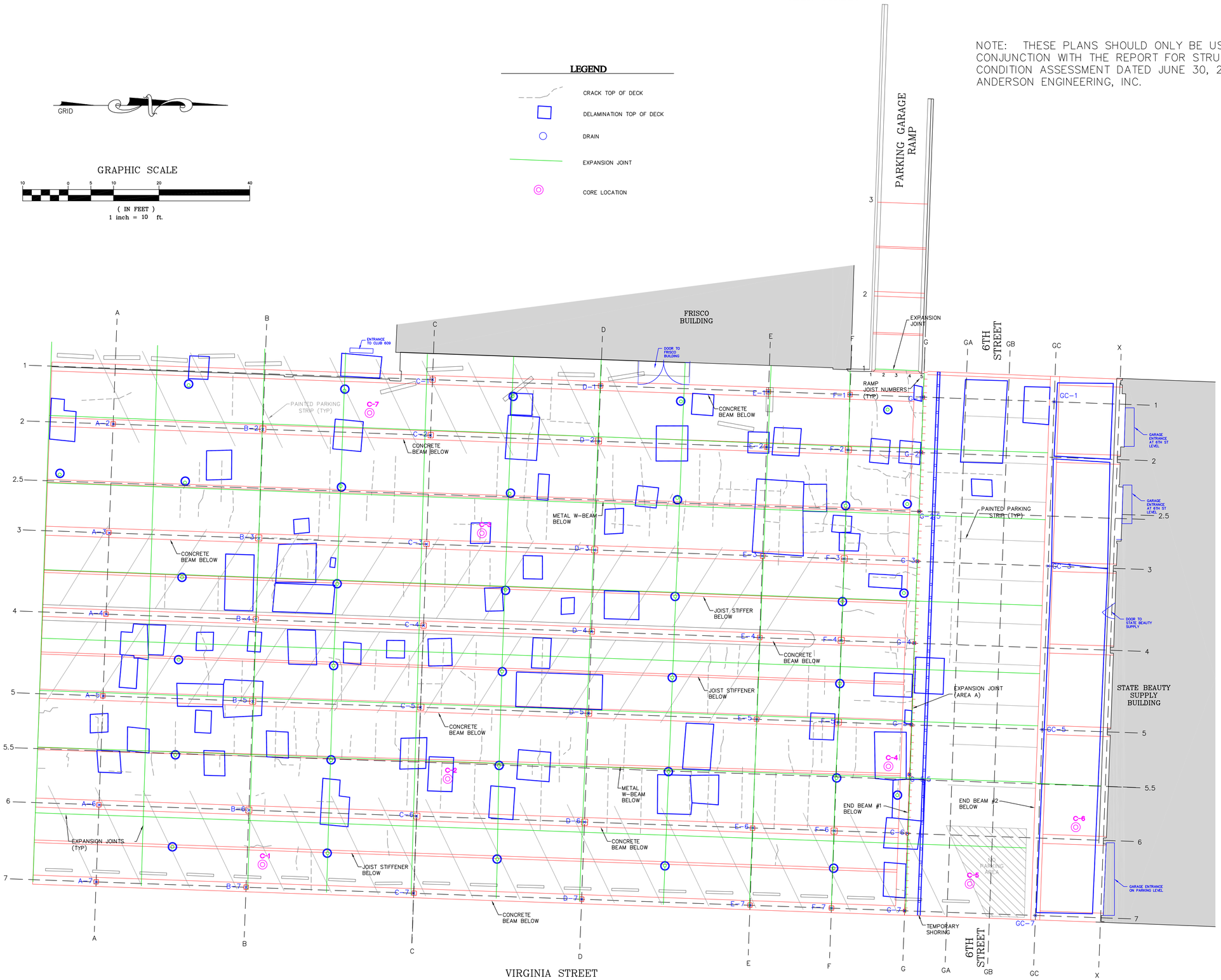
10 0 5 10 20 40

( IN FEET )
1 inch = 10 ft.

**LEGEND**

- CRACK TOP OF DECK
- DELAMINATION TOP OF DECK
- DRAIN
- EXPANSION JOINT
- CORE LOCATION

NOTE: THESE PLANS SHOULD ONLY BE USED IN CONJUNCTION WITH THE REPORT FOR STRUCTURAL CONDITION ASSESSMENT DATED JUNE 30, 2011 BY ANDERSON ENGINEERING, INC.




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FIELD BOOK:
JOB NUMBER: 50032-11

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CITY OF JOPLIN

STRUCTURAL EVALUATION
1990'S DECK OVERLAY
JOPLIN PARKING DECK - BOTTOM DECK
DELAMINATIONS AND CRACKS

6TH STREET AND VIRGINIA AVUENE
JOPLIN, JASPER COUNTY, MISSOURI

DRAWING NO. JOP-100-2457

SHEET NUMBER 1 OF 6

GRID

GRAPHIC SCALE

10 0 5 10 20 40

( IN FEET )
1 inch = 10 ft.

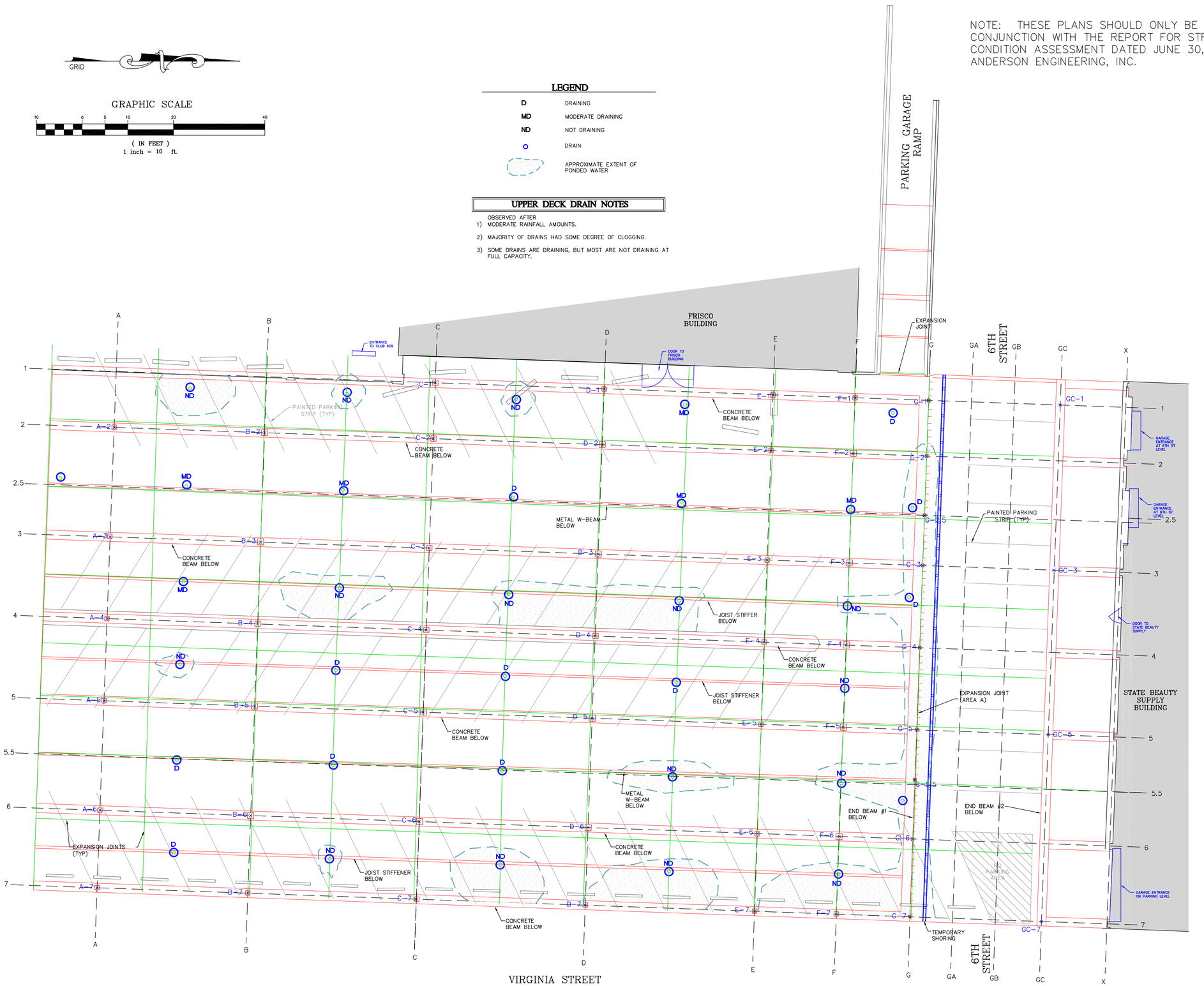
**LEGEND**

| | |
|---|---|
| D | DRAINING |
| MD | MODERATE DRAINING |
| ND | NOT DRAINING |
| O | DRAIN |
| | APPROXIMATE EXTENT OF PONDED WATER |

**UPPER DECK DRAIN NOTES**

OBSERVED AFTER
1) MODERATE RAINFALL AMOUNTS.
2) MAJORITY OF DRAINS HAD SOME DEGREE OF CLOGGING.
3) SOME DRAINS ARE DRAINING, BUT MOST ARE NOT DRAINING AT FULL CAPACITY.

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# STRUCTURAL EVALUATION
# JOPLIN PARKING DECK - DRAINS

6TH STREET AND VIRGINIA AVUENE
JOPLIN, JASPER COUNTY, MISSOURI

DRAWING NO. JOP-100-2457

SHEET NUMBER 2 OF 6

GRID

GRAPHIC SCALE

10 0 5 10 20 40

( IN FEET )
1 inch = 10 ft.

**LEGEND**

8 — MAJOR DELAMINATION

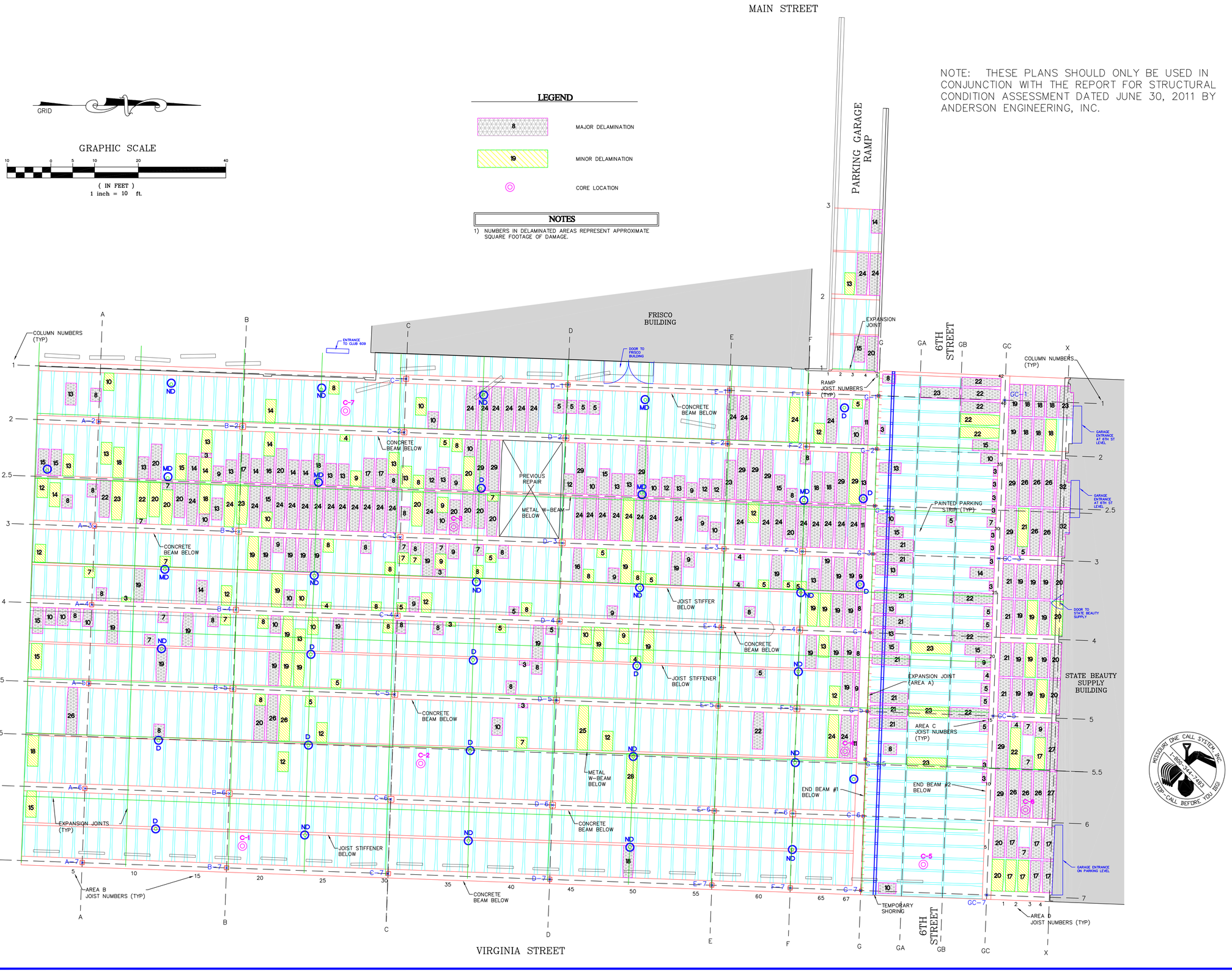
19 — MINOR DELAMINATION

CORE LOCATION

**NOTES**

1) NUMBERS IN DELAMINATED AREAS REPRESENT APPROXIMATE SQUARE FOOTAGE OF DAMAGE.

NOTE: THESE PLANS SHOULD ONLY BE USED IN CONJUNCTION WITH THE REPORT FOR STRUCTURAL CONDITION ASSESSMENT DATED JUNE 30, 2011 BY ANDERSON ENGINEERING, INC.





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CITY OF JOPLIN

STRUCTURAL EVALUATION

# ORIGINAL 1960'S DECK JOPLIN PARKING DECK - BOTTOM DECK DELAMINATIONS

6TH STREET AND VIRGINIA AVENUE
JOPLIN, JASPER COUNTY, MISSOURI

DRAWING NO. JOP-100-2457

SHEET NUMBER 3 OF 6

GRID

GRAPHIC SCALE

10 0 5 10 20 40

( IN FEET )
1 inch = 10 ft.

**LEGEND**

| | |
|---|---|
| CL | CHLORIDE TESTING |
| PH | CARBONATION TESTING WITH PHENOLPHTHALEIN |
| R | REBAR EXPOSED FOR INSPECTION |
| ● | SAMPLE TAKEN FOR TESTING OR INSPECTION |
| ✳ | REPRESENTS CRACKING IN CONCRETE JOIST |
| □ | REPRESENTS CRACKING SEAM WHERE JOIST MEETS PAN |
| ⬡ | DELAMINATION ON JOIST SEE TABLE IN REPORT FOR DIMENSIONS |
| ▽ | REPRESENTS DAMAGED CONCRETE JOIST AT METAL BEAM |
| ▬ | MAJOR DAMAGE TO JOIST DUE TO POSSIBLE IMPACTS FROM LARGE TRUCKS |

**NOTES**

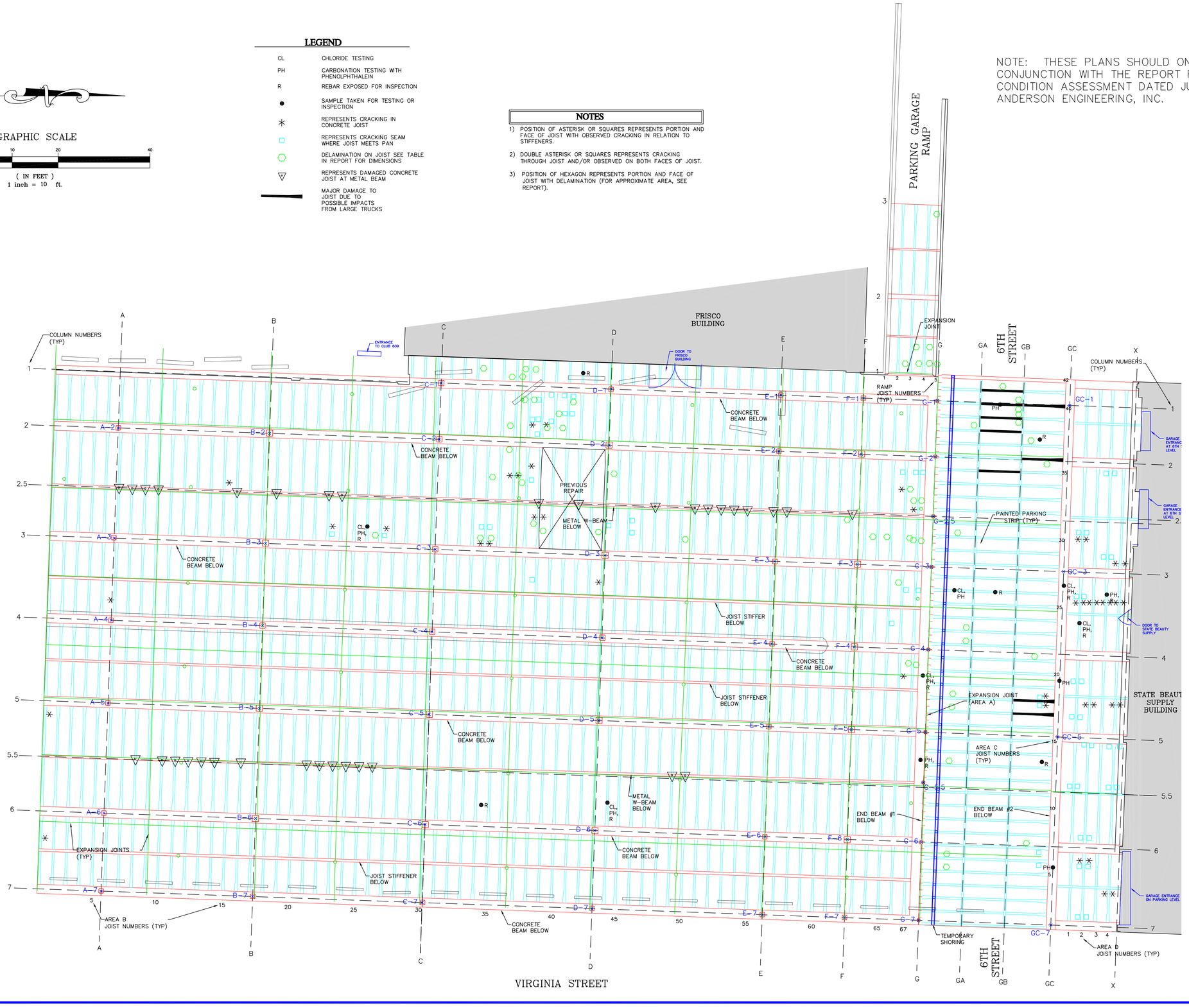
1) POSITION OF ASTERISK OR SQUARES REPRESENTS PORTION AND FACE OF JOIST WITH OBSERVED CRACKING IN RELATION TO STIFFENERS.

2) DOUBLE ASTERISK OR SQUARES REPRESENTS CRACKING THROUGH JOIST AND/OR OBSERVED ON BOTH FACES OF JOIST.

3) POSITION OF HEXAGON REPRESENTS PORTION AND FACE OF JOIST WITH DELAMINATION (FOR APPROXIMATE AREA, SEE REPORT).

NOTE: THESE PLANS SHOULD ONLY BE USED IN CONJUNCTION WITH THE REPORT FOR STRUCTURAL CONDITION ASSESSMENT DATED JUNE 30, 2011 BY ANDERSON ENGINEERING, INC.

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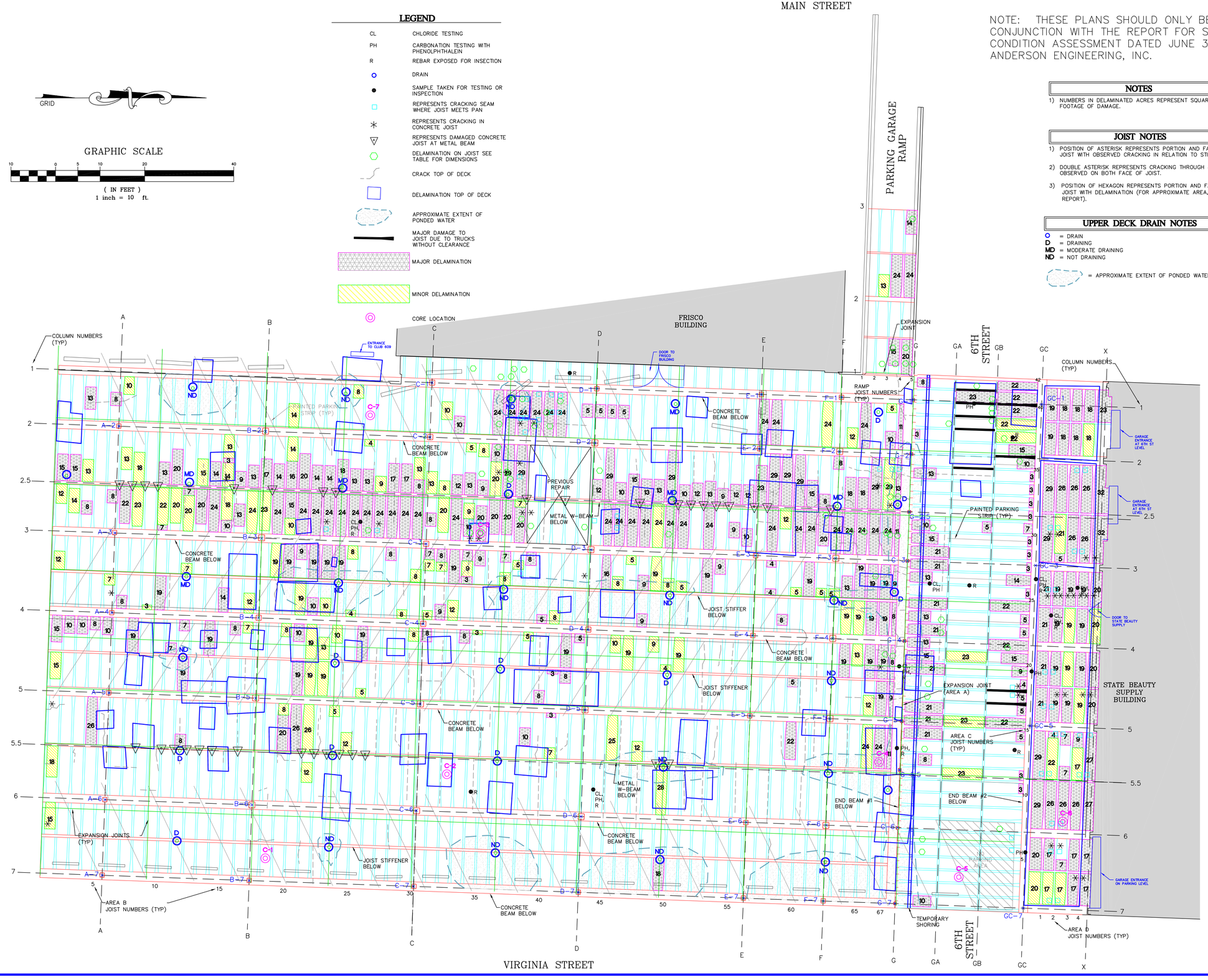
CITY OF JOPLIN

# STRUCTURAL EVALUATION
# JOPLIN PARKING DECK - BOTTOM DECK JOIST INSPECTION

6TH STREET AND VIRGINIA AVUENE
JOPLIN, JASPER COUNTY, MISSOURI

DRAWING NO. JOP-100-2457

SHEET NUMBER 4 OF 6




NOTE: THESE PLANS SHOULD ONLY BE USED IN CONJUNCTION WITH THE REPORT FOR STRUCTURAL CONDITION ASSESSMENT DATED JUNE 30, 2011 BY ANDERSON ENGINEERING, INC.

## NOTES

1) NUMBERS IN DELAMINATED ACRES REPRESENT SQUARE FOOTAGE OF DAMAGE.

## JOIST NOTES

1) POSITION OF ASTERISK REPRESENTS PORTION AND FACE OF JOIST WITH OBSERVED CRACKING IN RELATION TO STIFFENERS.
2) DOUBLE ASTERISK REPRESENTS CRACKING THROUGH JOIST AND OBSERVED ON BOTH FACE OF JOIST.
3) POSITION OF HEXAGON REPRESENTS PORTION AND FACE OF JOIST WITH DELAMINATION (FOR APPROXIMATE AREA, SEE REPORT).

## UPPER DECK DRAIN NOTES

O = DRAIN
D = DRAINING
MD = MODERATE DRAINING
ND = NOT DRAINING

= APPROXIMATE EXTENT OF PONDED WATER

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CITY OF JOPLIN

# STRUCTURAL EVALUATION JOPLIN PARKING DECK OVERALL INSPECTION

6TH STREET AND VIRGINIA AVENUE
JOPLIN, JASPER COUNTY, MISSOURI

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DRAWING NO. JOP-100-2457

SHEET NUMBER 5 OF 6

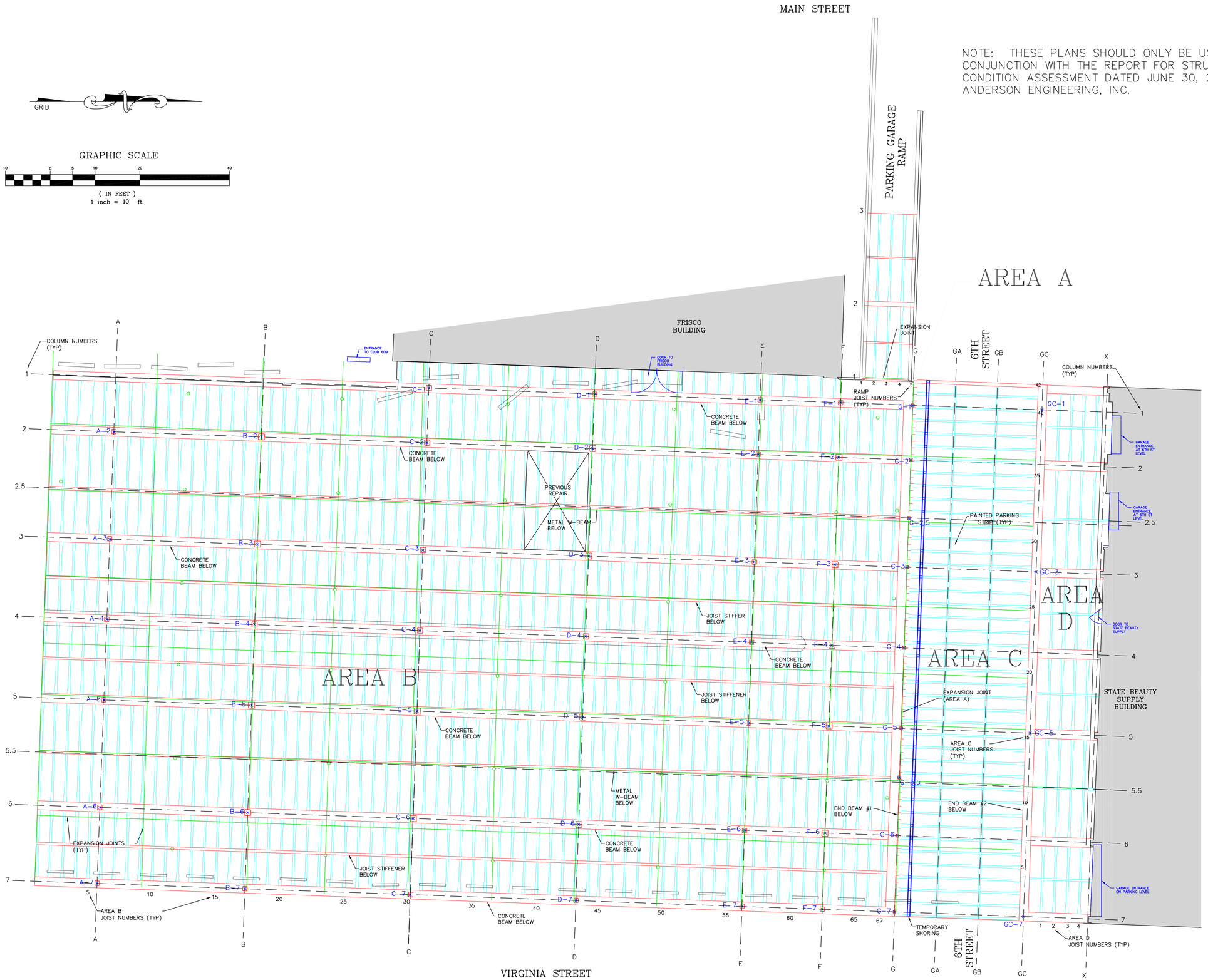
GRID

GRAPHIC SCALE

10 0 5 10 20 40

( IN FEET )
1 inch = 10 ft.

NOTE: THESE PLANS SHOULD ONLY BE USED IN CONJUNCTION WITH THE REPORT FOR STRUCTURAL CONDITION ASSESSMENT DATED JUNE 30, 2011 BY ANDERSON ENGINEERING, INC.




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CITY OF JOPLIN

# STRUCTURAL EVALUATION JOPLIN PARKING DECK LAYOUT

6TH STREET AND VIRGINIA AVUENE
JOPLIN, JASPER COUNTY, MISSOURI

DRAWING NO. JOP-100-2457

SHEET NUMBER 6 OF 6

ALLGEIER, MARTIN and ASSOCIATES, INC.
Consulting Engineers

November 17, 2020

Mr. Lynden Lawson, P.E.
Assistant Director of Public Works - Operations
City of Joplin
602 South Main Street
Joplin, MO 64801

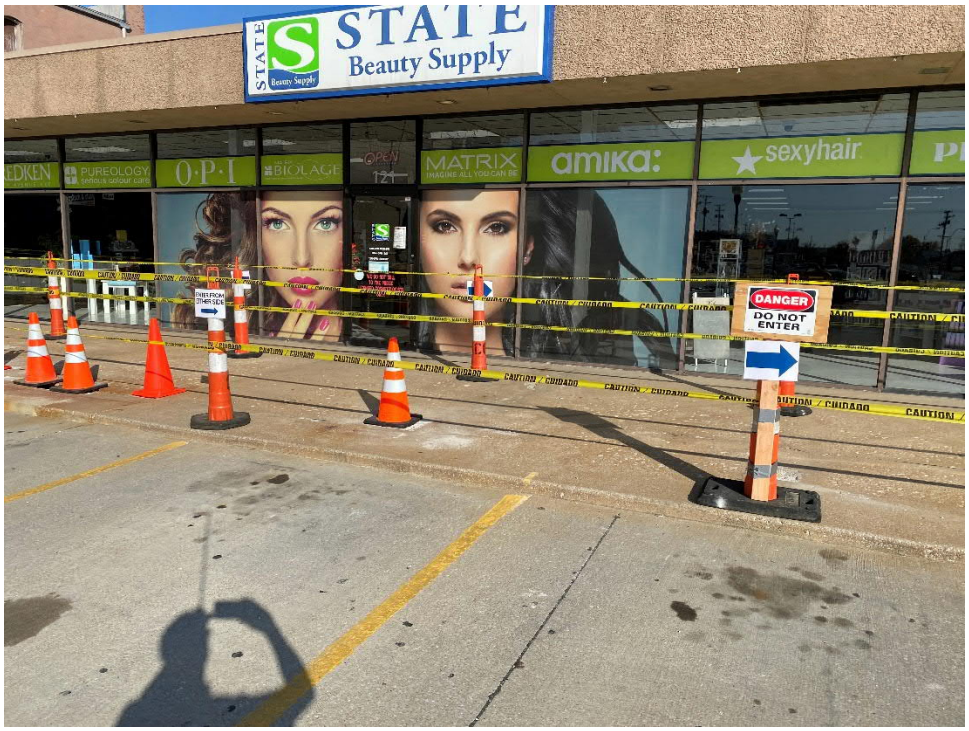
RE: Parking Deck - Sidewalk Assessment
6th and Virginia Avenue, Joplin, MO

OVERVIEW:

A visual assessment was conducted on November 6th and November 10th to verify the safety of the elevated sidewalk located south of the State Beauty Supply Building. The visual assessment was requested by Mr. Lynden Lawson after he received reports that the sidewalk contained large holes and cracks. It is our understanding that a plate that had been placed over some cracks in the sidewalk had been recently removed. Upon removal of the plate, the adjacent business owner became concerned after noticing the size and number of cracks found. After receiving a notification of the sidewalk condition, the City of Joplin installed cones, ribbons, and signage to restrict access over the compromised areas. The east and west ends of the sidewalk remained open so that access to the business could remain (See photographs 1.0 through 1.4).




Photograph 1.0
Looking at the west end of the sidewalk




Photograph 1.1
Looking northward at the middle of the sidewalk




Photograph 1.2
Looking at the east end of the sidewalk




Photograph 1.3
Looking East
Pedestrian Access Permitted along the left side of the Photograph
Numerous Longitudinal Cracks and Patching shown



Photograph 1.4
Looking East - Pedestrian Access

Parking Deck - Sidewalk Assessment
6th and Virginia, Joplin, MO
November 17, 2020

ATTENDANCE:

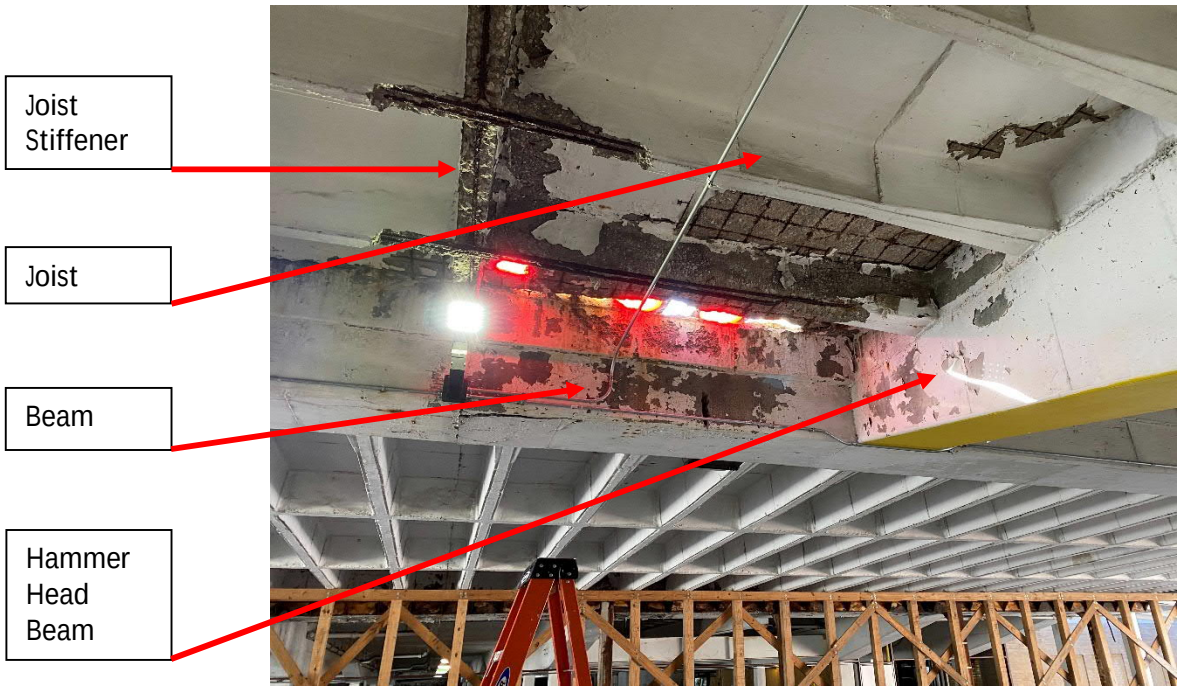
David Hertzberg, PE, Director of Public Works
Lynden Lawson, Assistant Director of Public Works - Operations
Dakota Rusk, Traffic Management
Jesua Castro, Allgeier Martin
Michael Atkinson, PE, Allgeier Martin

PURPOSE:

The purpose of the visual assessment is as follows:

1. Determine if the sidewalk could remain open to allow continued assess to the business from the parking lot.
2. What immediate steps are needed to maintain the stability of the structure and the safety of the area.

DEFINITION OF TERMS: (Refer to Photograph 2.0)




Photograph 2.0

Joist: Smaller intermediate concrete beams that span between major structural components.
Joist Stiffener: Smaller intermediate concrete beams that span between the Joists to add stability to the Joists.
Beams: Major concrete beams that span between supports to carry the Joists.
Hammer Head Beams: Major structural components that carry the Beams and/or Joists.
Columns (not shown): Major structural component that carries the load from the Hammer Head Beams down to the foundation.

OBERVATIONS:

1. The surface of the sidewalk contained numerous openings/holes and longitudinal cracks ranging from just a few feet long to nearly 24 feet in length. The width of the cracks varied from hairline to approximately 6-inches in width. The location of the cracks appeared to coincide with the spacing of the concrete Joists that supported the sidewalk; and the lengths appeared to coincide with the span lengths of the Joists between supports. The longitudinal cracks are considered structural in nature as a result of direct tension caused by thermal stresses.
2. Several areas of the sidewalk had been repaired or patched.
3. A differential settlement of approximately ½-inch was measured across one of the longitudinal cracks that exhibited the widest opening and greatest deterioration.
4. Acoustical sounding conducted on the sidewalk revealed wide spread delamination in the sidewalk.
5. In some areas, the Joists, Joist Stiffeners and Deck below the sidewalk exhibited severe to minor concrete spalling and deterioration of the exposed reinforcing steel.
6. The thickness of the Deck varied and measured 3.5 inches in good areas to approximately 1 inch in severely spalled areas with considerable section loss adjacent to the cracks and holes.
7. The areas exhibiting the greatest amount of deterioration was located directly above a stormwater inlet.
8. A construction joint located near the center of the concrete Beam above the stormwater inlet exhibited evidence of deterioration of reinforcing steel and the initial signs of concrete spalling.
9. A photograph taken along the length of the Beam did not appear to show signs of noticeable deflection.

STRUCTURAL CALCULATIONS:

To determine the extent of remaining structural capacity, calculations were conducted to determine the capacity of the Joists. This was made possible by estimating the amount of reinforcing steel in the Joints as noted by visual observation. Since the original plans could not be reviewed, conservative assumptions were made relative to the design type of the spans. Calculations were conducted using simple and continuous type span arrangements for comparison. A live load of 100 psf was applied to the structure for pedestrians. The structure was also derated by 50-percent to reflect the amount of deterioration in the Joists. Given that the structure fails using the simple support design, we can conjecture that the Joists were designed as continuous over the supports. Some areas where the reinforcing is exposed seems to support this design assumption.

Joists: Span arrangements are measured at 17'-24'-18'-18'-24'-17' measured between the Hammer Head Beams from West to East. The 24' span is the controlling span with an estimated overstress of 1.6 percent using the current Load and Resistance Factor Design (LRFD) method. Since the original structure was designed using the older and more conservative Allowable Stress Design (ASD) method, it is logical to conclude why the structure has a small overstress even with the structure being derated at 50 percent. Given that the structure experiences a small overstress of 1.6 percent with applied pedestrian loads, the portion of the sidewalk located over the deteriorated areas should remain closed. By eliminating pedestrian access, this will bring the stresses down to within the estimated threshold.

While eminent failure of the Joists is not an immediate concern, there are other associated concerns of deteriorated concrete falling on pedestrians under the sidewalk. A net or some other means to protect pedestrians walking below the structure should be put in place.

Beam: The main concrete Beam that is attached to the south ends of the Hammer Head Beams is also continuous along the entire width of the Parking Deck from West to East. It is identified as End Beam #2 (Line GC) on sheet 4 in Andersons Engineering report dated June 30, 2011. As shown in Photograph 3.0, 3.1 and 3.2, the beam is experiencing spalling at the joint. There is a concern that the deterioration of the reinforcing steel at this location will compromise the structural integrity in a section of the parking lot over 6th Street. There are several factors that warrant investigation of the beam. A joint usually offers an opportunity for water to reach the reinforcing steel. This joint is in a high stress area and above the stormwater inlet. The excessive deterioration of the remaining structure at this location suggests higher humidity levels could exist directly above the inlet.




Photograph 3.0
Beam Spalling at Joint



Photograph 3.1
Beam Spalling at Joint

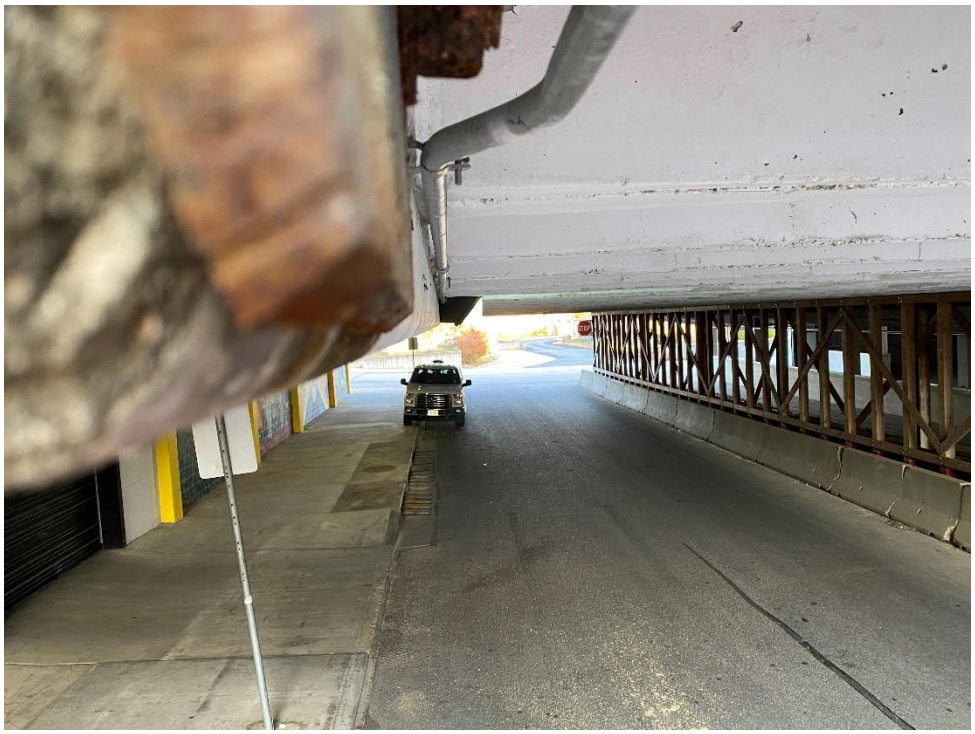


Photograph 3.2
Beam Spalling at Joint

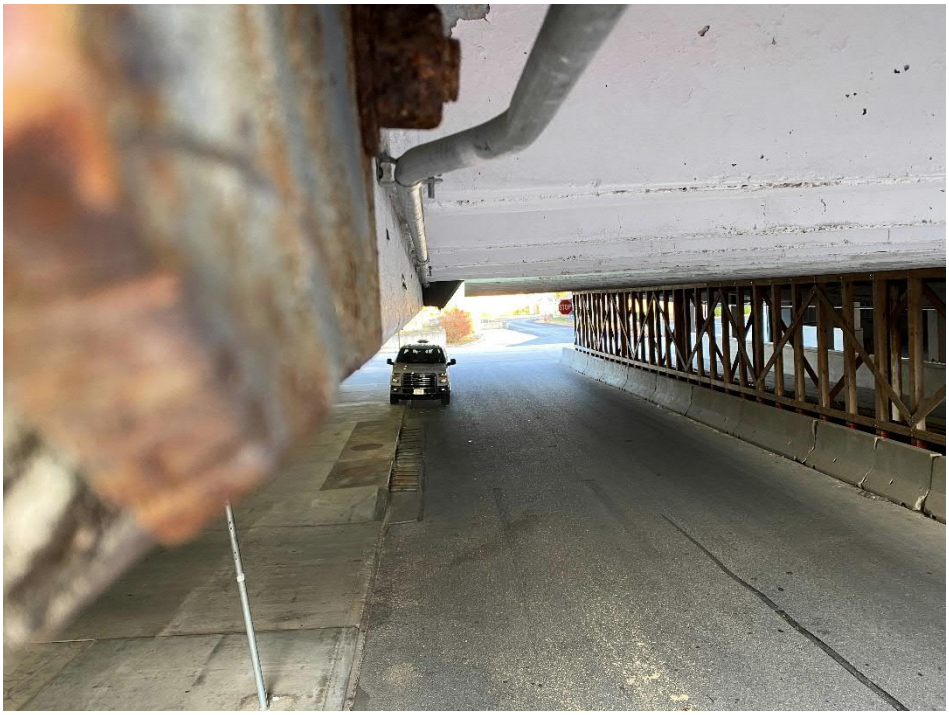
Photographs 4.0, 4.1 and 4.2 were taken so that a visual examination of any deflection could be recorded. While there was no immediate deflection noted in the Beam, this is an area of concern that should be investigated before the condition worsens. It is recommended that the spalled piece of concrete be removed so that inspection of the reinforcing steel and appropriate treatment be developed. A supplemental to this Assessment can be prepared once this work is complete.



Photograph 4.0
Check for Deflection



Photograph 4.1
Check for Deflection



Photograph 4.2
Check for Deflection

RECOMMENDATIONS:

1. Maintain closure of the compromised area as delineated during the inspection on November 6, 2020 and as shown in Photographs 1.0 through 1.4.
2. The pedestrian pathway provided at the extreme west and east end of the sidewalk including the 5-foot wide access along the face of the building is satisfactory and may remain open.
3. Prohibit vehicles from driving on the sidewalk at the loading area located on the east end of the sidewalk. Loading and unloading with hand carts is acceptable.
4. Install a net under the elevated sidewalk or some other means to protect pedestrians from falling debris onto the 6th Street sidewalk.
5. It is understood that the City of Joplin plans to replace the parking structure soon. In the meantime, semi-annual inspections should be conducted to monitor the progression of deterioration. If replacement is delayed, temporary rehabilitation efforts to restore the structure should be considered. This would consist of the removal of loose debris, cleaning reinforcing steel, re-establishment of reinforcing steel (as needed), and the replacement of lost concrete in the Joists. The purpose of this effort is to provide protection to the remaining reinforcing. Partial and full depth deck replacement is also required to restore the structure to a usable condition in the interim.
6. If the condition of the structure changes such as additional cracking, settlement, deflection, or evidence of additional spalling (such as concrete debris on the lower sidewalk), etc., the structure and 6th street should be closed immediately until further investigation is conducted. A closure plan with alternate routes for traffic and pedestrian access to the business should be prepared in advance.
7. Investigate the condition of the reinforcing steel in End Beam Number 2 and address as needed. A supplemental to this evaluation will be issued upon investigation.

This assessment was conducted according the basic guidelines as outlined in ACI 364.1, R-94 and reapproved in 1999, and according to ACI 201.1R. The assessment is limited to the area considered as the sidewalk in the front of the State Beauty Supply Building. This assessment is not intended to be fully comprehensive. It was intended to provide a general review of the structural condition of the sidewalk at the time of our visit. Thus, it does not cover items that may be discovered by invasive methods unless addressed by a supplemental. It should be noted that the report is based on visual observations with limited mechanical techniques and there is no claim, either stated or implied, that all conditions were observed. Allgeier Martin reserves the right to amend this report if additional evidence or information is revealed.

Sincerely,

**ALLGEIER, MARTIN and ASSOCIATES, INC.**

Michael Atkinson, P.E.
Vice President

Attachments:

Photographs (10 Pages)
Structural Calculations (3 Pages)
Sheet 4, Prepared by Anderson Engineering, Dated June 14, 2011
























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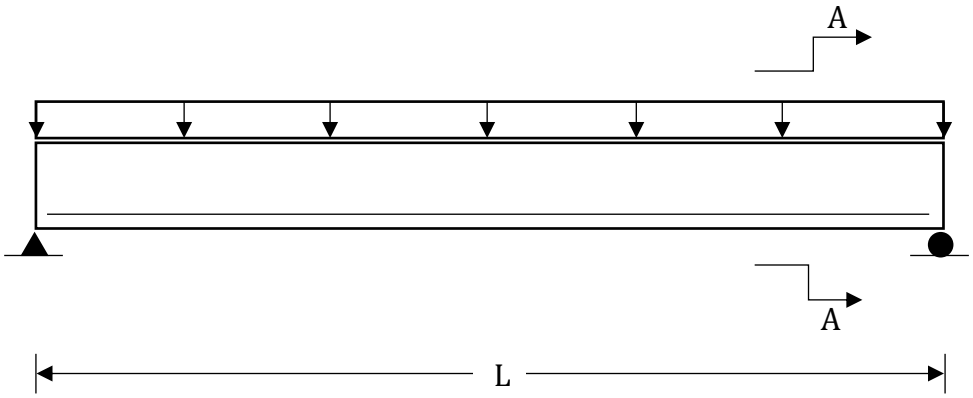




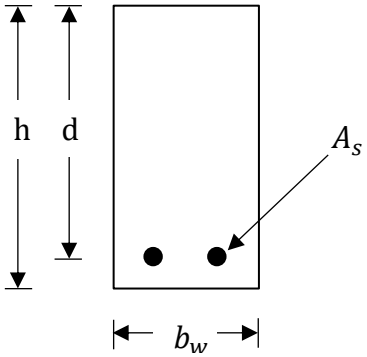





NO

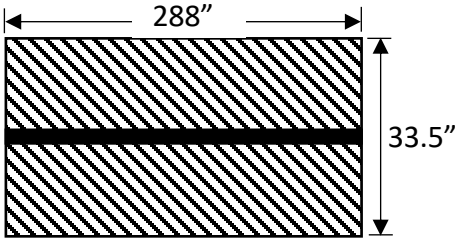



SECTION A-A




**Properties**

$b_w = 6$”
$h = 15$”
L = 24’ = 288”
clear cover = 2”
d = 15”- 2”- 0.5" = 12.5”
$f'_c = 4{,}000\ psi$
$f_y = 60{,}000\ psi$




Tributary Area

**Live Load**

Pedestrian Load = 100 psf

$$W_{LL} = \left[100\ psf\left(\frac{33.5"}{12"}\cdot\frac{288"}{12"}\right)\right] = 6700\ lb$$

Distributed Load=$\frac{6700\ lb}{24\ ft} = 279.2\frac{lb}{ft}$

**Dead Load**

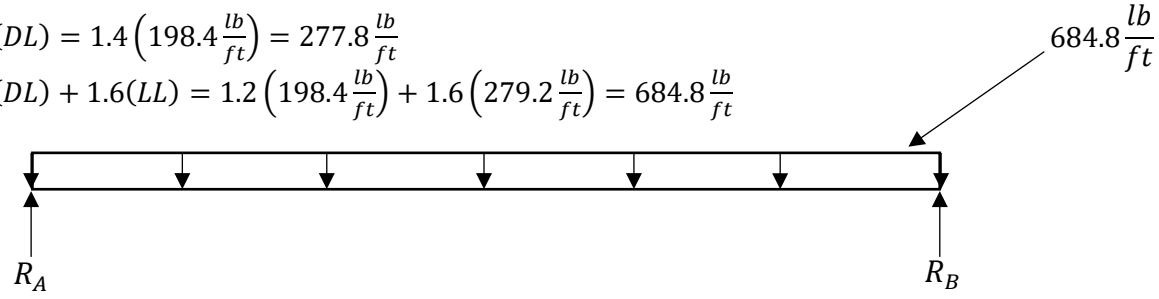
$\gamma_c = 150\ pcf$

$$W_{DL} = \left[150\ pcf\left(\frac{6"}{12"}\cdot\frac{15"}{12"}\cdot\frac{216"}{12"}\right)\right] + \left[150\ pcf\ \left(\frac{216"}{12"}\cdot\frac{33.5"}{12"}\cdot\frac{3"}{12"}\right)\right] = 4762.5\ lb$$

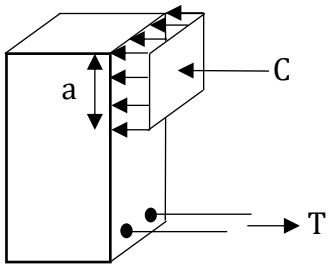
Distributed Load=$\frac{4762.5\ lb}{24\ ft} = 198.4\frac{lb}{ft}$

**LRFD**

1. $1.4(DL) = 1.4\left(198.4\frac{lb}{ft}\right) = 277.8\frac{lb}{ft}$
2. $1.2(DL) + 1.6(LL) = 1.2\left(198.4\frac{lb}{ft}\right) + 1.6\left(279.2\frac{lb}{ft}\right) = 684.8\frac{lb}{ft}$




$$M_u = \frac{wl^2}{8} = \frac{(251.6\ \frac{lb}{ft})(24\ ft)^2}{8} = 49305.6\ lb\cdot ft$$




**Area of Steel Required**

**2 #5 Steel Rebar**

$A_s = (0.31\ in^2)(2) = 0.62\ in^2$

T= $A_s f_y$

$C = 0.85 f'_c b_w a$

$T = C$

$0.85 f'_c b_w a = A_s f_y$

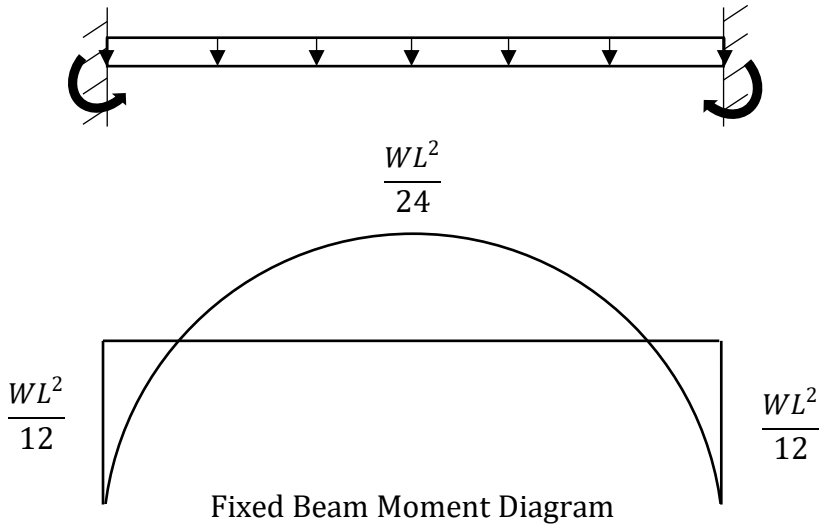
$a = \frac{A_s f_y}{0.85 f'_c b_w} = \frac{(0.62\ in^2)(60{,}000\ psi)}{0.85(4{,}000\ psi)(6\ in)} = 1.82\ in$

$M_n = A_s f_y \left(d - \frac{a}{2}\right) = (0.62\ in^2)(60{,}000\ psi)\left(12.5\ in - \left(\frac{1.82\ in}{2}\right)\right)\left(\frac{1\ ft}{12\ in}\right) = 35929\ lb \cdot ft$

$\phi = 0.9$

$\phi M_n > M_u$

$\mathbf{32336.1\ lb \cdot ft > 49305.6\ lb \cdot ft}$




Fixed Beam Moment Diagram

$$\frac{WL^2}{12} = \frac{(684.8\ \frac{lb}{ft})(24\ ft)^2}{12} = \mathbf{32870.4\ lb \cdot ft}$$

$$\frac{WL^2}{24} = \frac{(684.8\ \frac{lb}{ft})(24\ ft)^2}{24} = \mathbf{16435.2\ lb \cdot ft}$$

GRID

GRAPHIC SCALE

10 0 5 10 20 40

( IN FEET )
1 inch = 10 ft.

**LEGEND**

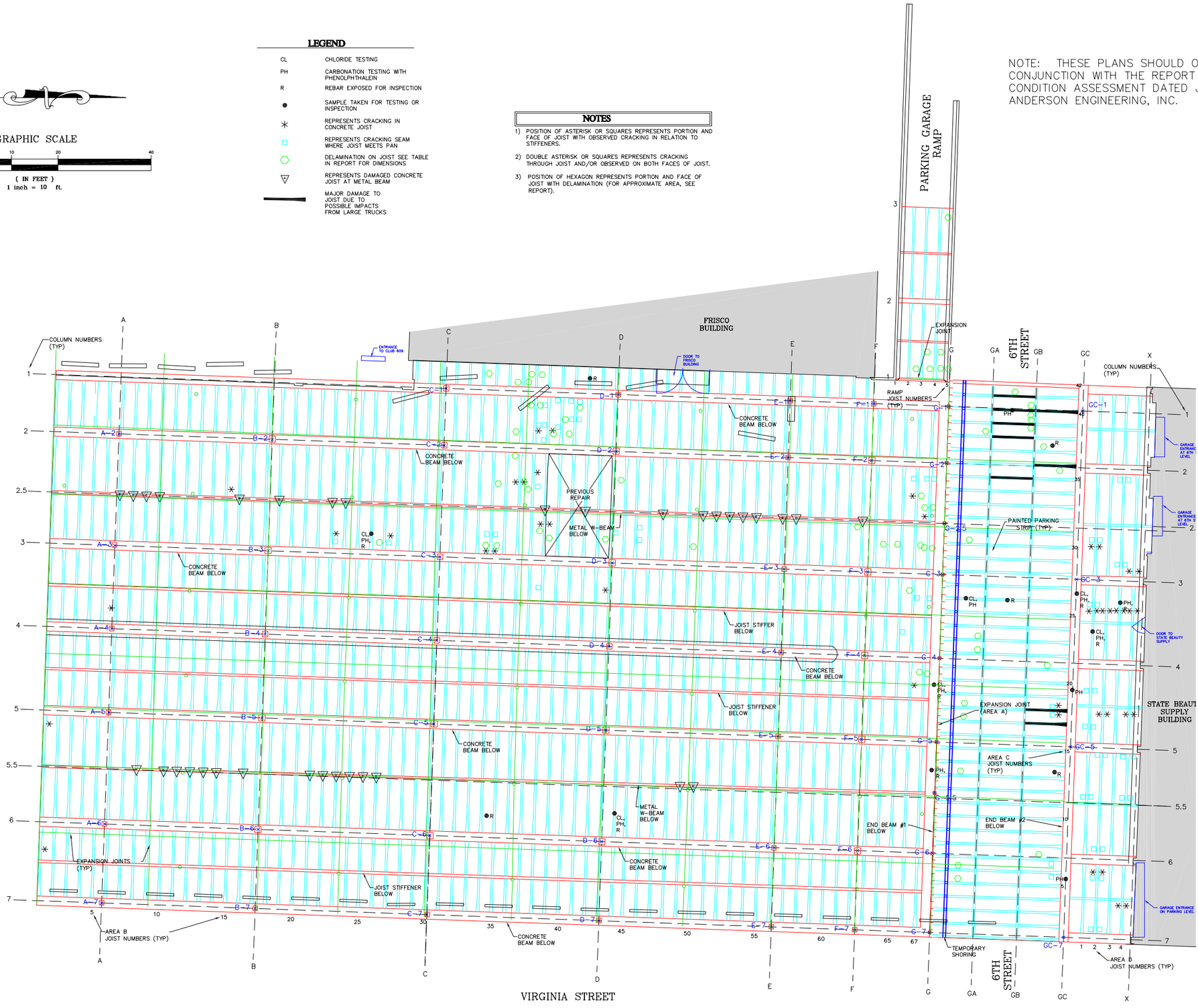
| | |
|---|---|
| CL | CHLORIDE TESTING |
| PH | CARBONATION TESTING WITH PHENOLPHTHALEIN |
| R | REBAR EXPOSED FOR INSPECTION |
| ● | SAMPLE TAKEN FOR TESTING OR INSPECTION |
| ✳ | REPRESENTS CRACKING IN CONCRETE JOIST |
| □ | REPRESENTS CRACKING SEAM WHERE JOIST MEETS PAN |
| ⬡ | DELAMINATION ON JOIST SEE TABLE IN REPORT FOR DIMENSIONS |
| ▽ | REPRESENTS DAMAGED CONCRETE JOIST AT METAL BEAM |
| ▬ | MAJOR DAMAGE TO JOIST DUE TO POSSIBLE IMPACTS FROM LARGE TRUCKS |

**NOTES**

1) POSITION OF ASTERISK OR SQUARES REPRESENTS PORTION AND FACE OF JOIST WITH OBSERVED CRACKING IN RELATION TO STIFFENERS.
2) DOUBLE ASTERISK OR SQUARES REPRESENTS CRACKING THROUGH JOIST AND/OR OBSERVED ON BOTH FACES OF JOIST.
3) POSITION OF HEXAGON REPRESENTS PORTION AND FACE OF JOIST WITH DELAMINATION (FOR APPROXIMATE AREA, SEE REPORT).

NOTE: THESE PLANS SHOULD ONLY BE USED IN CONJUNCTION WITH THE REPORT FOR STRUCTURAL CONDITION ASSESSMENT DATED JUNE 30, 2011 BY ANDERSON ENGINEERING, INC.

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ANDERSON ENGINEERING, INC
ENGINEERS - SURVEYORS - LABORATORIES - DRILLING
811 E. 3RD STREET• JOPLIN, MISSOURI 64801• PHONE (417) 782-7399


DRAWING INFO.

| | |
|---|---|
| FIELD BY: | SLM |
| DRAWN BY: | CRW |
| CHECK BY: | |
| DATE: | 6-14-11 |
| FIELD BOOK: | |
| JOB NUMBER: | 50032-11 |

| NO. | DESCRIPTION | DATE | BY |
|---|---|---|---|
| REVISIONS | | | |

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CITY OF JOPLIN

# STRUCTURAL EVALUATION
# JOPLIN PARKING DECK - BOTTOM DECK JOIST INSPECTION

6TH STREET AND VIRGINIA AVUENE
JOPLIN, JASPER COUNTY, MISSOURI

DRAWING NO. JOP-100-2457

SHEET NUMBER 4 OF 6

ALLGEIER, MARTIN and ASSOCIATES, INC.
Consulting Engineers

December 2, 2020

Mr. Lynden Lawson, P.E.
Assistant Director of Public Works - Operations
City of Joplin
602 South Main Street
Joplin, MO 64801

RE: Parking Garage – Structural Assessment after Siding Installation
6th and Virginia Avenue, Joplin, MO

OVERVIEW:

A visual assessment was conducted on December 1st and 2nd, 2020 to evaluate the structural integrity of the elevated parking structure following the installation of a siding system to enclose the lower parking garage. The visual assessment was requested by Mr. Lynden Lawson after becoming concerned that the installation of drilled anchor bolts to install brackets to support the siding structure may have compromised the structure.

ATTENDANCE:

Mr. Bryan Wickland, Building Inspector, City of Joplin (December 1st)
Mr. Dennis Farrell, Contractor, Farrell Construction (December 2nd)
Mr. Michael Atkinson, PE, Allgeier Martin (December 1st and 2nd)

PURPOSE:

The purpose of the visual assessment is to determine if drilling holes in the reinforced concrete beams and columns to install anchor bolts compromised the structural integrity of the elevated parking structure.

**Parking Garage – Structural Assessment after Siding Installation**
6th and Virginia, Joplin, MO
December 2, 2020

DEFINITION OF TERMS: (Refer to Photograph 1.0)




**Photograph 1.0**

Wall Girt: A horizontal structural member that is attached to sidewalls, columns, or posts to support paneling.
Post: For this purpose, the post is a vertical structural member that is bolted at the top and bottom to support the Wall Girts. These are commonly used for door jams and end wall assemblies in metal building construction.
Angle Brackets: A bracket that is used to facilitate a connection between a Wall Girt or Post to a Hammer Head Beam, Column or Slab.
Hammer Head Beams: Major structural components that carry the Beams and/or Joists.
Columns: Major structural component that carries the load from the Hammer Head Beams down to the foundation.

OBERVATIONS:

1. The lower level of the parking structure was enclosed by installing common metal building components. To accomplish the installation of the components, 3/8" diameter expansion type anchor bolts were drilled into the Columns and the Hammer Head Beams to facilitate the installation of Angle Brackets.
2. The placement of the Angle Brackets are installed at various locations on the Columns and the Hammer Head Beams as shown in the following photographs.
3. After interviewing Mr. Dennis Farrell, it is believed that 3-1/2 inch long anchor bolts were installed using a common masonry hammer drill bit.

4. A visual examination of the drill cuttings near the anchor bolt locations did not reveal evidence of metal shavings. This would suggest that the reinforcing steel was not reduced by drilling operations.



**Photograph 2.0**
**Looking East at East wall.**



**Photograph 2.1**
**Angle Bracket Bolted near top of Column**



**Photograph 2.2**
**Angle Bracket Bolted near top and middle of Column**



**Photograph 2.3**
**Angle Bracket Bolted into Column**
**at the bottom of new wall (approximately mid height)**



**Photograph 2.4**
**Angle Bracket Bolted into Bottom of Hammer Head Beam**



**Photograph 2.5**
**Angle Bracket Bolted into Side of Hammer Head Beam**

STRUCTURAL ASSESSMENT:

In brief, it is the opinion of this office that there is a very low chance that the structure was significantly compromised due to the installation of the anchor bolts. This opinion is based upon the following:

1. Interviews with local contractors, inspectors, and personal experience supports that it is very difficult to drill into reinforcing steel using conventional masonry hammer type drill bits. It was also reported that continued attempts to drill into reinforcing steel would damage the bit and prevent further drilling.
2. Assuming that the concrete cover over the reinforcing steel was designed and constructed between a typical value of 1.5 to 2-inches, it is possible that the length of the anchor bolts are long enough to reach past the reinforcing steel. However, examination of the drill cuttings, when available, did not reveal the presence of steel cuttings. The cuttings consisted of pulverized concrete that is consistent with using conventional hammer type drilling bits. Unless a different type of bit was used to drill holes, we conjecture that the installation of the anchor bolts did not significantly damage the reinforcing steel.
3. An interview with Mr. Farrell indicated that a conventional hammer drill was used to drill the holes. This is consistent with the evidence found on-site. He also indicated that if the drill would not advance, then he instructed the driller to move over to avoid damage to any reinforcing steel and drilling equipment.
4. Most of the anchor bolts were installed in non-critical areas and are not concerning. However, Photograph 2.5 illustrates the installation of the anchor bolts in the side of the upper region of the Hammer Head Beam over a Column. This is in an area where the integrity of the reinforcing steel is critical to the stability of the structure. Assuming a typical value of 1.5 to 2-inches of cover for the primary reinforcing steel, it would appear that the anchor bolts are installed below the reinforcing steel thereby leaving the primary reinforcing steel undisturbed. Given this information, there is a low probability that the structure is compromised at this location. However, if the reinforcing steel is compromised, then the following symptom would likely occur.
    a. A vertical crack may appear on the side of the Hammer Head Beam at the location of the anchor bolt.
    b. The crack would take on a V shape where it would be widest at the top. The failure mode would likely be long term and slow while cracking would become more noticeable over time.

RECOMMENDATIONS:

Visually monitor all areas where anchor bolts are installed in the upper regions of the side of the Hammer Head Beams over the Column locations as shown in Photograph 2.5.

1. Look for cracking or any changes in appearance on a daily basis for the first week and report any changes.
2. Extend visual inspection on a weekly basis for 4-weeks, then extend inspection on a monthly basis for the next 6-months and report any changes.
3. The purpose of the inspections is to provide ample time for the structure to experience various loading conditions and time to react to the modifications.

4. If there are no changes after the expiration of the monthly inspections, then the inspections may cease.

Sincerely,

**ALLGEIER, MARTIN and ASSOCIATES, INC.**



Michael Atkinson, P.E.
Vice President

# Informational Search

Produced by:


**408 E. 32nd Street**
**Joplin, MO 64801**
**(417) 623-2961**

**1517 E. Bradford Parkway**
**Springfield, MO 65804**
**(417) 889-1818**

**5265 S. HWY 71, Ste. G**
**P.O. Box 467**
**Pineville, MO 64856**
**(417) 223-4896**

**2001 State Hwy 248**
**Gretna Plaza, Suite 10**
**Branson, MO 65616**
**(417) 893-2554**

**103 S. Market Street**
**Mt. Vernon, MO 65712**
**(417) 466-3737**

**135 E. 3rd Street**
**Carthage, MO 64836**
**(417) 358-5908**


**This search is not an opinion of title, nor is it a commitment to insure title. This search is furnished for reference purposes only and should not be relied upon as a commitment to insure title to the premises herein described. Title insurance is available for your protection through this office for an additional fee. The liability of the Company under this search is limited to the amount paid for the same.**

BY Linda Doerge

Linda Doerge, Authorized Signatory
Signing Agent No.: 235587
Title Agency No.: 8302359

**Produced By**
WACO TITLE

## *SCHEDULE A*

Number: 2005281-124 Effective Date: **January 5, 2021, 8:00 am**

1. This is an informational search only. The liability of the Company under this search is limited to the amount paid for the same.

2. A search of the records of **Jasper** County, State of Missouri, indicates that the real estate described below was last recorded in the name(s) of:

   **Tract 1:**
   **Louis W. McDonald and Leona M. McDonald, husband and wife, subject to the rights of the City of Joplin by Report of Commissioners filed in Book 1029 Page 351**
   **Vesting Deed Report 1029-351**

   **Tract 2:**
   **The City of Joplin, Missouri, a Municipal Corporation Vesting Deed**

   **Tract 3:**
   **The City of Joplin, Missouri, a Municipal Corporation Vesting Deed**

   **Tract 4:**
   **J. Connor Wise, subject to the rights of the City of Joplin by Report of Commissioners filed in Book 1029 Page 351 Vesting Deed Report 1029-351**

   **Tract 5:**
   **The City of Joplin, a Municipal Corporation (Air Space only) 1039-208**

2. The land referred to in this search is described as follows:

   **Tract 1:**
   **All of Lots Numbered One (1) and Two (2) in Porters Second Addition to the City of Joplin, Jasper County, Missouri.**

   **Tract 2:**
   **All of Lots Numbered Three (3), (4) and (7) and the East One-half of Lot Numbered Six (6) in Porters Second Addition to the City of Joplin, Jasper County, Missouri.**

   **Tract 3:**
   **All of Lot Numbered Five (5), and the West One-Half of Lot Numbered Six (6) in Porters Second Addition to the City of Joplin, Jasper County, Missouri.**

   **Tract 4:**

**Beginning at the Northeast corner of Lot One (1) in Porter's Second Addition to the City of Joplin; running thence West to the Northwest corner of said lot, running thence North to the South line of the right of way of the St. Louis-San Francisco Railway Company formerly St. Louis and San Francisco Railroad; running thence East along the South line of said right of way to the West line of Virginia Avenue; and running thence South along the West line of Virginia Avenue to the place of beginning. (NOTE: The Joplin City Map shows this as Miscellaneous Lot 92 )**

**Tract 5:**
**Air Space above the following described parcel, created by Air Space Agreement and Conveyance dated November 17, 1964, filed November 17, 1964 at 11:21 a.m. in Book 1039 at Page 208:**

**Commencing at the Southwest corner of Section 2, Township 27, Range 33: thence North along the West line of said Section 2 a distance of 322.57 feet for a point of beginning, thence continuing North on last described course a distance of 200.66 feet; thence Easterly making an angle of 85°21' to the right of las described course a distance of 120.40 feet to the West line of Virginia Avenue in the City of Joplin; thence South measured along said west line of Virginia Avenue a distance of 200.66 feet; thence Westerly a distance of 120.40 feet to the point of beginning; saving and excepting that portion of the above described property which lies within the limits of Sixth Street as platted in said City of Joplin, and exception West 10 feet of above described tract.**

## SCHEDULE B

The following items are not researched and are not covered in any way by this search:

Rights or claims of parties in possession not shown by the public records.

Encroachments, overlaps, boundary line disputes, and any other matters that would be disclosed by an accurate survey and inspection of the premises.

Easements or claims of easements not shown by the public records.

Any lien, or right to a line, for services, labor or material heretofore or hereafter furnished, imposed by law and not shown by the public records.

Taxes or special assessments that are not shown as existing liens by the public records.

Pending suits filed in the Jasper County court system.

Homeowners' Associate dues.

Bankruptcy actions filed with the bankruptcy courts.

Based on our search of the records of Jasper County, State of Missouri, the following is a listing of exceptions to the title:

1. General and special taxes and assessments herein after listed, if any (all amounts shown to be exclusive of interest penalties and costs):
2. Note: Records show the premises in question to be tax exempt as to the date of this policy. This policy should not be construed as insuring the future tax exempt condition of said premises.
3. Code enforcement bill, if any, in favor of the City of Joplin for furnishing mowing or trash removal. (You will need to contact the City of Joplin at 624-0820 ext 244 to see if there are any bills that affect subject premises.)
4. Building lines, easements and restrictions as established by the plat of said subdivision as referred to in Schedule A, and as shown on the script accompanying said plat filed in Plat Book A Page 224.
5. Building lines, easements and restrictions as established by the Plans of Joplin Parking Lot Structure as referred to in Document No. 23085 filed filed November 16, 1964 at 12:45 a.m. as to Tract 5, complete copy at the recorder's office. Parking PlansSpecifications
6. Rights of the Fee Owner of the Land that Air Space Agreement listed in Book 1039 Page 208 is over. Last Vesting Deed is filed in Book 1812 Page 1797. 1812-1797
7. Option of Lease file August 21, 1962 at 10:55 a.m. in Book 980 at Page 520, Document No. 19560, as to Tracts 1 and 2. 980-520
8. Option to Lease filed August 21, 1962 at 10:57 a.m. in Book 980 Page 522, Document No.

19561, as to Tracts 1 and 2. 980-522

9. Option to Lease filed August 21, 1962 at 10:59 a.m. in Book 980 at Page 526, Document No. 19562, as to Tracts 1 and 4. 980-526

10. Rights of tenants in possession under unrecorded leases solely as tenants and solely with respect to space occupied by each such tenant, (together with non-exclusive rights in common with other tenants in areas used by all tenants).

11. Deed to the State of Missouri, acting by and through the State Highway Commission of Missouri filed in Book 1211 Page 2531, as to Lots 5, 6 and 7 Porter's Second Addition. 1211-2531

12. Rights of the City of Joplin file in Report of Commissioners filed August 26, 1964 at 8:27 a.m. in Book 1029 at Page 351. NOTE: J. Connor Wise was not included as a defendant in this Case but his legal description was, see Book 845 Page 366, as to Tracts 1 and 4. 1029-351 845-366

13. Ordinance filed in Book 1847 at Page 47. 1847-47

14. No open Mortgages and/or Deeds of Trust were found: NOTE: The title search performed on the land described in Schedule A did not disclose any open Mortgages and/or Deeds of Trust. If this is believed to be an error, please contact the title department for further review prior to closing. In the alternative, please verify and confirm that all parties have no knowledge of any outstanding obligations or debt.

15. This Commitment/Report is being issued for the purpose of information only, requirements will be made and additional fees will be charged to issue a policy, the liability of this company is the amount paid for same.

NOTE: We did not check for Judgments filed against the City of Joplin.

NOTE: Regarding Tract 5, we only research the Air Space and not fee title to the land.