CITY OF PORTSMOUTH

Department of Public Works

RFP #07-15

Structural Evaluation of Public Garage

Addendum #1

August 4, 2014

This Addendum forms part of the original document marked: **RFP #07-15** Structural Evaluation of Public Garage.

The following questions have been asked and answered:

Q: Where can I find as-built drawings of the garage?

A: https://www.dropbox.com/sh/iklgtcmnndqg8kb/AABlmLbfV8P7UH8Ts8jH2irma

Q: Will the City want information on the garage meeting ADA and safety standards?

A: Yes. If you find shortcomings in safety or ADA compliance, include them in your report.

Q: Should the consultant evaluate plumbing and electrical systems in the garage?

A: Yes.

Q: Will the City want an evaluation of operational issues?

A: Yes, if a noted operational practice is having impacts on the structural soundness of the facility.

Q: Have there been any environmental hazards assessments done on the garage?

A: No.

Q: What tests have been previously done to the garage structural elements?

A: There was a 2009 study done on Chloride level in the concrete. It can be found attached.

Q: Are there other studies that have been done on structural issues in the garage?

A: Yes, and they can be found attached.

All else remains unchanged from original RFP document.

Please acknowledge this addendum within your proposal, failure to do so may subject a bidder to disqualification.

END OF ADDENDUM #1

PE Paradigm Engineering, LLC
Structural
Civil
Setting the Standard

December 2, 2009

Mr. Steven Parkinson, P.E., Director
City of Portsmouth
Department of Public Works
680 Peverly Hill Road
Portsmouth, NH 03801

Re: **Portsmouth Parking Garage – Concrete Floor Chloride Testing**

Authorization

In accordance with your written authorization to proceed under the "Independent Consultant Agreement" Contract #090428007 Exhibit C between Paradigm Engineering LLC and the City of Portsmouth, Department of Public Works and dated May 1, 2009, we present this report of findings for chloride testing performed at various locations throughout the existing parking structure.

Available Documents and Plans

The followings documents were provided to evaluate the existing as-built condition of the building.

1. Construction documents prepared by the firm of Wright-Pierce Architects & Engineers in Topsham, Maine dated January 18, 1985 consisting of 46 sheets of drawings (including Civil, Structural, Architectural, Electrical, and Plumbing drawings)

Orientation

For purposes of this report, the Hanover Street side of the parking garage is considered to be the northern exposure.

Inspection Findings

Concrete deck and ramps were observed at all elevated levels by the Engineer and City personnel. Locations for concrete sampling were identified and agreed upon between the Engineer and technical representative of the City, Thomas Richter.

A minimally invasive investigation of the existing concrete deck was conducted which included extraction of concrete powder samples at 1 inches and 2 inch depths from top of concrete at various

locations. Samples were extracted for testing by Mr. Michael Casad of the City of Portsmouth Public Works Department.

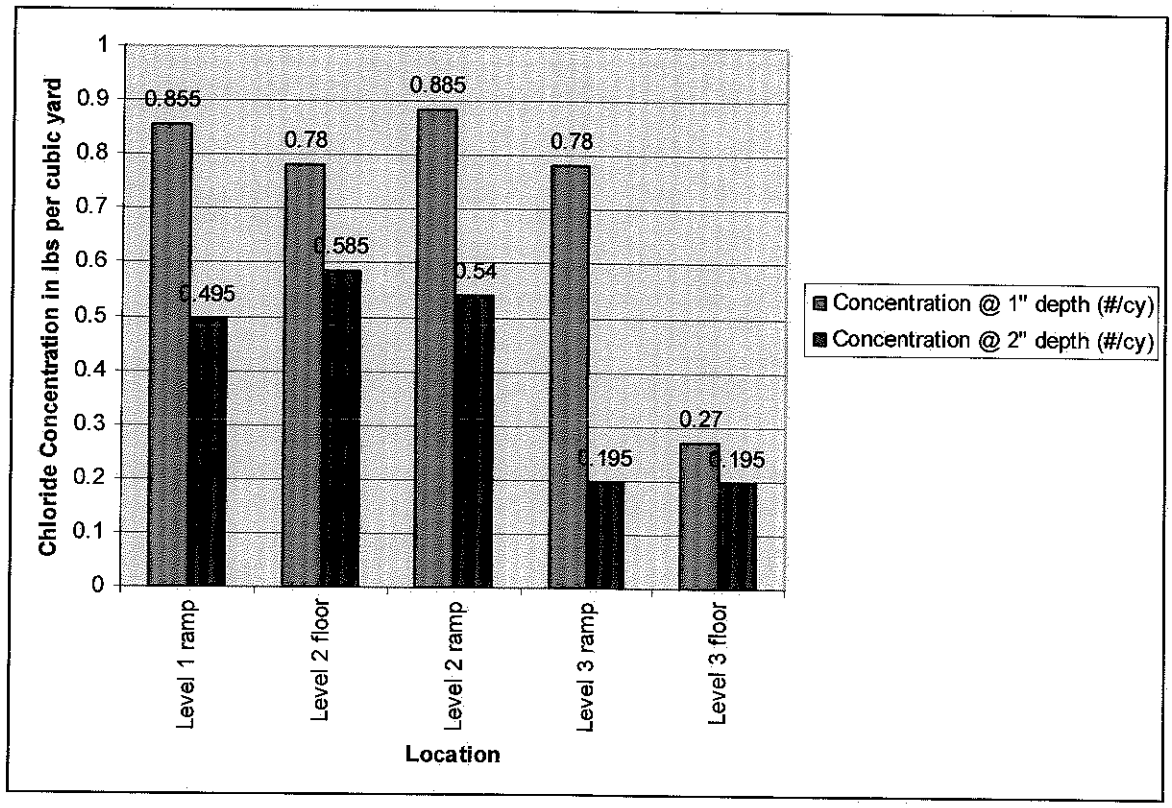
1. Concrete topping was observed to be cracked and spalled at several elevated locations on ramp travel ways on all levels, except the more recently constructed 5th level throughout the parking structure.

2. Patching of these areas will be required to re-establish concrete topping integrity, as this topping serves to protect prestressed panels below from moisture intrusion and potential corrosion of prestressing strands.

Structural Evaluation

1. 1.35 lbs per cubic foot of chloride concentration is recognized as the threshold for establishment of corrosive environment in concrete.

2. The results of concrete chloride testing is as follows:



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3. Although chloride concentrations approach the corrosive threshold level at all but one location for the 1" depth, chloride levels are reduced considerably at the 2" depth. This indicates that a limited concrete patching program would be expected to be successful over the long term.

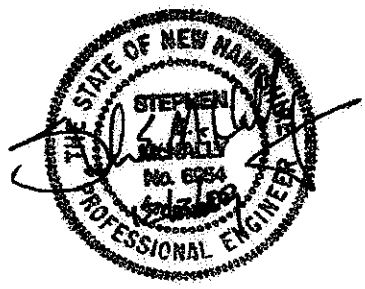
4. Cracking and spalling of concrete topping at various locations may therefore be the result of freeze-thaw action in combination with compression stress from cyclical flexural deflection of supporting beams.

5. Patching of concrete topping should be accomplished by sawcutting a rectangular area around the vicinity of each degraded region of concrete and excavating all deteriorated concrete topping down to the top of prestressed concrete panel. Selection of cementicious patching material should be a high strength, low shrinkage, fast setting, polymer-modified or latex-modified concrete installed in strict conformance with manufacturer preparation requirements.

This completes our understanding of the requirements of this assignment. Please call me at the office to discuss any questions and comments.

Respectfully yours,

Paradigm Engineering, LLC



Stephen E. McNally, P.E.
Principal, NH License # 6954

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MATERIALS RESEARCH DIVISION
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www.modernind.com
Complete Material Testing and Research Services

ANALYTICAL REPORT

TESTED FOR: Miller Engineering & Testing, Inc.
P.O. Box 4776
Manchester, NH 03108

LABORATORY NO: INO102298

ATTENTION: Joseph Garvey

DATE RECEIVED: 11/13/09

REPORT DATE: 11/23/09

REMARKS:

Sample Description : Ten (10) Concrete Samples

Project : Portsmouth Parking Garage
Project No. 09.296.NH

Sample	Chloride, %
L1R1	0.57
L1R2	0.33
L2F1	0.52
L2F2	0.39
L2R1	0.59
L2R2	0.36
L3R1	0.52
L3R2	0.13
L3F1	0.18
L3F2	0.13

1.35 #/cy is threshold for corrosive levels

By weight

1.35#/150#/cy = 0.9%

Respectfully Submitted,
MODERN INDUSTRIES, INC.

James R. Yarris
Manager, MRD Pittsburgh

1-Client
JRY/dla

PE Paradigm Engineering, LLC

Structural
Civil

Setting the Standard

September 2, 2009

City of Portsmouth
Department of Public Works
680 Peverly Hill Road
Portsmouth, NH 03801

Attn: Stephen Parkinson, Director of Public Works

RE: Portsmouth Parking Garage, Evaluation of Beam Support Failure At Fleet Street Stairwell (Stair Tower #1) / Level 5

AUTHORIZATION

Evaluation of the failure of steel beam support to an existing masonry wall located at Stair Tower #1 (as identified on all construction documents) at the 5th level of parking structure was authorized under the "Independent Consultant Agreement" Contract #090428007 between Paradigm Engineering LLC and the City of Portsmouth, Department of Public Works and dated May 1, 2009.

This report investigates the apparent cause of failure of a bearing seat providing support for a W12x19 beam at the 5th level. This beam bearing is supported on existing 8" masonry at the northeast corner of Stair Tower #1 identified as Grid 1.5B.

AVAILABLE DOCUMENTS AND PLANS

The followings documents were provided to evaluate the existing as-built condition of the building.

1. Construction documents prepared by the firm of Wright-Pierce Architects & Engineers in Topsham, Maine dated January 18, 1985 consisting of 46 sheets of drawings (including Civil, Structural, Architectural, Electrical, and Plumbing drawings)
2. Construction documents prepared by Reed & Reed Inc. of Woolrich, Maine and The Maguire Group Inc. of Portsmouth, New Hampshire dated October 29, 1999

consisting of 41 sheets of drawings (including Civil, Structural, Architectural, Electrical and Plumbing drawings).

3. There are no drawings that provide identification of the design, layout or connections for the pre-cast wall panels and pre-cast pre-stressed concrete floor panels.

ORIENTATION

For purposes of this report, the Fleet Street side of the parking garage is considered to be the western exposure.

INSPECTION FINDINGS

Observations of the damaged area of structure were conducted by Mr. Stephen McNally PE and Mr. Craig L. Marshall SE PE on August 13, 2009. A visual, non-destructive investigation of the existing structure was conducted to include field measurement, photo documentation and evaluation of the existing conditions. Photographs have been incorporated into this report.

GENERAL

The damage subject to this investigation consists of a single location (northeast corner of the east wall of Stair Tower #1) where masonry under a W12x19 beam has fractured and spalled. Walls of Stair Tower #1 at the 4th and 5th level consist of 8" CMU masonry with 4" face brick for a total wall thickness of 12". Masonry at Stair Tower #1 was originally constructed in 1985 and was designed to be free standing extending from foundation to approximately 12'-0" above the 4th level. An extension of the stair tower was constructed in 1999 and is approximately 10'-1" wide x 20'-0" long by 12'-0" high. Original design of existing stair tower above the 4th level was intended to support roof dead and live load plus the weight of stairwell masonry and brick. A W12 x 19 beam was installed in 1999 at the new 5th level spanning between a W33 spandrel beam and stair tower extension.

Beam pocket at northeast corner of Stair Tower #1 (Grid 1.5B)

Support for the W12x19 beam at the 5th level was incorporated into existing 8" masonry at the northeast corner of Stair Tower #1. "Pocketing" of bearing support required removal of face

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brick and a portion of existing 8" CMU block. The portion of CMU masonry that remained was the rear (west) shell of block. Volume of block missing consisted of four courses of 8" CMU block totaling 32" in height. Two courses were meant to be a fully grouted "pillow block" for beam bearing and two courses of masonry for placement of the beam itself.

Beam bearing plate consists of a ½" thick x 8" wide x 6" long steel base plate and two ¾" diameter x 12" long headed stud anchors. The bearing plate and anchors were observed to have moderate to severe pitting on visible surfaces. It is not clear whether the bearing plate was placed in a pocket with the bearing plate welded in the field or welded in the shop. Depending upon the procedure used, it defines the process used for placement of grout in the pillow block and amount of welding that could be placed on each side of the beam to bearing plate. The "pillow block" appears to have been grouted with a "dry" grout and did not fill the cavity in its entirety (the grout appears to have been packed into the void by hand). The open pocket around the beam remainss un-grouted allowing moisture access to the bearing plate and connection.

The 8" thick masonry wall and 4" face brick above the beam appears largely unsupported as evidenced by broken masonry and brick. There were no vertical or horizontal reinforcing bars observed in the cavity. The entire masonry pocket has spalled, exposing the bearing and anchorage to the elements. The bearing plate appears to have 2" of bearing remaining on existing masonry.

Beam Pocket Located at Southeast Corner of Stair Tower #1 (Grid 1.5A)

Similar to the northeast corner, a new W12x19 beam was added in 1999 and "pocketed" into existing masonry wall at the southeast corner of Stair Tower #1. The beam pocket has cracked the face brick but shows no other signs of distress. A 5th level W12x19 has been incorporated into an extension of beam line that is acting as a drag strut for the vertical cross bracing system along grid A. The drag strut is a tension/compression member that has been exerting force on the masonry wall and beam connection. Additionally, this connection distributes horizontal loading into the masonry wall for which the wall was not designed to resist.

Moment frame

The W 33x152 spandrel beam adjacent to Stair Tower 1 has experienced a horizontal "sweep" (horizontal movement/deflection). This appears to be the result of two issues. First is the

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horizontal force that the 5th level W12x19 beam is imposing on the W33x152 due to installation of the beam support. The second issue is support of pre-cast exterior panels by the W33x152. The pre-cast concrete wall panels extend approximately 6" below the bottom flange of beam and 3'-6" above the top of slab. The wall panel is connected to the 5th level pre-cast slab and does not appear to be attached to the bottom flange of beam. There are flange braces located at 3rd points of the beam span and extend from the bottom W33 beam flange to the bottom of pre-cast floor panels. Anchor bolts that attaching braces to pre-cast concrete floor panels are experiencing deformation (bending).

New W14x145 column extensions have been added to existing stub columns from the 1985 addition (existing columns are noted to be W14x68 and W14x90. New columns start approximately 40" above the 4th level of parking structure. The new columns and beams form a moment frame in the north-south direction. It is important to note that new column extensions are larger in flange width /thickness, as well as depth and weight than the existing column below.

Support of slab at 5th level

Based upon field observations and review of 1999 drawings, the 5th level pre-cast floor panel immediately adjacent to Stair Tower #1 is not attached to masonry and is supported solely by W12x19 beams in the vertical and horizontal directions.

STRUCTURAL EVALUATION

Conclusions

Beam seat failure appears to be due to a combination of two factors. First, the masonry failure is the direct result of the 1999 design approach being in conflict with the original 1985 design. Specifically, the 1985 design considered Stair Tower #1 masonry walls independent of the floor slab and framing and included beams oriented north-south, parallel to masonry walls creating an end element supporting the slab. The 1985 design intended that loading be transferred only into the moment frame along the north-south direction and cross bracing along the east west direction.

The 1999 design partially fell in line with the original design concept by separating the 5th level pre-cast floor panel from the stair tower walls, but then diverged by attaching W12 beams

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supporting floor panels directly to existing masonry of the stair tower. The 1999 design also did not provide an end element (beam) oriented parallel to the east masonry wall, which resulted in unresolved horizontal forces induced into the slab having no direct path of resistance. 5th level framing to Stair Tower #1 masonry appears to be the only location in the entire structure where the deck slab is attached directly to an existing masonry wall. This attachment creates a propped cantilever support condition for the stair tower and changes the original design concept, which was to be a fully cantilevered tower with a fixed base. We note that the section of slab from stair tower to the moment frame along Grid 2 and from Grid A to Grid B was neither designed for nor strong enough to resist the lateral force imposed by the 1999 design or to provide bracing to Stair Tower #1 at the 5th level.

The second issue resulting in damage was incomplete construction of masonry stair tower. Specifically, masonry jamb and corner reinforcing is missing as well as grouting of masonry cells. 1999 plans detail installation of the W12 beam to bear directly on a masonry wall; however this most recent design assumed "new" masonry construction rather than "retrofitted" existing masonry. This field modification did not address removal of existing block, proper procedure for grouting existing masonry, amount of weld required or whether the weld was to be shop or field installed. Removal of existing masonry has an impact on support of masonry wall above and created a condition that prevented the proper installation of two courses of solid grouted masonry "pillow block" below the 5th level beam seat. The connection as constructed has fractured and is not currently a viable support for the W12x19.

The distribution of lateral forces imposed by wind and seismic requirements must be transferred to moment frames and vertical cross bracing (MWFRS system) through the concrete diaphragm consisting of 6" pre-cast pre-stressed concrete panels. After reviewing 1999 drawings however, there was insufficient information identifying the load path for lateral loads to be directed to resisting elements. Without a clear load path, our office is not able to determine whether the parking structure is properly tied together to act as a unit.

1985 Contract Construction Drawings

Original building drawings define the existing construction of Stair Tower #1 masonry wall, and indicate vertical and horizontal reinforcing as well as placement of slab, beams and supports at the masonry tower. Review of drawings reveal that the masonry wall design requires masonry lintels above door openings at all levels with two #5 bars horizontal. All corners of the masonry

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tower should also have one #4 bar vertical. Horizontal reinforcing was to suppose to be lapped 21" at corners so reinforcing remains continuous. Based upon the field conditions, it was noted that the vertical #4 at the corner, horizontal corner bars, and lintel reinforcing were missing.

1999 Contract Construction Drawings

This most recent design of a 5th level addition to the existing parking structure required an extension of Stair Tower #1 masonry wall from the top of existing masonry walls. The design of new masonry walls detailed in the 1999 submission indicate that they are heavily reinforced (greater than minimum reinforcing required for an 8" masonry wall) using #6, Grade 60 reinforcing. This would indicate that these masonry walls may have been intended to resist horizontal and vertical loading from the parking structure in addition to weight of the masonry wall. Existing masonry walls from the 1st to 5th levels are lightly reinforced using #4, Grade 40 reinforcing and have not been designed to resist lateral loads from the primary structure. Additionally there are no details provided in the 1999 plan set for attachments of new masonry wall reinforcing to existing masonry below.

The W12x19 beam located along Grid B is supported by the moment frame beam (W33x152) on one end (Grid 2B) and existing masonry wall on the other end (Grid 1.5B). This beam is translationally fixed (no slip or expansion movement allowed) to the masonry wall. The bearing at masonry wall has been detailed to require a minimum seat length of 8". This detail does not address the modified field condition of a new beam pocketed into the existing masonry wall. The as-built bearing condition also does not meet the required 8" seat length requirement as noted in the detail and does not address the combined lateral and vertical loading condition. Based upon observed conditions, this connection does not resolve the horizontal component of force due to lateral loads and building movement. 1999 plan details identify two courses of masonry block under the beam bearing that were to be fully grouted. The as-built condition provides only partially grouted pillow block. Block under beam bearing has subsequently failed and spalled. No reinforcing is visible at this corner, but was required to tie newly grouted masonry and existing masonry together. The bearing plate supporting the W12x19 beam appears to not fully bear on the masonry. The bearing plate is supported mostly on the edge of masonry shell, which increases the potential of not having sufficient grout around the headed anchor mounted to the bottom of bearing plate. Based upon the lack of reinforcing, the potential of a completely un-grouted masonry corner could actually exist and may result in inadequate support for the W12x19.

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The W12x19 along Grid A from Grid 1.5 to 2 appears to have been installed in a similar manner as the beam along Grid B from Grid 1.5 to 2 but has not experienced the same extent of damage, due to restraint provided by the drag struts and braced frames.

6" pre-cast concrete floor panels at the 5th level are not attached directly to existing masonry of the stair tower which is consistent with the floor levels below. The section of pre-cast slab (Grid 1.5 to 2 and Grid A to B) located between the moment frame and east masonry wall of Stair Tower #1 is supported by two W12x19 beams, which provide support of gravity loads (dead plus live) and lateral loads (wind, seismic). It appears that lateral loading for this area is partially restrained at the connection of the W12x19 beam to existing masonry wall, which hasn't likely been designed to accommodate lateral loads.

There are two primary mechanisms that are causing translational movement of the W12 beam at the masonry beam pocket. First, as vehicles engage the bottom of ramp at each 5th level, significant vibration is experienced at the top of ramp. This suggests that as vehicles impact the bottom of ramp, the horizontal component of that load translates through the deck and weak axis bending of moment frame beams all the way to the top of ramp resulting in a dynamic vertical deflection sensation and horizontal movement. At the 5th level, this lateral deflection results in the W12 beam to move in the beam pocket. Secondly, we conclude that a lack restraint from pre-cast floor panels adjacent to the masonry wall will cause these panels to rotate, due to differential drift between the moment frames and braced frames. This also causes a horizontal force to be transferred to the beam pocket through the W12x19 beam.

Installation of 6" pre-cast solid concrete floor panels appear to have not conformed to contract drawings. Field observations confirm that panels have been secured by welding to supporting beams with primed steel plates. Based upon structural drawings, all connections involving pre-cast floor panels require stainless steel plates and fastened by welding.

6" pre-cast floor panels have no specification regarding the manufacturer, connection spacing and welding of panel to panel attachments for lateral loads, and properties of the panels in the 1999 design drawings. Information from "Spancrete" (a recognized manufacturer of hollow core panels), indicate that the 6" thick pre-cast floor panels may be loaded 50% beyond capacity for 22'-0" spans (present from Grid B to C) and 13% beyond capacity for 20'-0" spans, if four rather than six 7/16" dia. strands were included in the slabs. Based upon information from Spancrete

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Manufacturer Load Tables, floor panels are dangerously overstressed (122% beyond capacity) at the 5th level, due to the additional concrete landing and step that are not shown on either the structural or architectural drawings. The location of beam failure not coincidentally occurs at the same location as the overstressed floor panel(s) adjacent to the stair tower.

There are no details defining bracing or connection of pre-cast wall panels to steel beams in the structural drawings. Drawings indicate a detail with angle braces set at 45 degree at 3rd points to brace the bottom flange of the moment frame beam element to the pre-cast concrete panels. This detail is limited to pre-cast concrete floor panels on both sides of the W33 beam. The moment frame beam (W33x152) along Grid 2 supports an approximate 7'-3" deep pre-cast concrete wall panel on one side with pre-cast floor panels on the other side. Architectural drawings show a configuration of concrete wall panel supported at bottom and top of slab but then references structural drawings for connections of which there are none. The concrete panel is exerting both a vertical and torsional rotation load on the W33x152 member. The torsional load appears to be applied to the beam top flange where the pre-cast wall panel is attached to pre-cast floor panel. Additionally, a vertical concrete haunch on the back side of the pre-cast wall panel bears on the W33x152 beam bottom flange. The haunches are locate near the ends of the wall panel and support vertical dead load of the panel. Also, drawing details note that connections to the beam are to be stainless steel plates and bolts. Bolts and plate that were installed appear to be corroding, therefore bolts appears to be made of primed mild steel.

It appears the 5th level floor section adjacent to Stair Tower #1 may be introducing additional horizontal force into the W12x19 resulting in more torsional load on the W33x152. This combination of loading conditions has been contributing to deformation of the anchor bolt at these angle braces.

Drawings indicate that three vertical #6 bars are to be installed to stiffen the corners of masonry stair tower to form an end element for the wall. With placement of the W12x19 beam at the 5th level corner, support of masonry above has been compromised and will eventually result in further cracking of masonry above the beam.

Architectural and structural drawings have not anticipated installation of a concrete landing and step at the 5th Level. This landing is 6" to 12" thick and impacts the damaged W12x19 beam pocket by inducing an additional load that overloads the beam and its support.

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The 4" thick x 7'-3" high exterior pre-cast wall panels have a detail only indicating that a pre-cast wall section is present on the exterior of building. The detail refers to structural drawings for connections of panels to structural steel. Structural drawings do not provided a layout, details, or design information for these concrete panels. It remains unclear what criteria has been used to manufacture and install these panels to the structure.

The new W14x145 column attached to the existing stub columns do not follow the details on structural drawings. Preparation of the ends of new and existing steel to accommodate full groove welding was also not completed per AWS D1.1 Specifications. Additionally, backer bars required for installation of full groove welds were not installed. The weld was irregular and had slag on the back side. Welding of the moment beam to column at Grid 2A also appears to have corroded. IT is apparent that cleaning and preparation for the cold galvanized coating was not properly done in the welded area to adequately protect the connection. This condition has potential to weaken the connection as it further corrodes under loading. The new W14x145 columns are larger in size (width and depth) than the existing column below at all new column locations. New columns do not fully bear on existing columns below.

RESOLUTION

The solution to this issue is as follows:

1. Damage to the existing connection at the northeast corner of Stair Tower #1 requires the entire corner to be rebuilt. This involves removal of all debris and fractured masonry, installation of required reinforcing and pressure grouting of the entire masonry cavity.

2. A new steel column should be installed under the existing W12x19 at the 5th level. The end of beam end should be cut so it bears fully on the column. The new column should be located adjacent to, but independent of, the 8" block (in the face brick space) and supported by the W12x19 at the 4th Level.

3. The pre-cast slab at the 5th level requires horizontal loading to be transferred to a resisting member (moment frame or vertical cross-bracing). One option is to install horizontal cross bracing that would be placed against the bottom of pre-cast floor

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panels and connected to the W12x19 beam, the building columns, and the pre-cast panels in order to redirect horizontal forces.

4. Install a new edge element (beam) adjacent to the east masonry wall to provide support for the edge of the pre-cast floor panel and a boundary element for the floor slab.

5. Review all welding and bolting for fatigue due to corrosion and deformation of new structural elements.

6. Material testing is recommended to fully analyze the remaining capacity of the remaining sections of the 1999 addition.

This completes our understanding of this structural condition assignment. Please feel free to contact me at our office with questions or comments.

Respectfully,

Paradigm Engineering, LLC

THE STATE OF NEW HAMPSHIRE
STEPHEN E. McNALLY
No. 9744
LICENSED
PROFESSIONAL ENGINEER

Stephen E. McNally, P.E.
Principal

Craig Marshall, P.E. S.E.
Sr. Structural Engineer

Enc. Pictures.

PE

Paradigm Engineering LLC
463 US Route One, P.O. Box 288, York, Maine 03909
Tel. (207)363-5248 Fax (207)363-3237
Email: smcnally@paradigmstructures.com

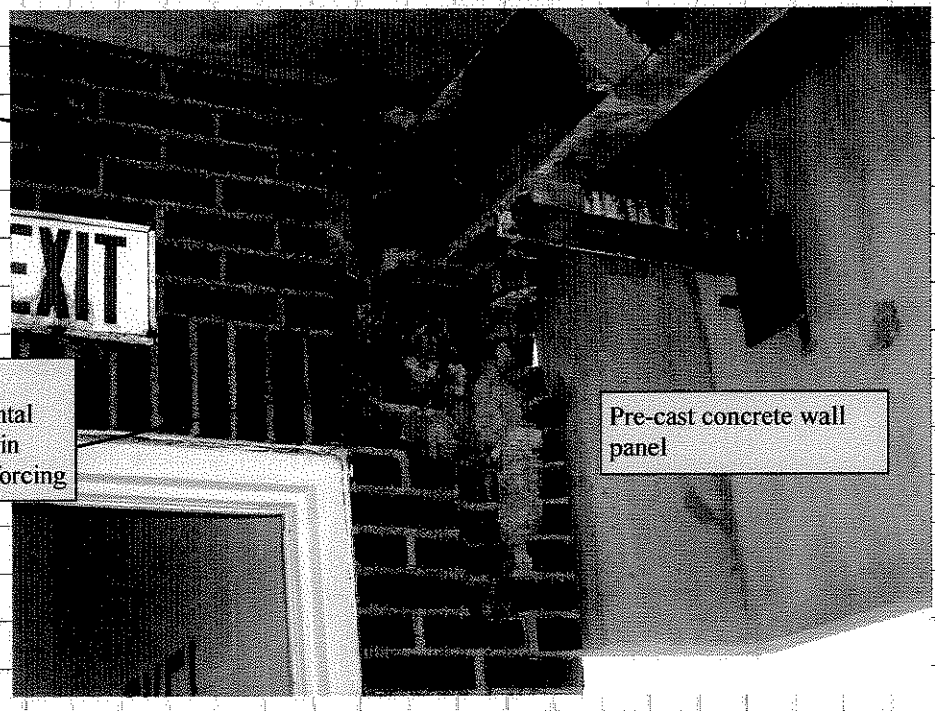
PROJECT: Portsmouth Parking Garage ID 090428007

SHEET NO: 1 OF 20

INSPECTED BY: S. McNally, P.E DATE: Aug 30, 2006

CHECKED BY: C. Marshall, P.E., S.E. DATE: Aug 30, 2006

REMARKS:



Photo#1-W12x19 at Northeast Corner-Stair Tower #1

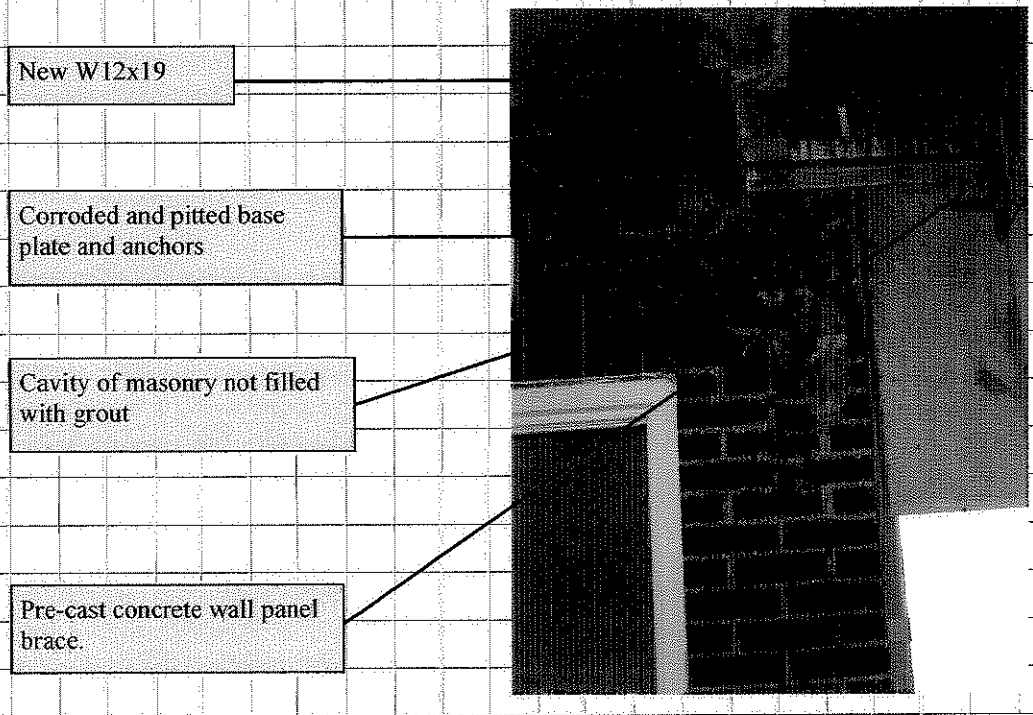


Photo #2-W12x19 at Northeast Corner-Stair Tower #1

Paradigm Engineering LLC
463 US Route One, P.O. Box 288, York, Maine 03909
Tel. (207)363-5248 Fax (207)363-3237
Email: smcnally@paradigmstructures.com

PROJECT: Portsmouth Parking Garage ID 090428007
SHEET NO: 2 OF 20
INSPECTED BY: S. McNally, P.E DATE: Aug 30, 2006
CHECKED BY: C. Marshall, P.E., S.E. DATE: Aug 30, 2006
REMARKS:

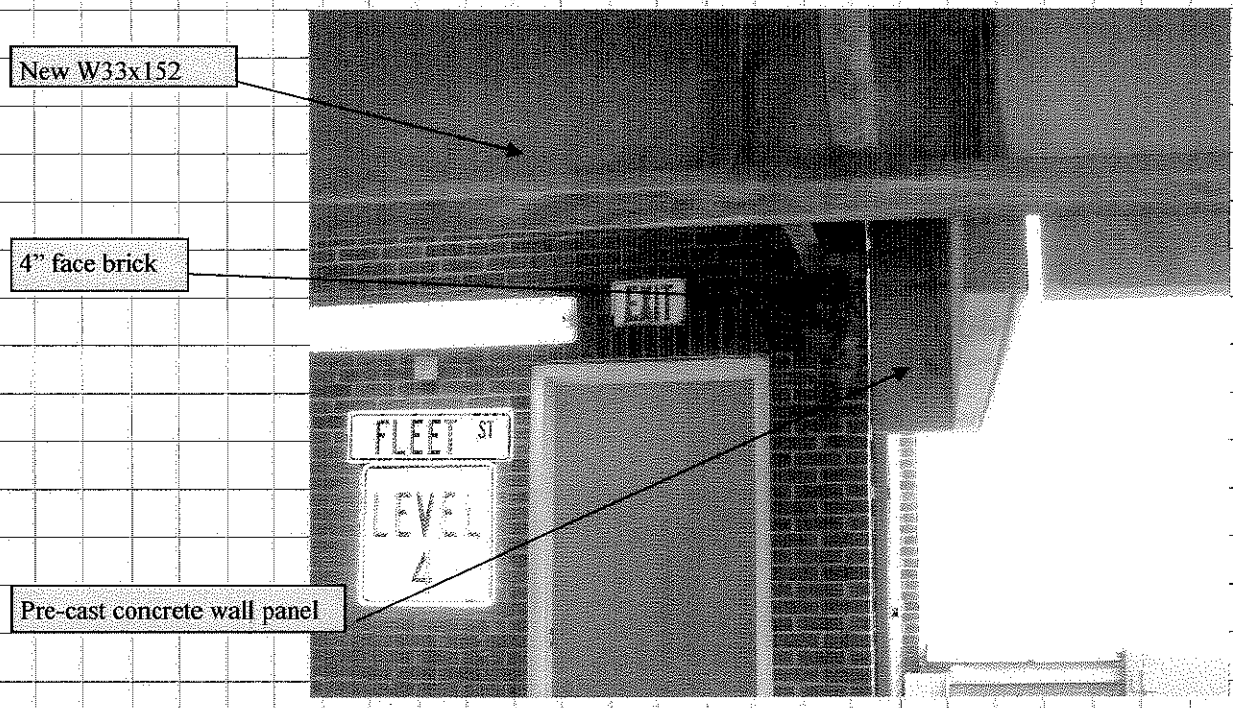


Photo #3-5th level east wall Stair Tower #1

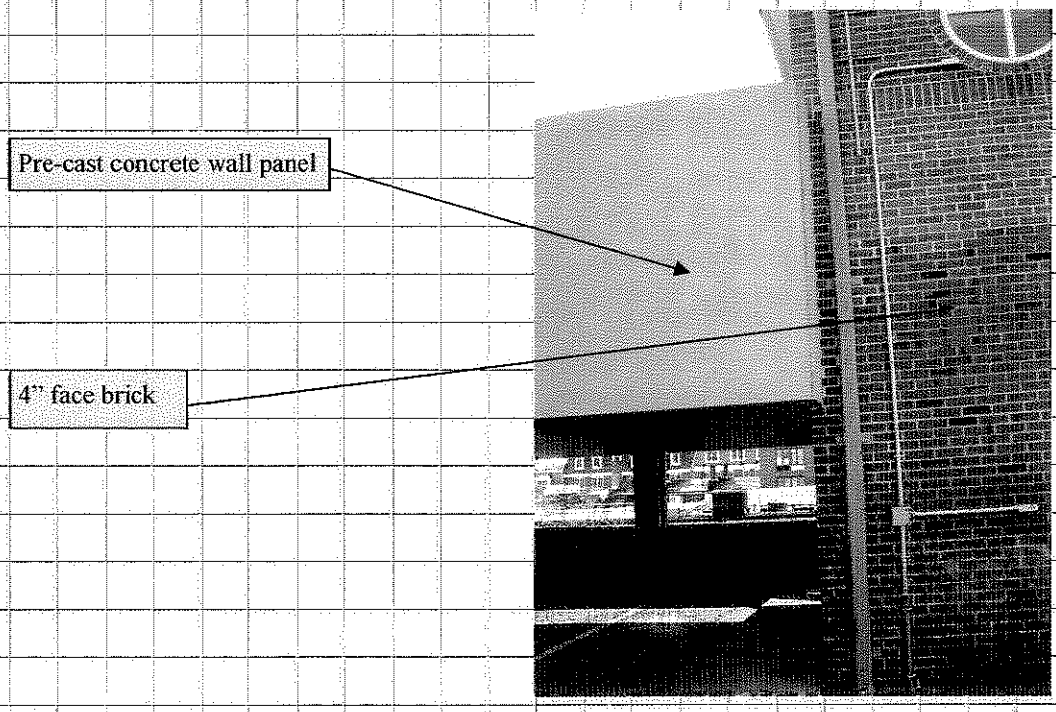


Photo #4-Exterior elevation at northeast corner (Grid 1.5B)

Paradigm Engineering LLC
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PROJECT: Portsmouth Parking Garage ID 090428007
SHEET NO: 3 OF 20
INSPECTED BY: S. McNally, P.E DATE: Aug 30, 2006
CHECKED BY: C. Marshall, P.E., S.E. DATE: Aug 30, 2006
REMARKS:

Photo#5-Elevation W12x19 at Northeast Corner-Stair Tower #1 (Grid 1.5B) and W33x152

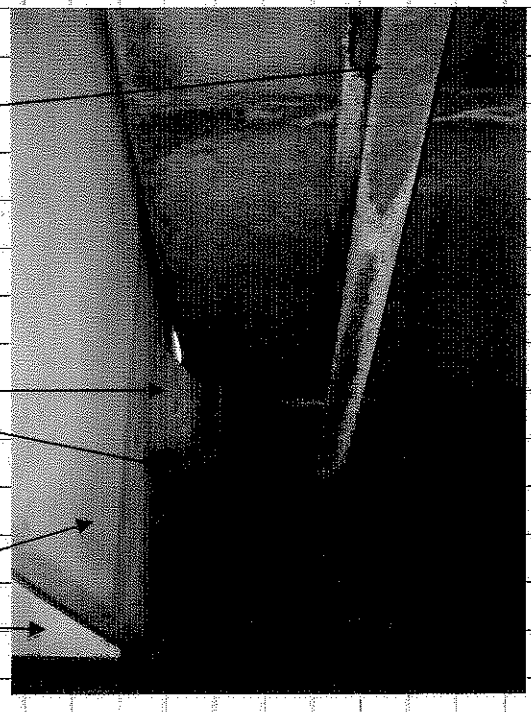

Photo #6-W12x19 to W33x152 with pre-cast concrete wall panel

Paradigm Engineering LLC
463 US Route One, P.O. Box 288, York, Maine 03909
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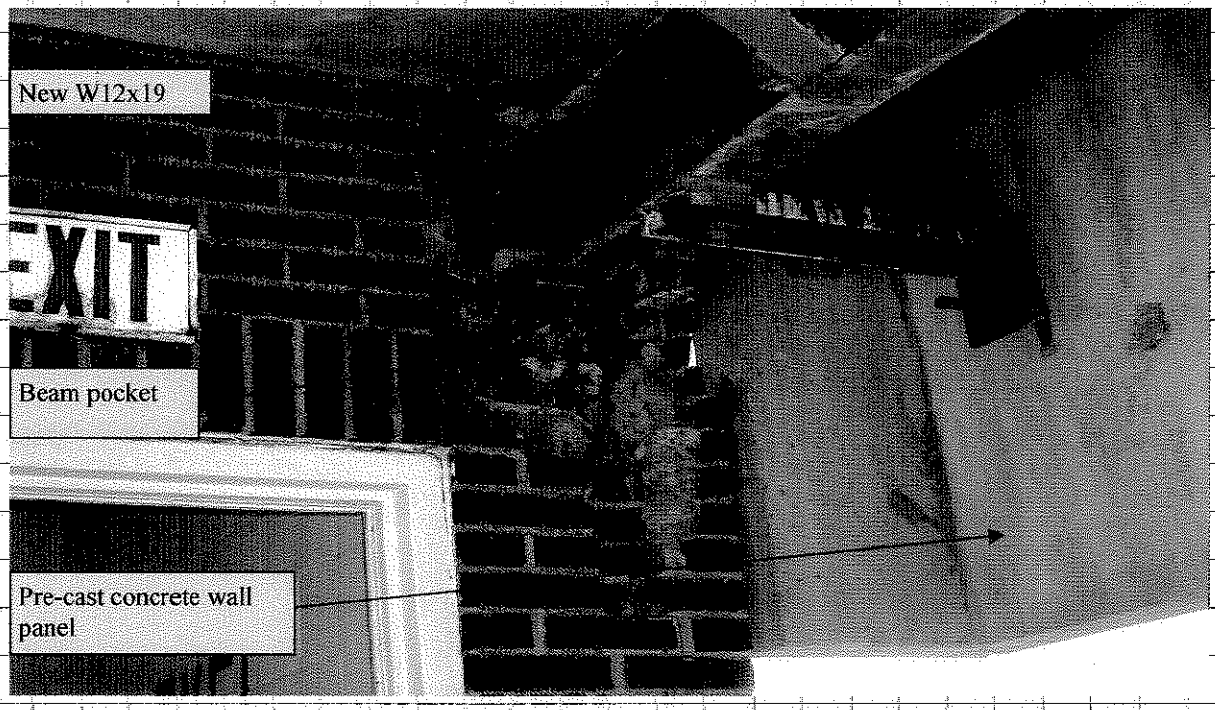
Email: smcnally@paradigmstructures.com

PROJECT: Portsmouth Parking Garage ID 090428007
SHEET NO: 4 OF 20
INSPECTED BY: S. McNally, P.E DATE: Aug 30, 2006
CHECKED BY: C. Marshall, P.E., S.E. DATE: Aug 30, 2006
REMARKS:



Photo#7-W12x19 at Northeast Corner-Stair Tower #1

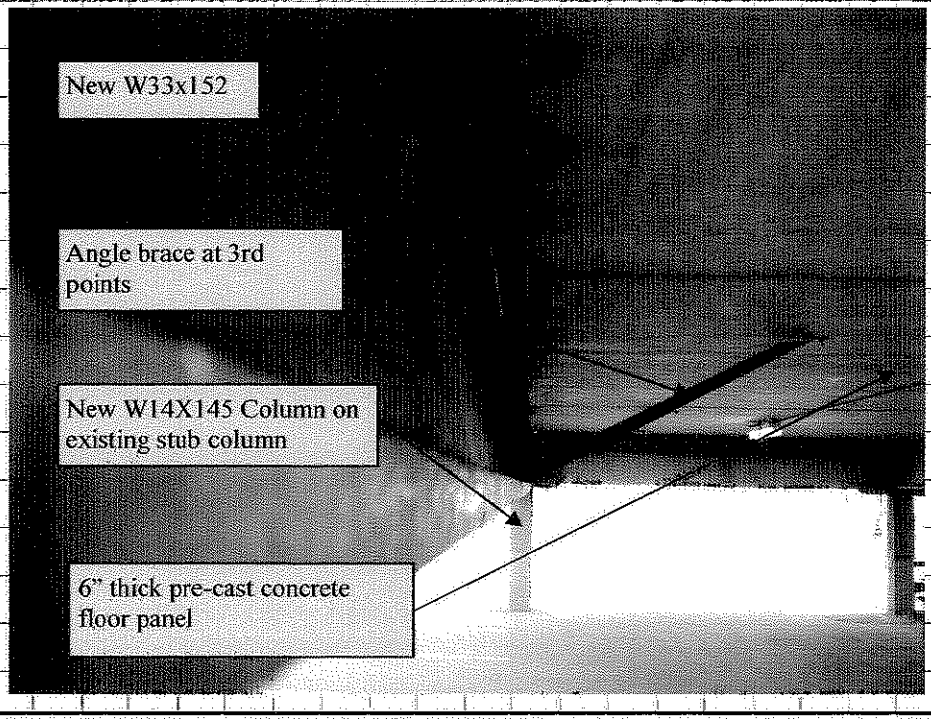
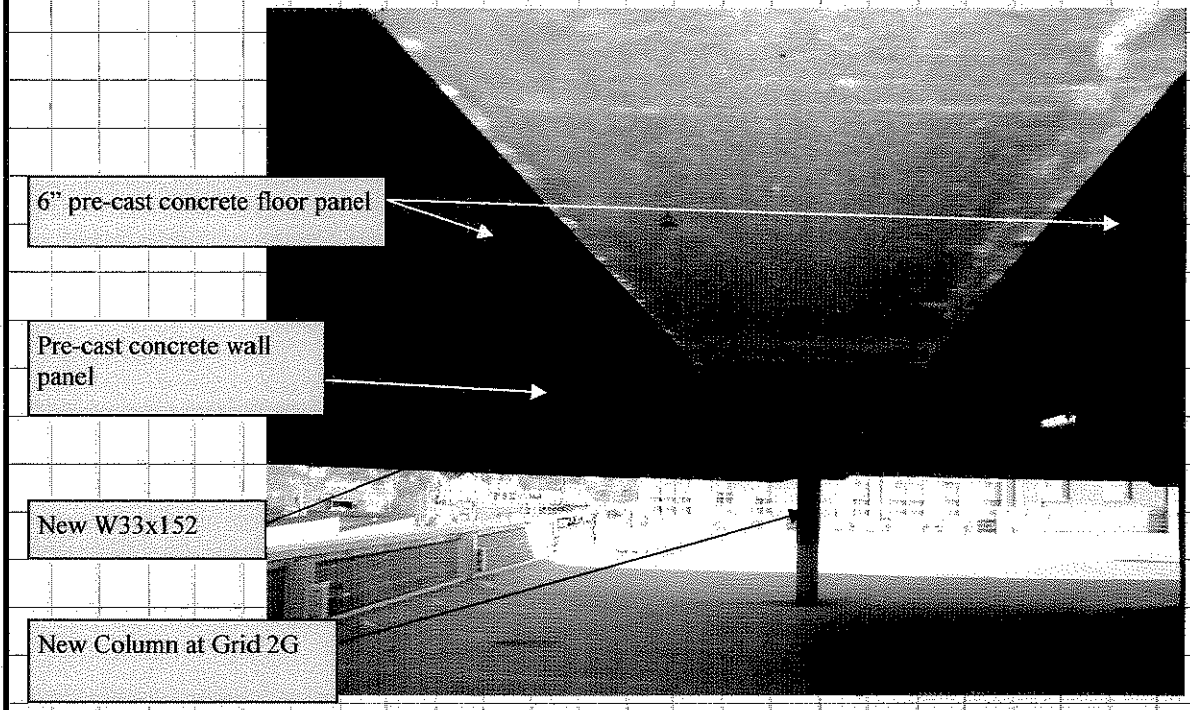


Photo #8-Angle brace at 3rd points W33x152

Paradigm Engineering LLC
463 US Route One, P.O. Box 288, York, Maine 03909
Tel. (207)363-5248 Fax (207)363-3237
Email: smcnally@paradigmstructures.com

PROJECT: Portsmouth Parking Garage ID 090428007
SHEET NO: 5 OF 20
INSPECTED BY: S. McNally, P.E DATE: Aug 30, 2006
CHECKED BY: C. Marshall, P.E., S.E. DATE: Aug 30, 2006
REMARKS:



Photo#9-W33x152 along Grid 2

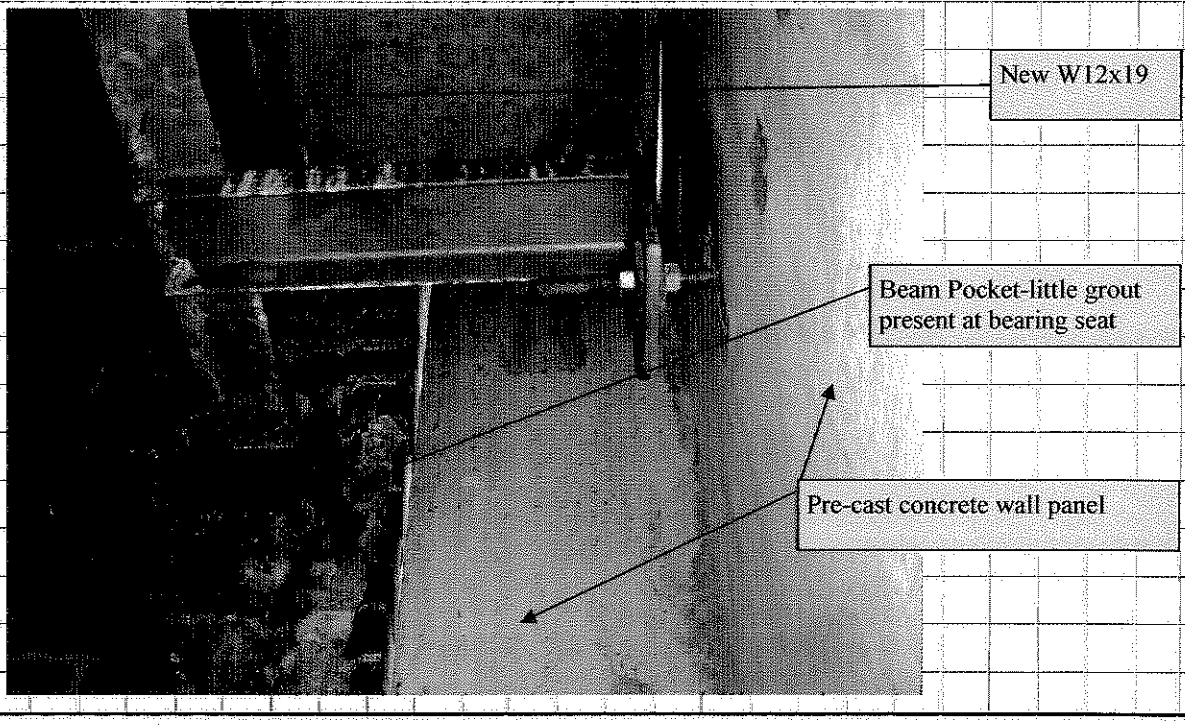


Photo #10-W12x19 at Northeast Corner-Stair Tower #1

Paradigm Engineering LLC
463 US Route One, P.O. Box 288, York, Maine 03909
Tel. (207)363-5248 Fax (207)363-3237
Email: smcnally@paradigmstructures.com

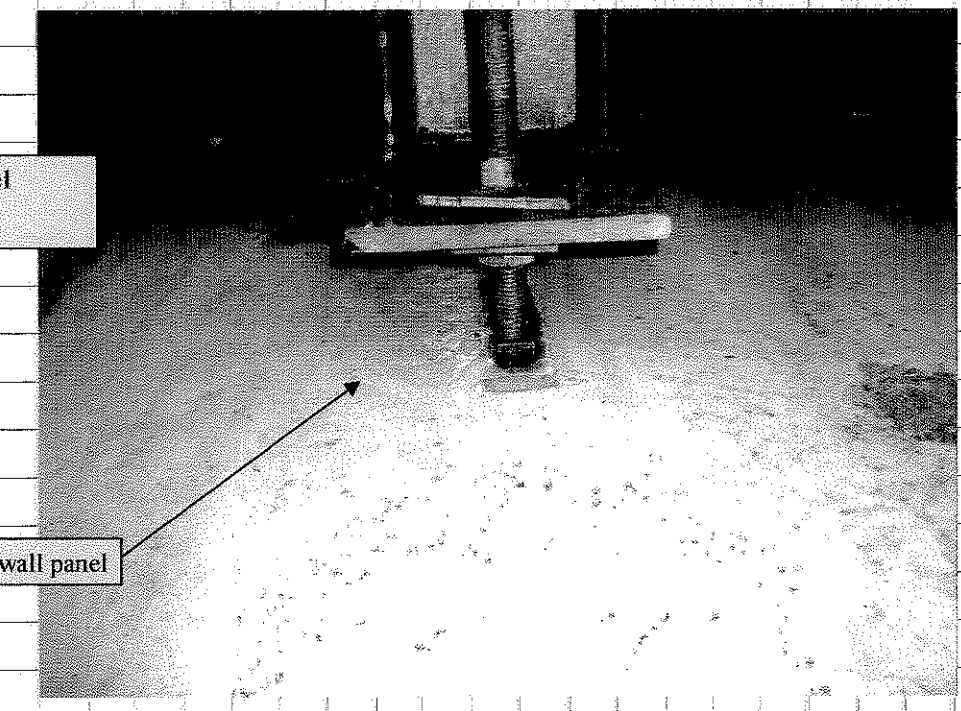
PROJECT: Portsmouth Parking Garage ID 090428007

SHEET NO: 6 OF 20

INSPECTED BY: S. McNally, P.E DATE: Aug 30, 2006

CHECKED BY: C. Marshall, P.E., S.E. DATE: Aug 30, 2006

REMARKS:



Photo#11-Pre-cast concrete wall panel brace at Grid 1.5B (looking up)

Photo #12-W12x19 at Northeast Corner-Stair Tower #1 at Grid 1.5B

Paradigm Engineering LLC
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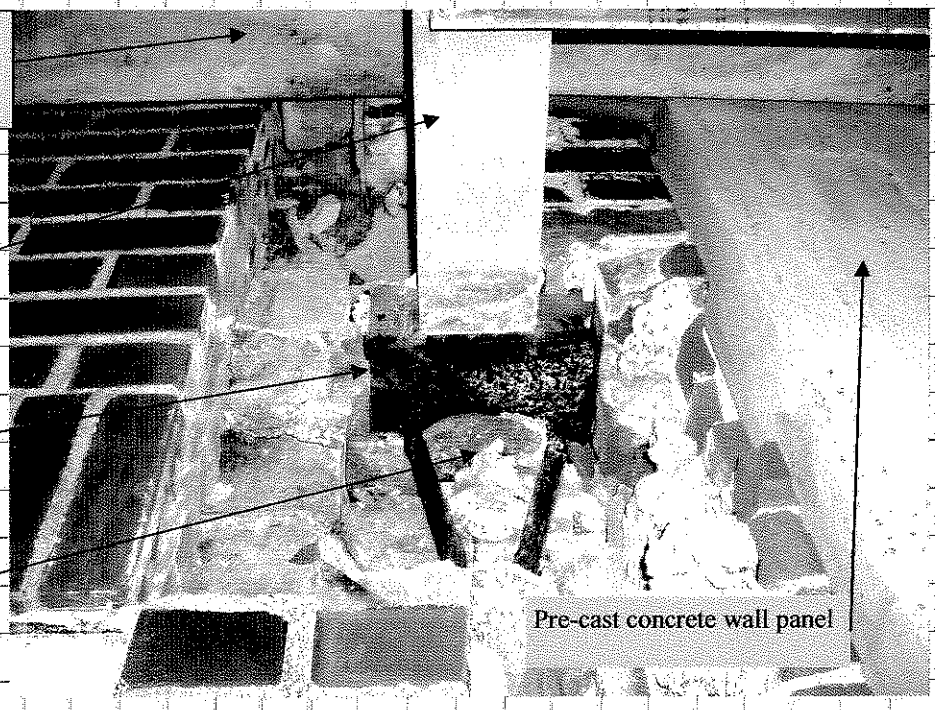
PROJECT: Portsmouth Parking Garage ID 090428007
SHEET NO: 7 OF 20
INSPECTED BY: S. McNally, P.E DATE: Aug 30, 2006
CHECKED BY: C. Marshall, P.E., S.E. DATE: Aug 30, 2006
REMARKS:



Photo#13-W12x19 at Northeast Corner-Stair Tower #1

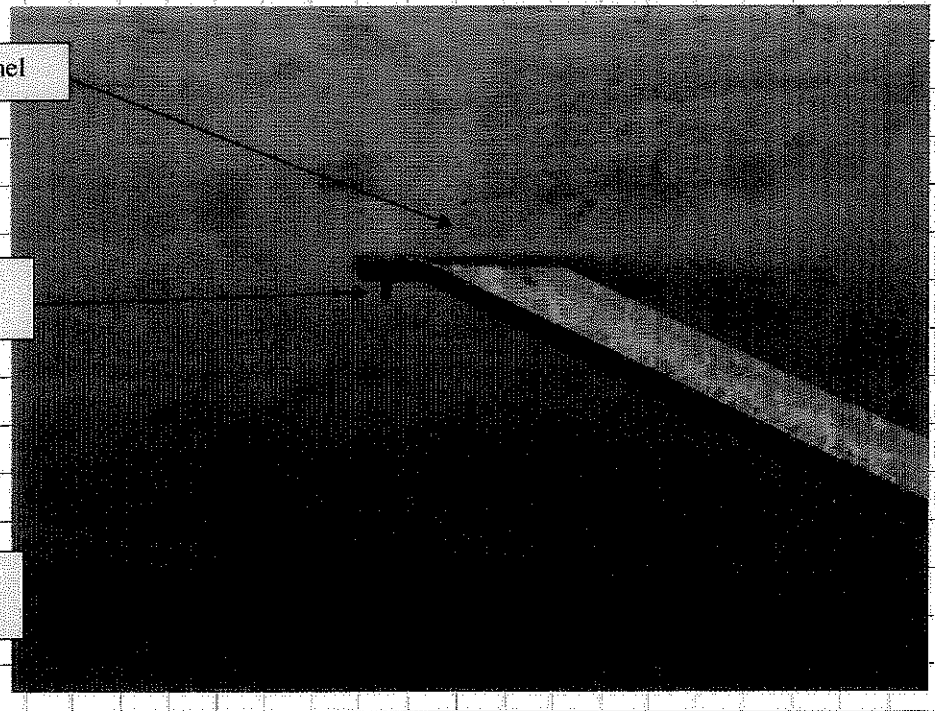


Photo #14-Angle brace at 6" pre-cast concrete floor panel

Paradigm Engineering LLC
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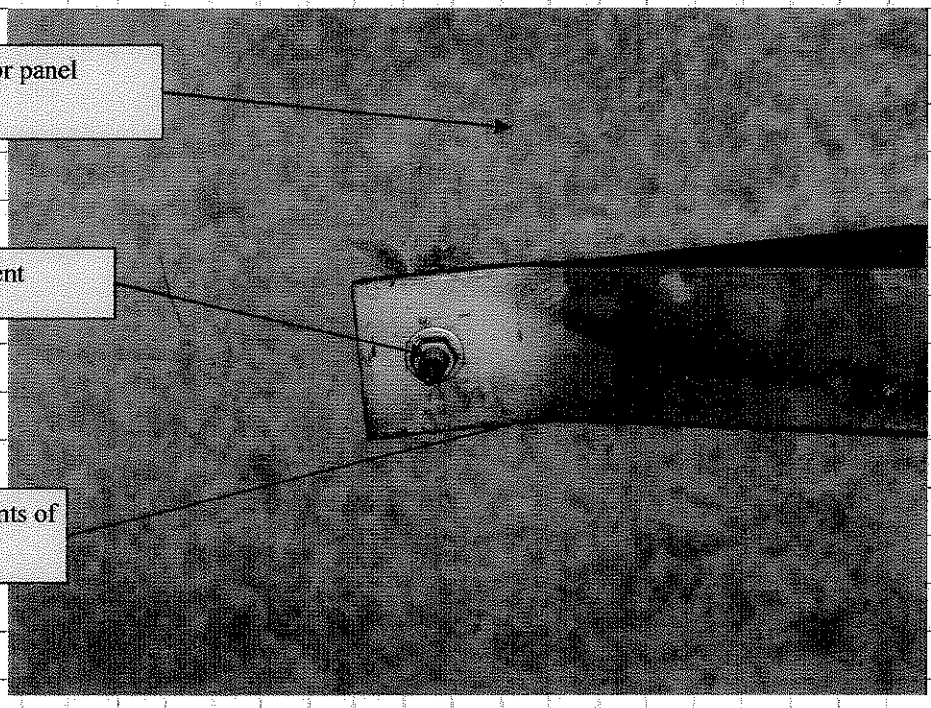
Tel. (207)363-5248 Fax (207)363-3237
Email: smcnally@paradigmstructures.com

PROJECT: Portsmouth Parking Garage ID 090428007
SHEET NO: 8 OF 20
INSPECTED BY: S. McNally, P.E DATE: Aug 30, 2006
CHECKED BY: C. Marshall, P.E., S.E. DATE: Aug 30, 2006
REMARKS:



Photo#15-Angle brace at 6" pre-cast concrete floor panel

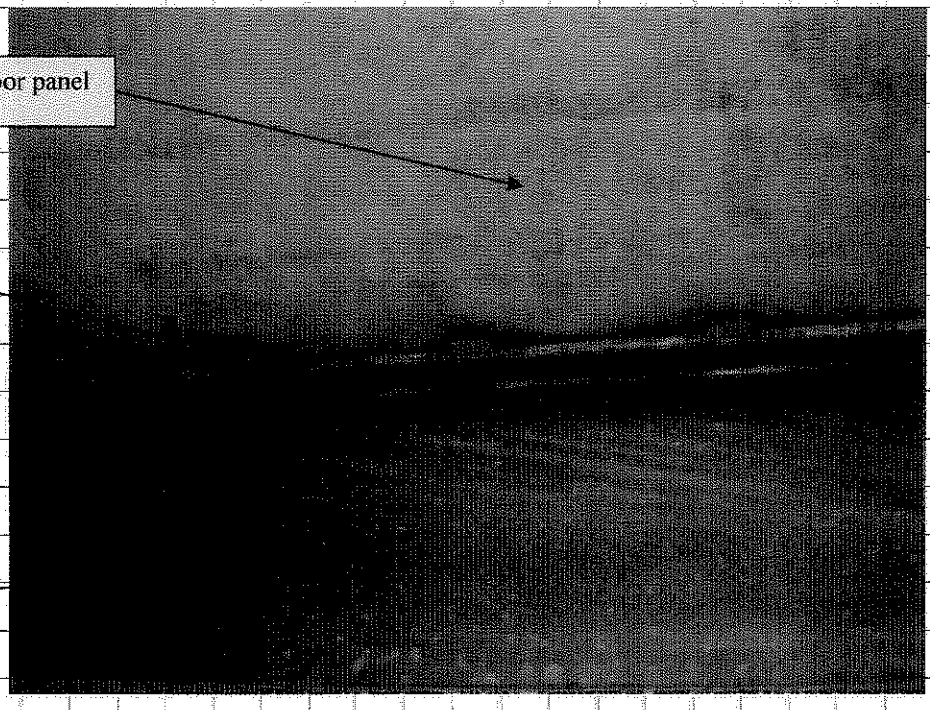


Photo #16-6" thick pre-cast concrete floor panel to steel beam

Paradigm Engineering LLC
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Tel. (207)363-5248 Fax (207)363-3237
Email: smcnally@paradigmstructures.com

PROJECT: Portsmouth Parking Garage ID 090428007
SHEET NO: 9 OF 20
INSPECTED BY: S. McNally, P.E DATE: Aug 30, 2006
CHECKED BY: C. Marshall, P.E., S.E. DATE: Aug 30, 2006
REMARKS:

Photo#17-W12x19 at Southeast Corner-Stair Tower #1 at Grid 1.5A

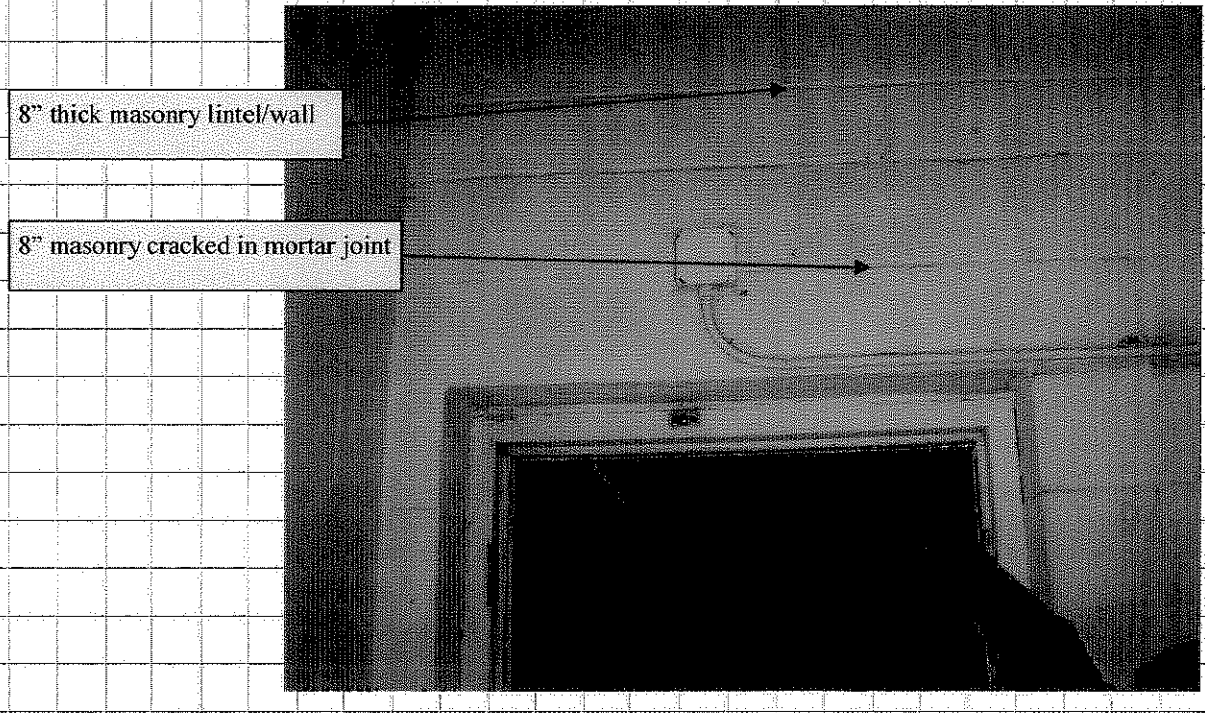

Photo #18-Cracked masonry aove door at Northeast Corner-Stair Tower #1 at Grid 1.5B

Paradigm Engineering LLC
463 US Route One, P.O. Box 288, York, Maine 03909
Tel. (207)363-5248 Fax (207)363-3237
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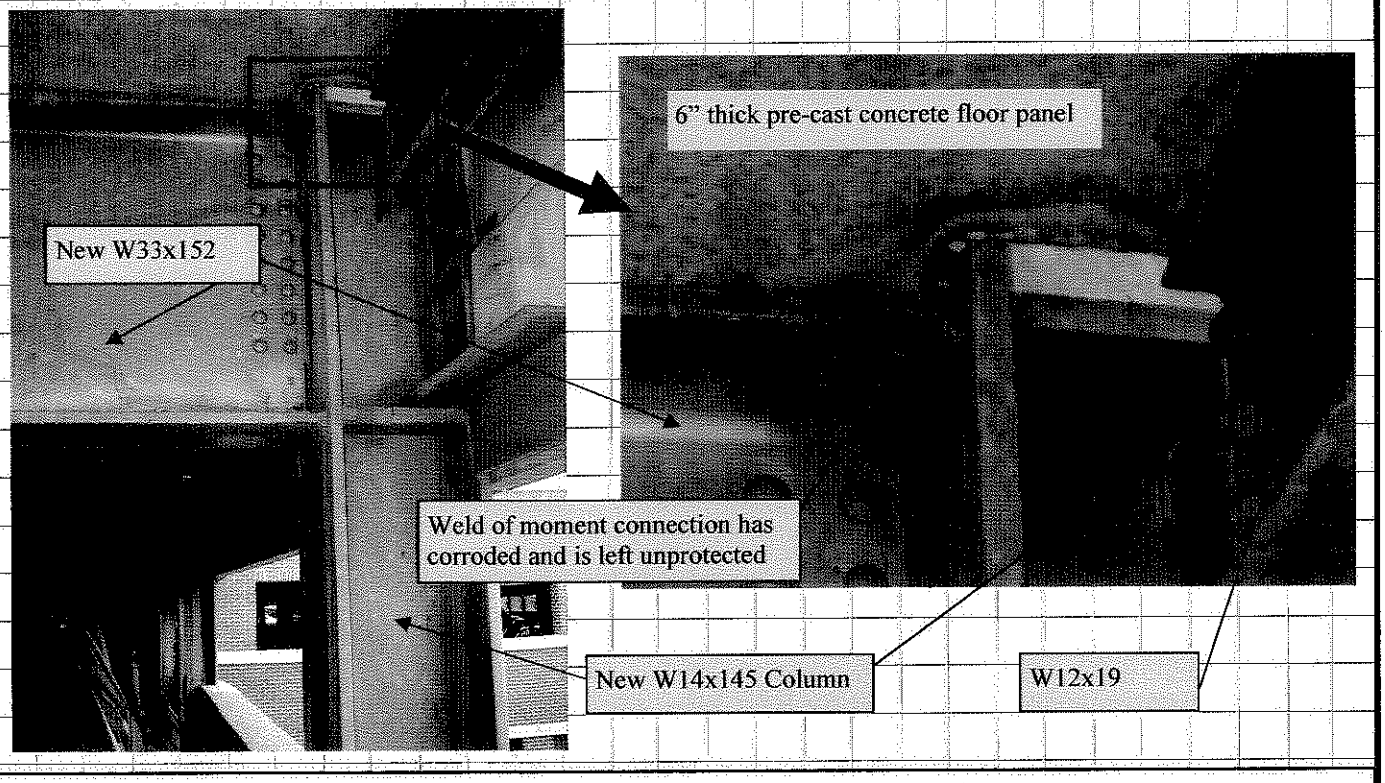
PROJECT: Portsmouth Parking Garage ID 090428007
SHEET NO: 10 OF 20
INSPECTED BY: S. McNally, P.E DATE: Aug 30, 2006
CHECKED BY: C. Marshall, P.E., S.E. DATE: Aug 30, 2006
REMARKS:



Photo#19-Column to Beam connection at Grid 2A

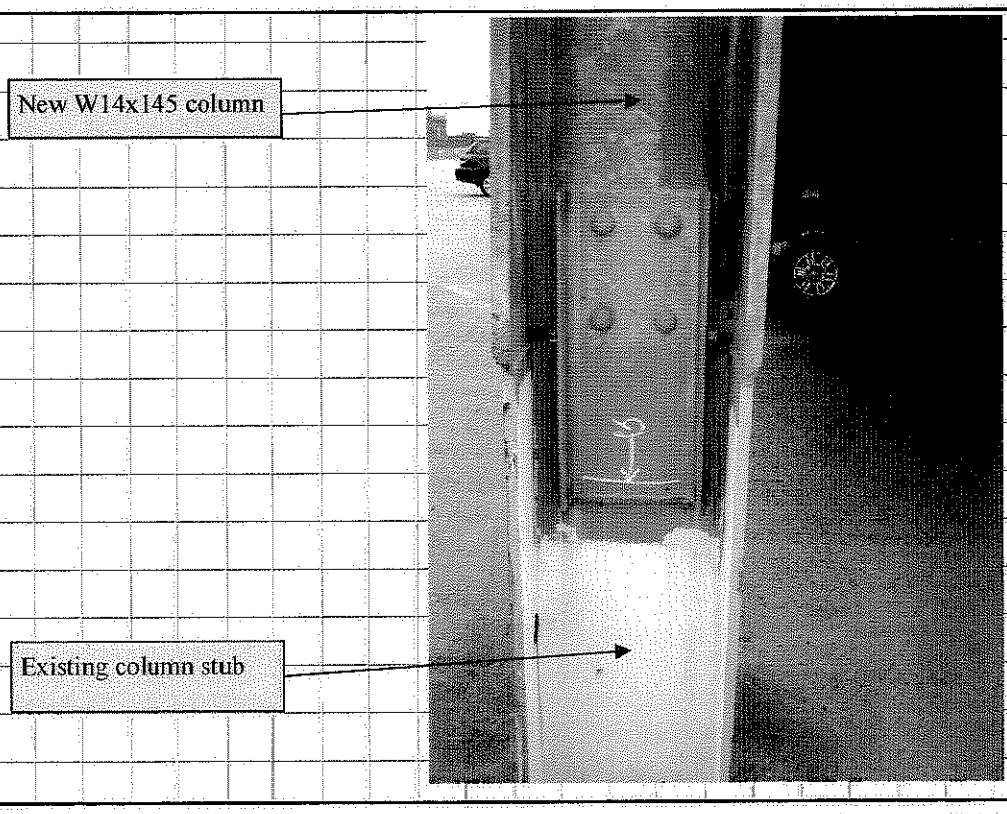


Photo #20-W14x145 column to existing column at Grid 2G

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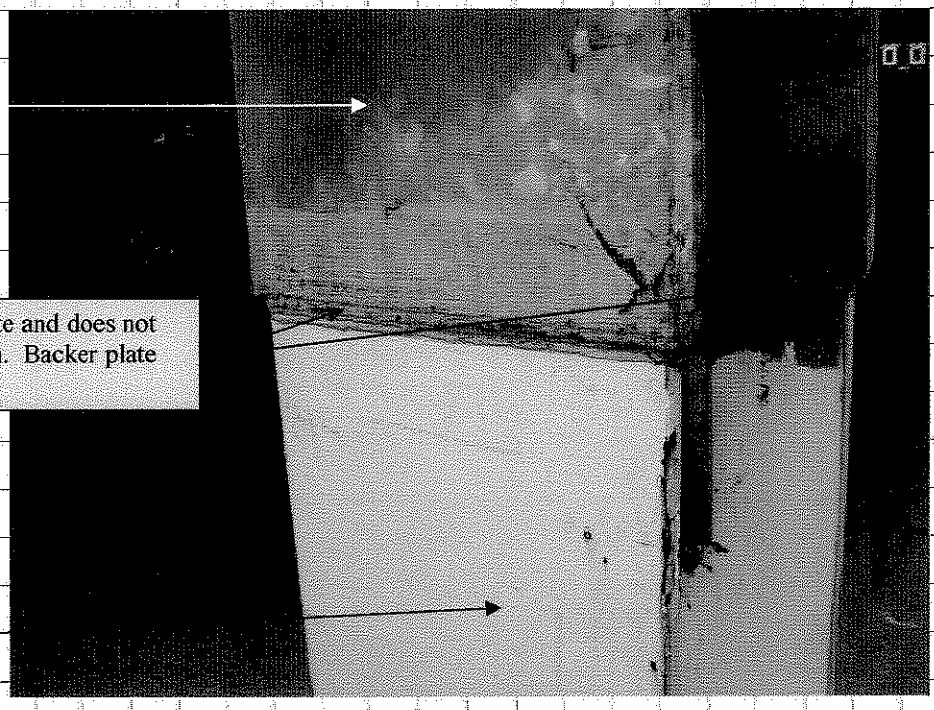
PROJECT: Portsmouth Parking Garage ID 090428007
SHEET NO: 11 OF 20
INSPECTED BY: S. McNally, P.E DATE: Aug 30, 2006
CHECKED BY: C. Marshall, P.E., S.E. DATE: Aug 30, 2006
REMARKS:



Photo#21-New column to existing column at Grid 2G

Photo #22-W12x19 New column ro existing column at Grid 2G

Paradigm Engineering LLC
463 US Route One, P.O. Box 288, York, Maine 03909
Tel. (207)363-5248 Fax (207)363-3237
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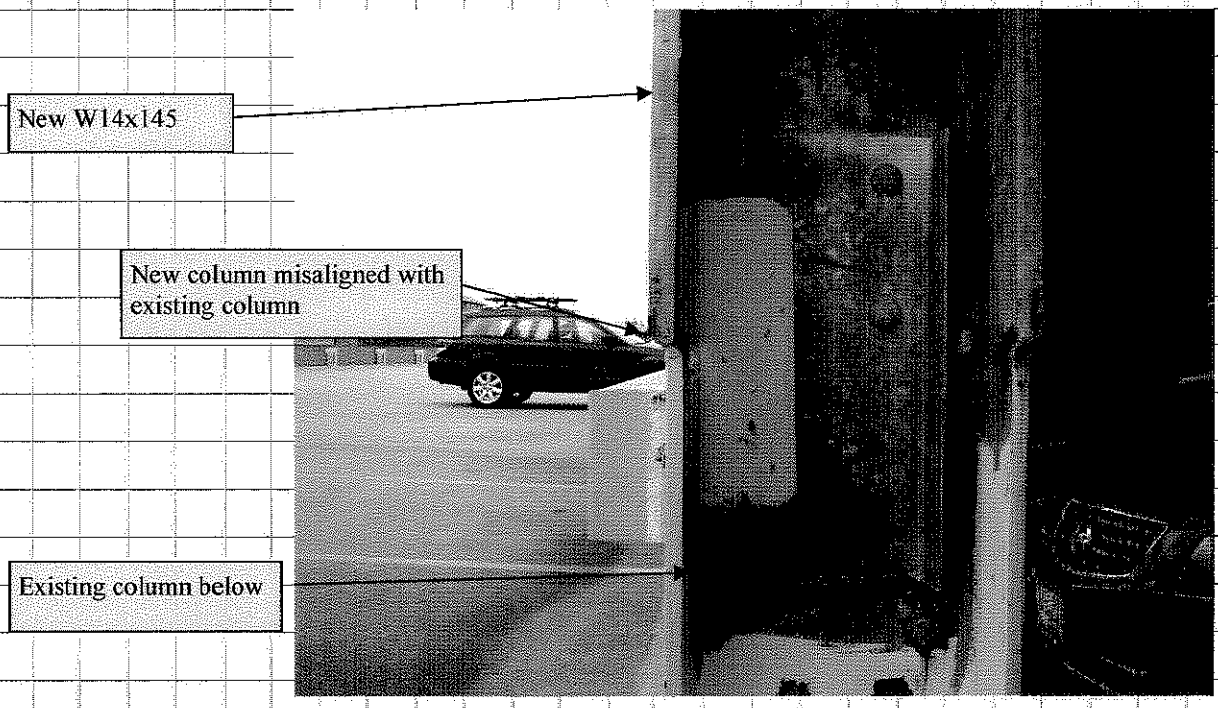
PROJECT: Portsmouth Parking Garage ID 090428007
SHEET NO: 12 OF 20
INSPECTED BY: S. McNally, P.E DATE: Aug 30, 2006
CHECKED BY: C. Marshall, P.E., S.E. DATE: Aug 30, 2006
REMARKS:



Photo#23-W12x19 at Northeast Corner-Stair Tower #1

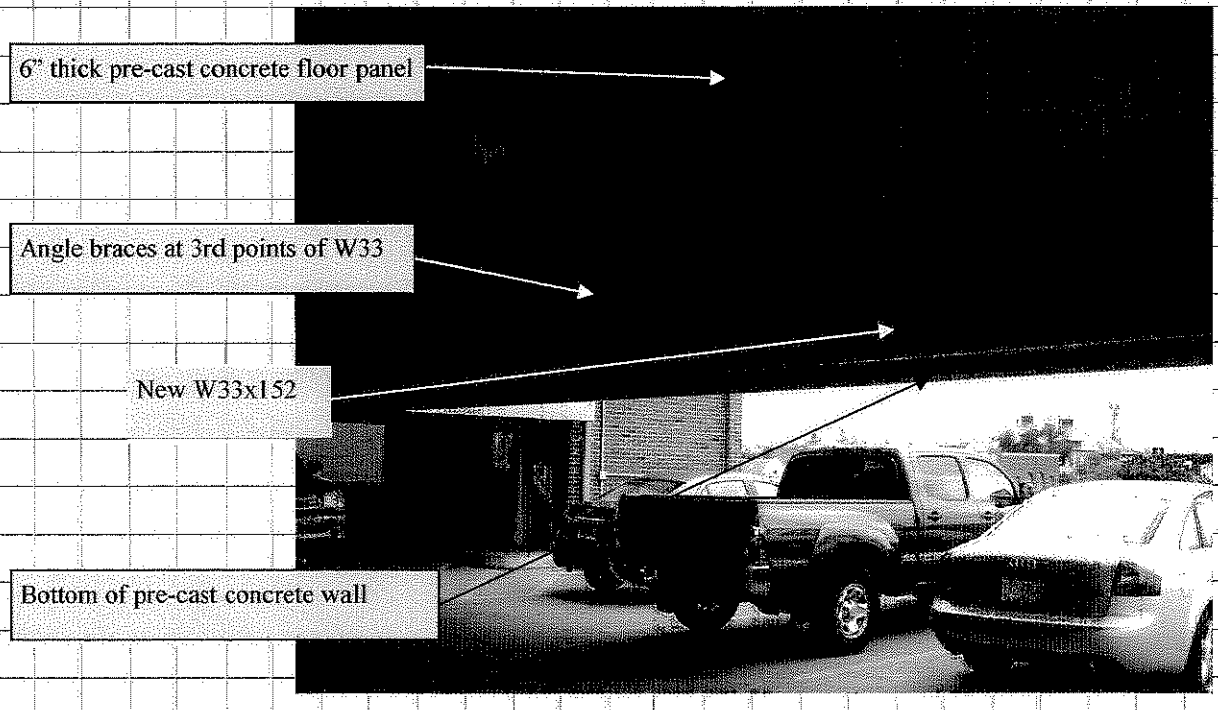


Photo #24-W12x19 at Northeast Corner-Stair Tower #1

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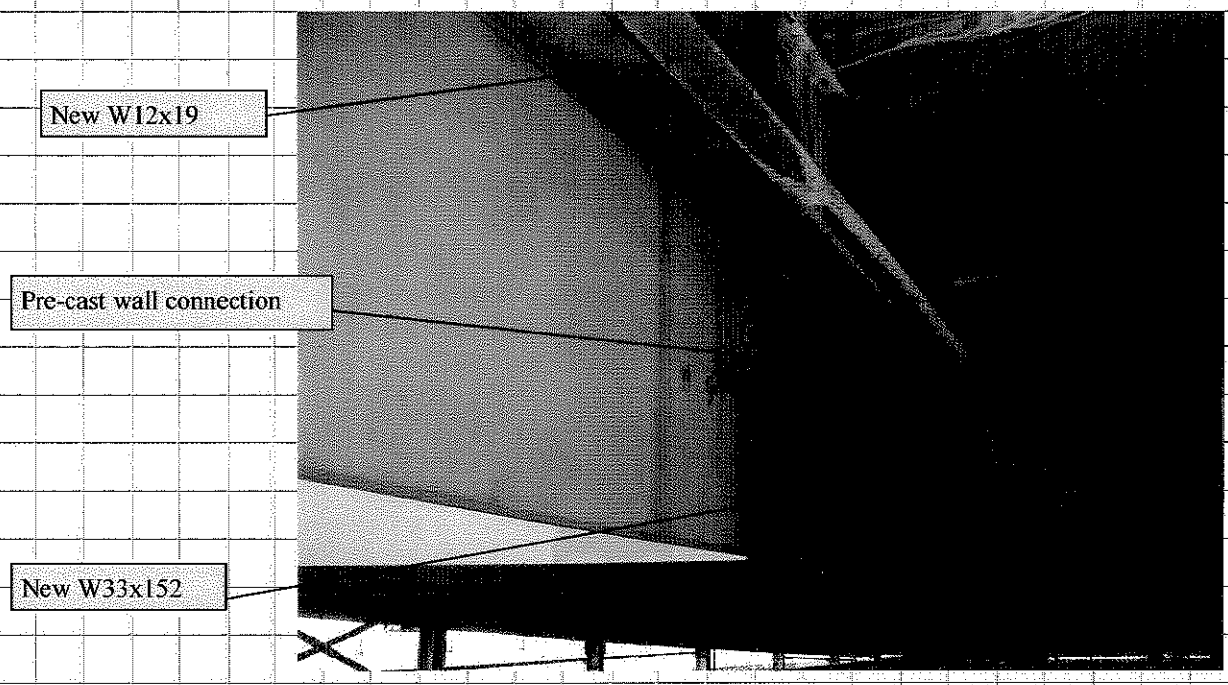
PROJECT: Portsmouth Parking Garage ID 090428007
SHEET NO: 13 OF 20
INSPECTED BY: S. McNally, P.E DATE: Aug 30, 2006
CHECKED BY: C. Marshall, P.E., S.E. DATE: Aug 30, 2006
REMARKS:



Photo#25-W12x19 to W33x152 at Grid 2B

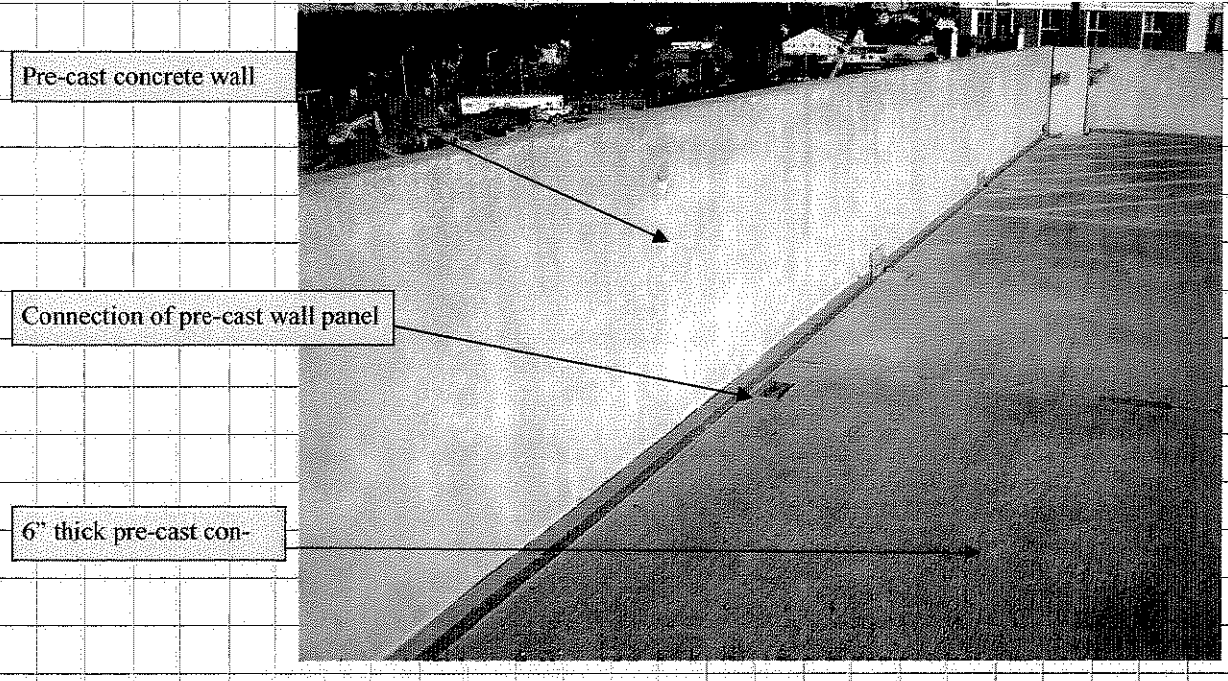


Photo #26-Pre-cast concrete wall to pre-cast concrete floor panel

Paradigm Engineering LLC
463 US Route One, P.O. Box 288, York, Maine 03909
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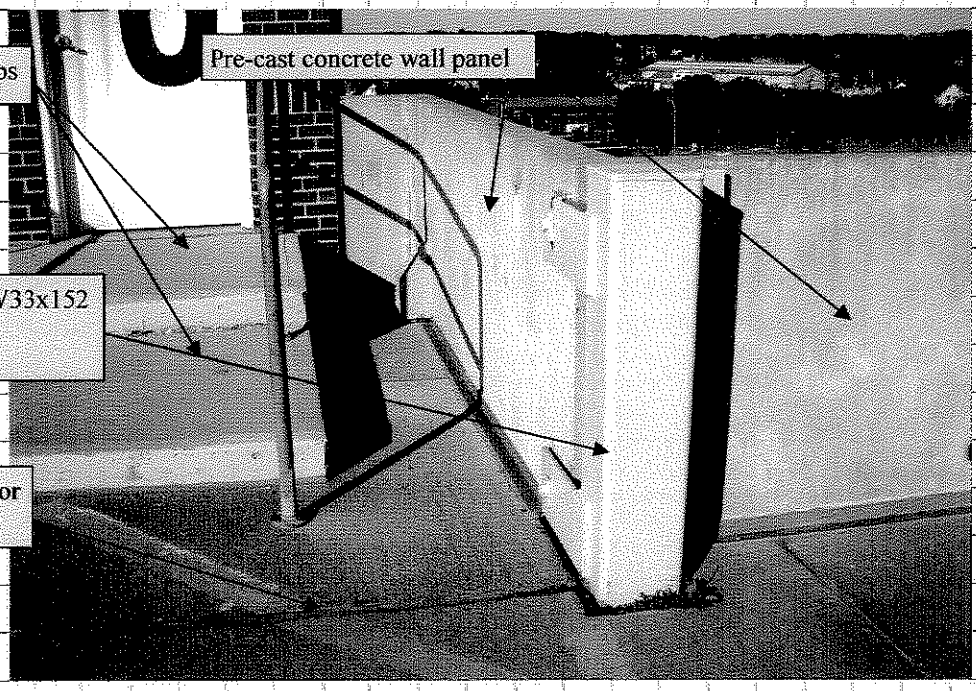
PROJECT: Portsmouth Parking Garage ID 090428007
SHEET NO: 14 OF 20
INSPECTED BY: S. McNally, P.E DATE: Aug 30, 2006
CHECKED BY: C. Marshall, P.E., S.E. DATE: Aug 30, 2006
REMARKS:



Photo#27-5th level at Grid 2B

Photo #28-W12x19 at Northeast Corner-Stair Tower #1

Paradigm Engineering LLC
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Tel. (207)363-5248 Fax (207)363-3237
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PROJECT: Portsmouth Parking Garage ID 090428007
SHEET NO: 15 OF 20
INSPECTED BY: S. McNally, P.E DATE: Aug 30, 2006
CHECKED BY: C. Marshall, P.E., S.E. DATE: Aug 30, 2006
REMARKS:

Photo#29-Pre-cast wall at stair tower at Grid 1.5A

Photo #30-6" concrete floor panel layout

Paradigm Engineering LLC
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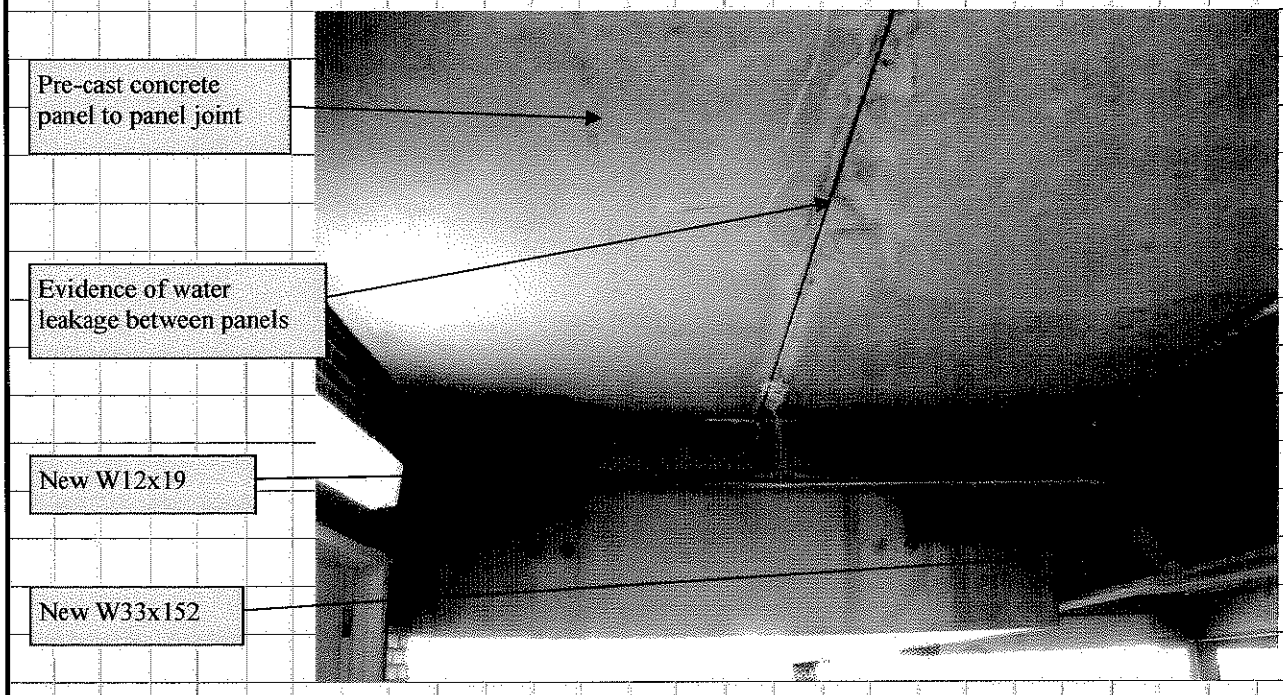
PROJECT: Portsmouth Parking Garage ID 090428007
SHEET NO: 16 OF 20
INSPECTED BY: S. McNally, P.E DATE: Aug 30, 2006
CHECKED BY: C. Marshall, P.E., S.E. DATE: Aug 30, 2006
REMARKS:



Photo#31-W12x19 to W33x152 at Grid 2B

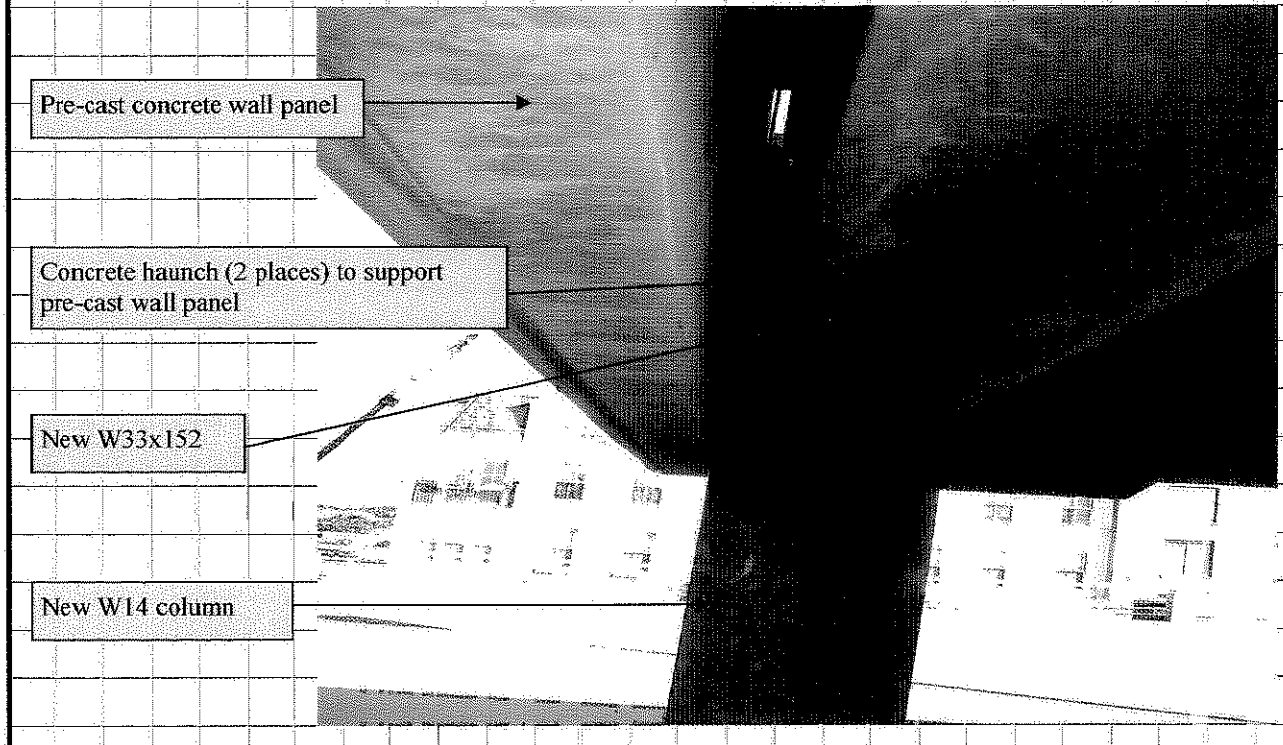


Photo #32-Pre-cast concrete panel support

Paradigm Engineering LLC
463 US Route One, P.O. Box 288, York, Maine 03909
Tel. (207)363-5248 Fax (207)363-3237
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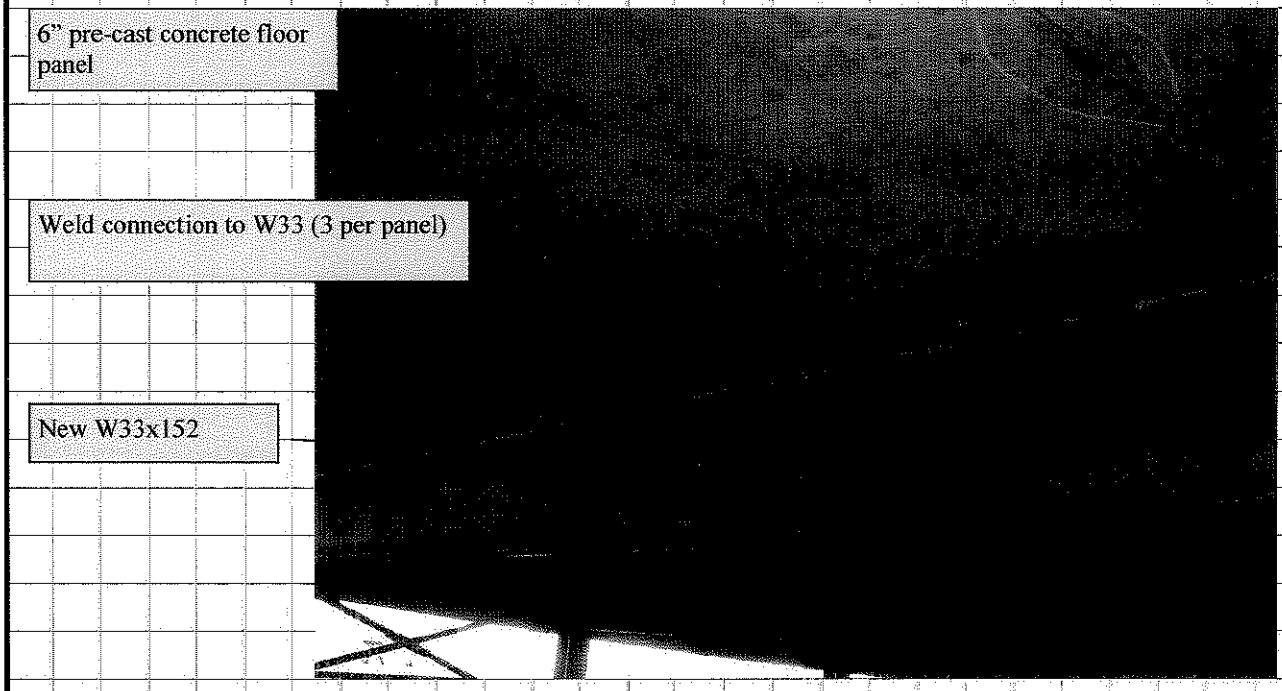
PROJECT: Portsmouth Parking Garage ID 090428007
SHEET NO: 17 OF 20
INSPECTED BY: S. McNally, P.E DATE: Aug 30, 2006
CHECKED BY: C. Marshall, P.E., S.E. DATE: Aug 30, 2006
REMARKS:



Photo#33-Connection of 6" floor panel to W33

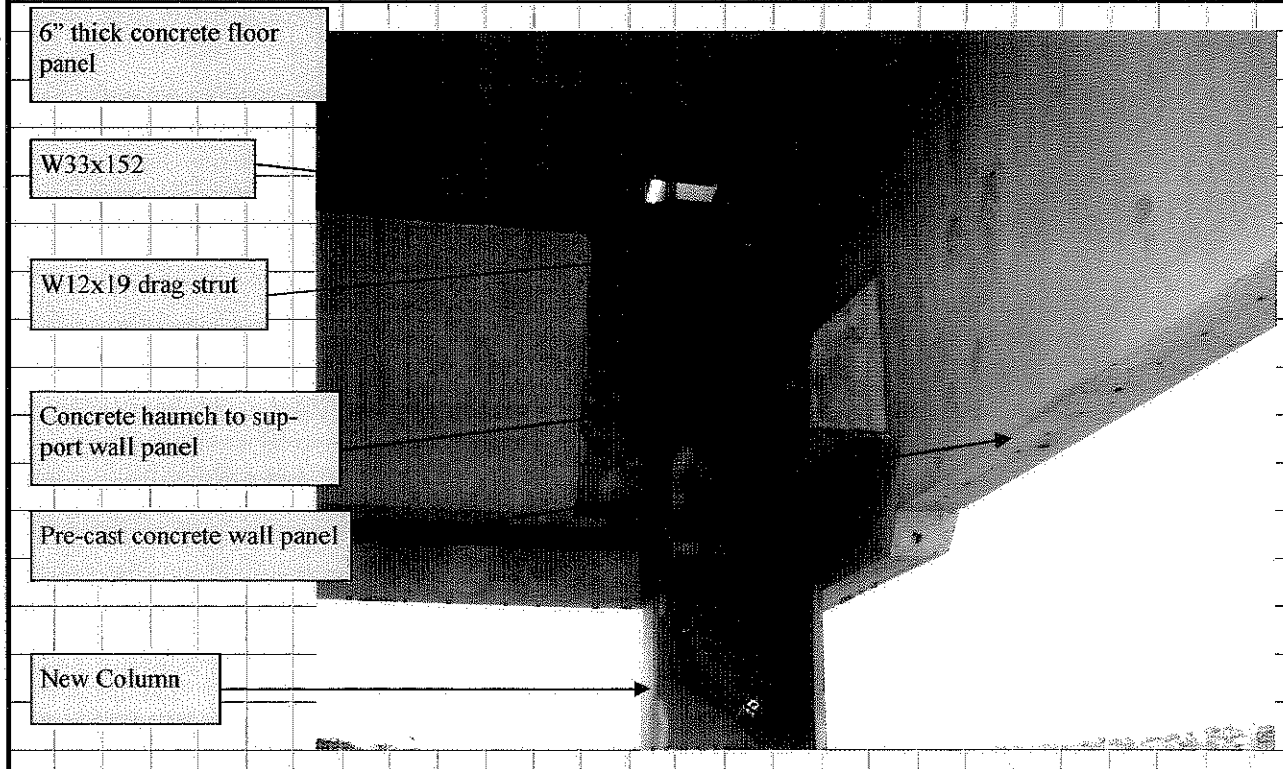
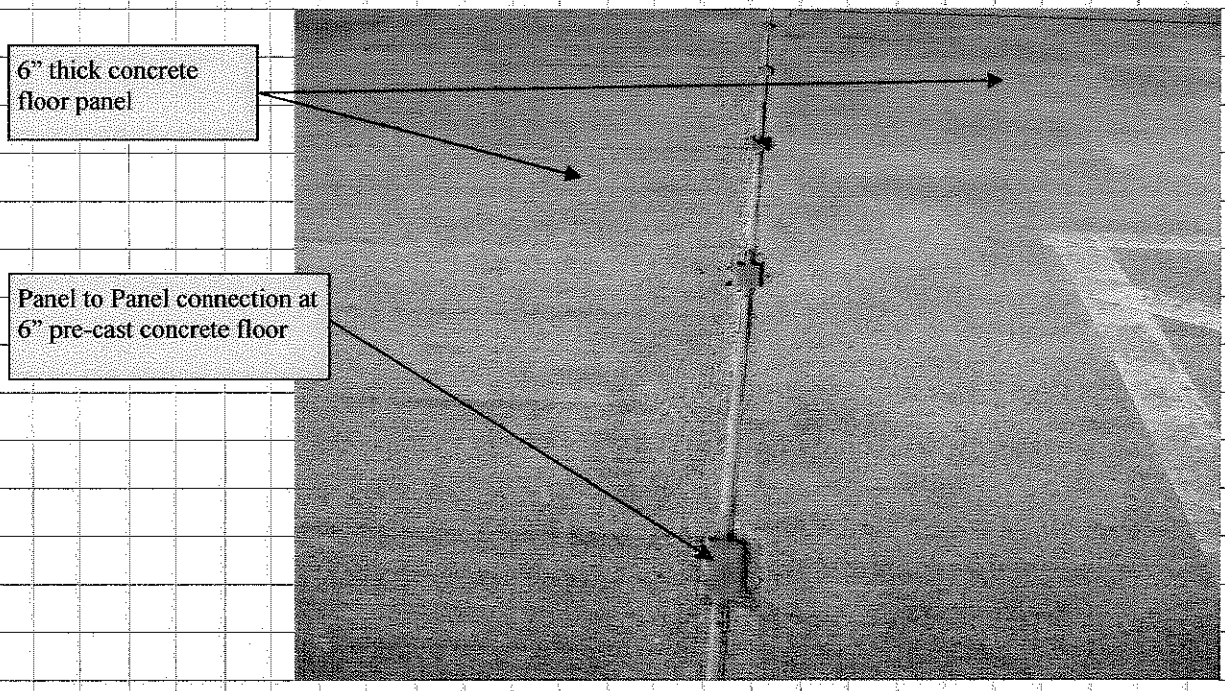


Photo #34-Moment connection at 2G

Paradigm Engineering LLC
463 US Route One, P.O. Box 288, York, Maine 03909
Tel. (207)363-5248 Fax (207)363-3237
Email: smcnally@paradigmstructures.com

PROJECT: Portsmouth Parking Garage ID 090428007
SHEET NO: 18 OF 20
INSPECTED BY: S. McNally, P.E DATE: Aug 30, 2006
CHECKED BY: C. Marshall, P.E., S.E. DATE: Aug 30, 2006
REMARKS:



Photo#35-6" thick pre-cast floor panel to panel layout

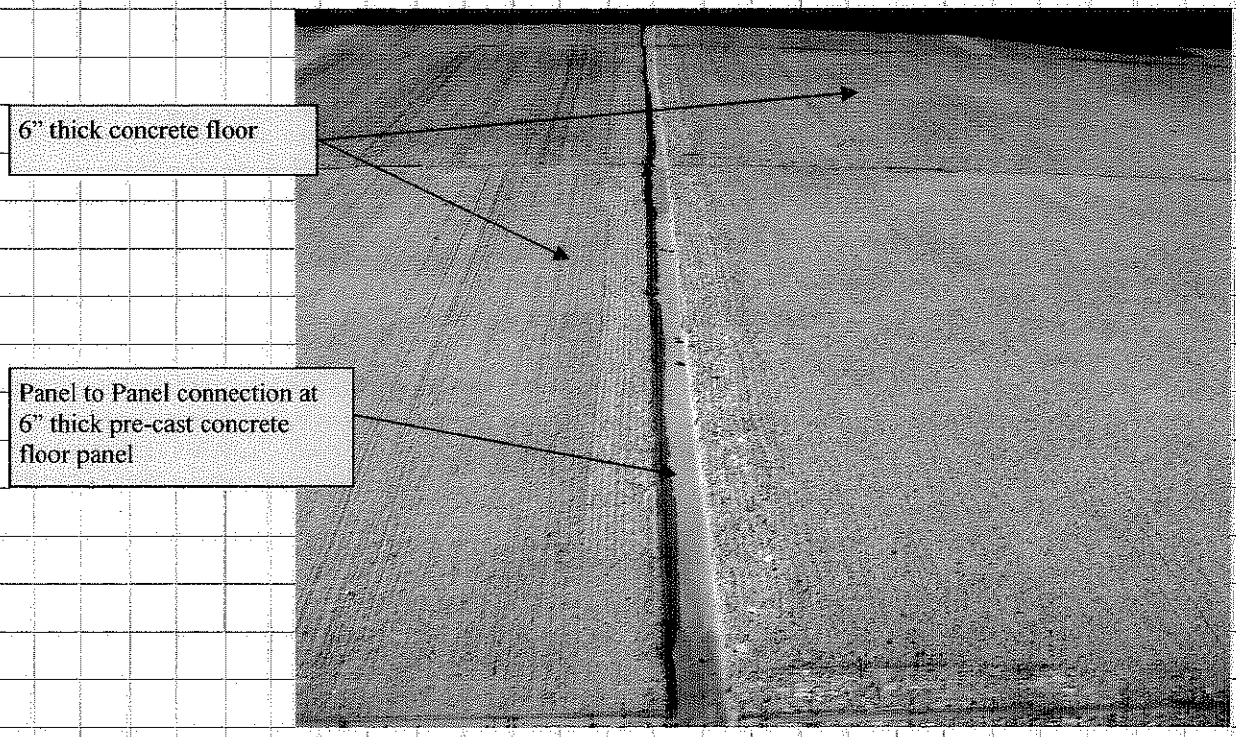


Photo #36-Pre-cast concrete panel to panel joint

Paradigm Engineering LLC
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Tel. (207)363-5248 Fax (207)363-3237
Email: smcnally@paradigmstructures.com

PROJECT: Portsmouth Parking Garage ID 090428007
SHEET NO: 19 OF 20
INSPECTED BY: S. McNally, P.E DATE: Aug 30, 2006
CHECKED BY: C. Marshall, P.E., S.E. DATE: Aug 30, 2006
REMARKS:

Photo#37-W12x19 to W33x152 at Grid 2B

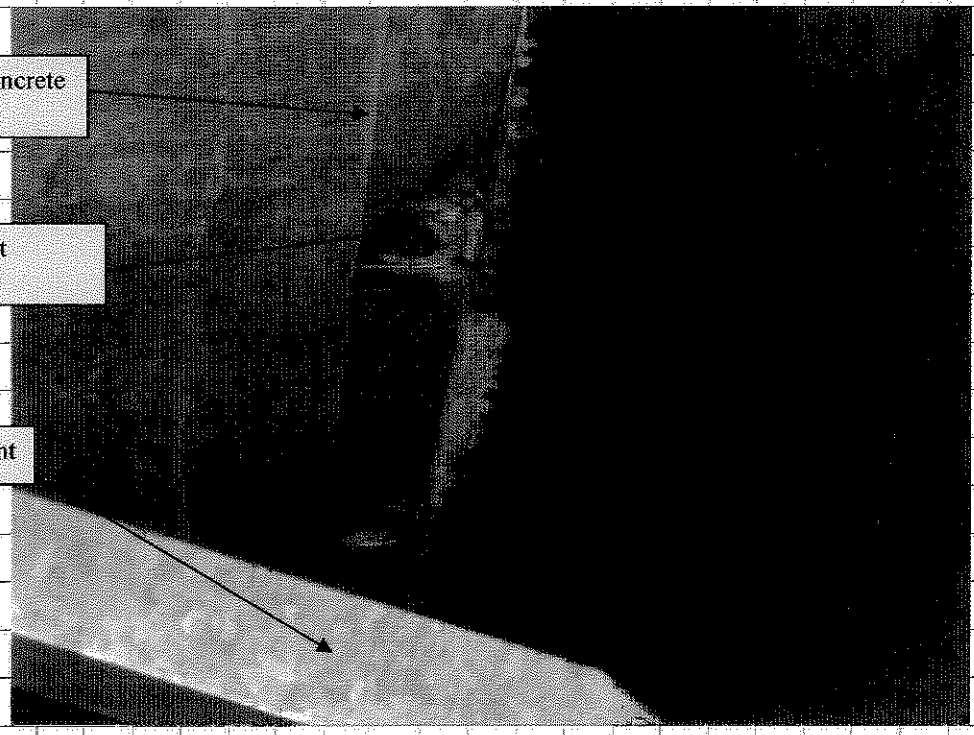

Photo #38-Pre-cast concrete floor panel to W33

Paradigm Engineering LLC
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Email: smcnally@paradigmstructures.com

PROJECT: Portsmouth Parking Garage ID 090428007

SHEET NO: 20 OF 20

INSPECTED BY: S. McNally, P.E DATE: Aug 30, 2006

CHECKED BY: C. Marshall, P.E., S.E. DATE: Aug 30, 2006

REMARKS:

Photo#39-Stair Tower #1 at 4th level

JSN Associates, Inc.

One Autumn Street
Portsmouth, NH 03801
Tel (603)433-8639
Fax (603)431-2811
www.jsneng.com

03/23/11

Thomas Richter
Engineering Technician
Public Works Department
680 Peverly Hill Road
Portsmouth, NH 03801
603.766.1414
603.427.1539
tcrichter@pw.cityofportsmouth.com

RE: Cracked Masonry Veneer Wall – Hanover St. Parking Garage, Portsmouth

Dear Mr. Richter,

This morning I visited the Hanover St. Parking Garage, at your request, to observe the condition of a masonry veneer wall that was exhibiting a large crack.

The wall is on the North side of the building at the second level (Hanover St., entry level), near the middle of the façade. The wall is 12" thick and approximately 7'-4" tall. It is comprised of a 4" brick veneer in front of an 8" concrete block structural wall. The block wall sits on a steel beam supported by the building columns, whereas the veneer extends lower than the block to sit on a support plate welded to the bottom of the steel beam. The wall support beams are located approximately 40" below the parking deck elevation.

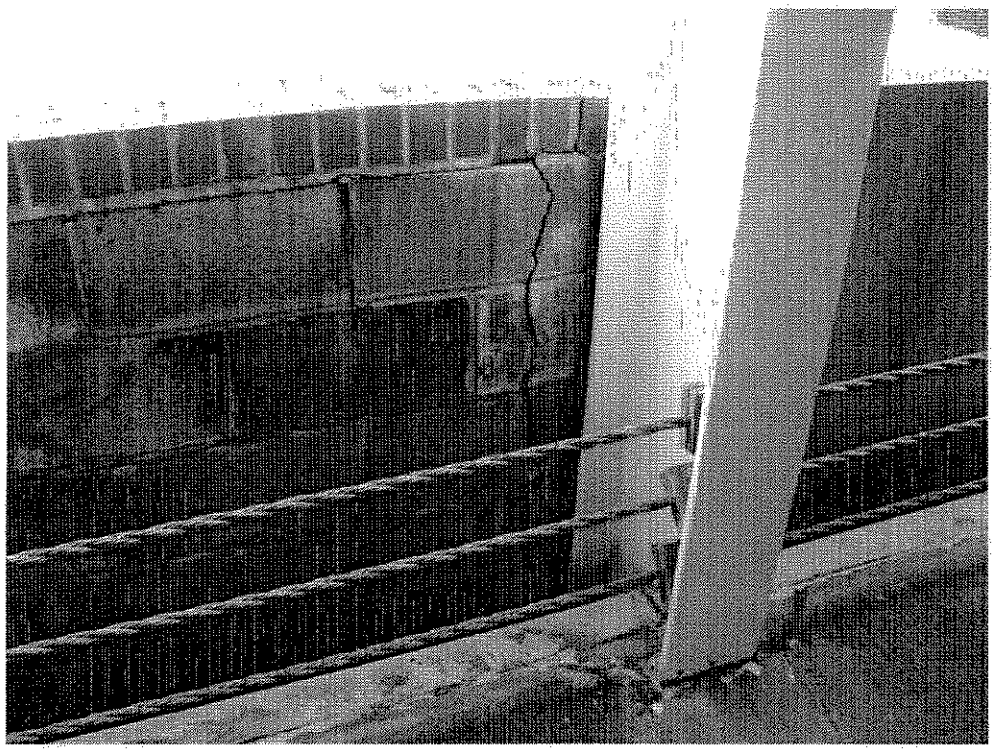
There is a gap of approximately 6"± between the inside face of the block and the edge of the parking deck, consequently there are wall restraint ties between the block and the steel beams at the parking deck. From the elevation of the ties, the wall cantilevers upward to approximately 36" above the parking deck.

The brick has been laid with control joints at 20' on center, to match the spacing of the building columns. The concrete block wall does not appear to have control joints; the length of continuous wall exceeds 40', which is the accepted maximum spacing between control joints.

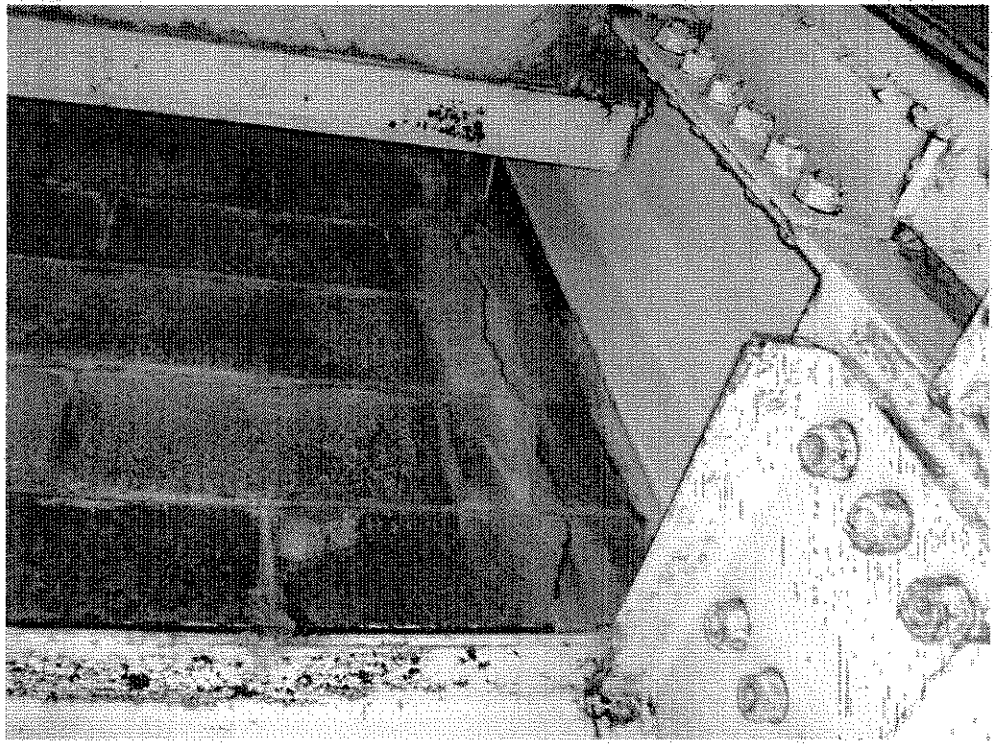
At one end of the wall, the masonry construction butts a precast concrete veneer panel. The butt joint is centered on a column (10^{th} column, from the corner of Hanover St. and Fleet St.), and appears to have been caulked. The concrete veneer panels are 20' long (matching the spacing of the building columns) and 7-'4" tall (matching the height of the masonry wall). They are supported by bolting to plates cantilevering from the building columns at the top connections. The top connections are at approximately 12" from the top of the panels. The bottom connections are corbels at the inside face of the panels bearing on seat angles cantilevered from the columns. The panels are bolted to the seat angles. The concrete veneer panels are 3-5/8" thick and are flush with the inside face of the masonry veneer walls. At the butt joint, the brick veneer wraps the end of the masonry wall, allowing the brick to be visible where the face of brick is proud of the face of the concrete veneer panel. The brick also runs as a cap over the top of the block wall.

The crack is a significant rupture through the face-shell at the inside face of the masonry wall. The vertical crack is centered at the first core of the first block at the end of the wall that butts a concrete veneer panel. The crack runs from the brick cap downward, through the location of the wall tie, to the top of the steel beam. The face-shells of the block on each side of the crack exhibit horizontal displacement towards the inside of the building. The brick veneer at the outside face of the wall does not exhibit cracking in the same area, however, the brick veneer at the end of the wall has a vertical crack that corresponds to the outside face of the block behind the veneer.

Based on my observations at the garage and my review of pictures taken during my visit, it is my opinion that an initial crack was caused during warm weather when the masonry wall expanded and was restrained by the adjacent concrete panel that is attached directly to the steel columns. The crack opened during colder temperatures and then water infiltrated the wall. Freeze thaw cycles of the moisture in the block then caused additional damage, resulting in the current condition.



1 – Crack at End of Masonry Wall (View from Second Floor)



2 – Crack at End of Masonry Wall (View from First Floor)

It should be noted that it does not appear that the concrete block wall has grouted cores with reinforcing or a bond beam. This leaves the face-shells of the block to take the force from horizontal expansion and contraction. The block wall does not have control joints where the force could be dissipated. Additionally, the concrete panel butts just the inside 3-5/8" of the wall, because it is flush to the inside face of the block wall. All of the force is therefore concentrated on just one face-shell (at the inside face of the block).

It is also my opinion that the condition is not of immediate danger. The wall appears to have enough residual integrity to continue to work as designed. Additionally, the broken pieces of wall are contained by the brick and the adjacent concrete panel. The condition should be observed to ensure that it doesn't worsen, and I suggest that the damage be repaired.

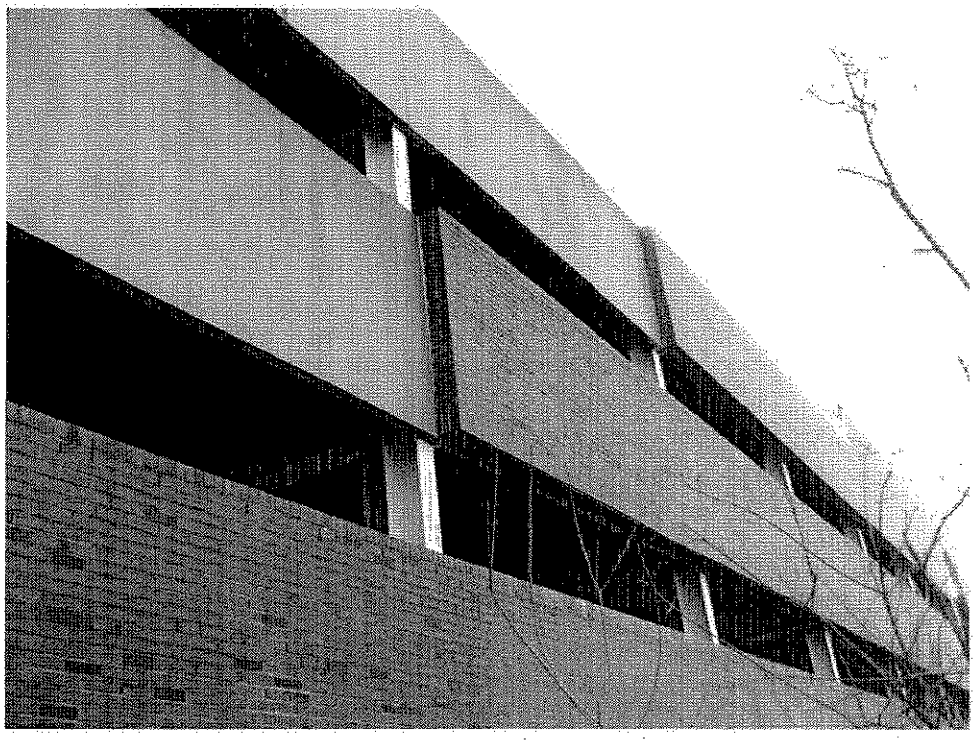
The broken pieces of block can be removed during repair. Whether just the face-shells are removed or more block needs to be removed from the end of the wall will depend on the extent of the internal damage (which cannot be observed without limited demolition). New block or block soaps should be provided. I recommend grouting the first block core for the height of removed block. The intent is to provide mass that can distribute any future forces to both face-shells of the concrete block wall. The surrounding brick veneer should be re-pointed and possibly replaced where the bricks have been damaged. No special grout, mortar, or block is necessary, so materials that match those that exist are acceptable. The masonry work required is within the typical abilities of a mason.

Thank you for the opportunity to provide you with structural review services. Please call me at (603) 433-8639, extension 203, if you have any questions about this report or I can be of additional assistance.

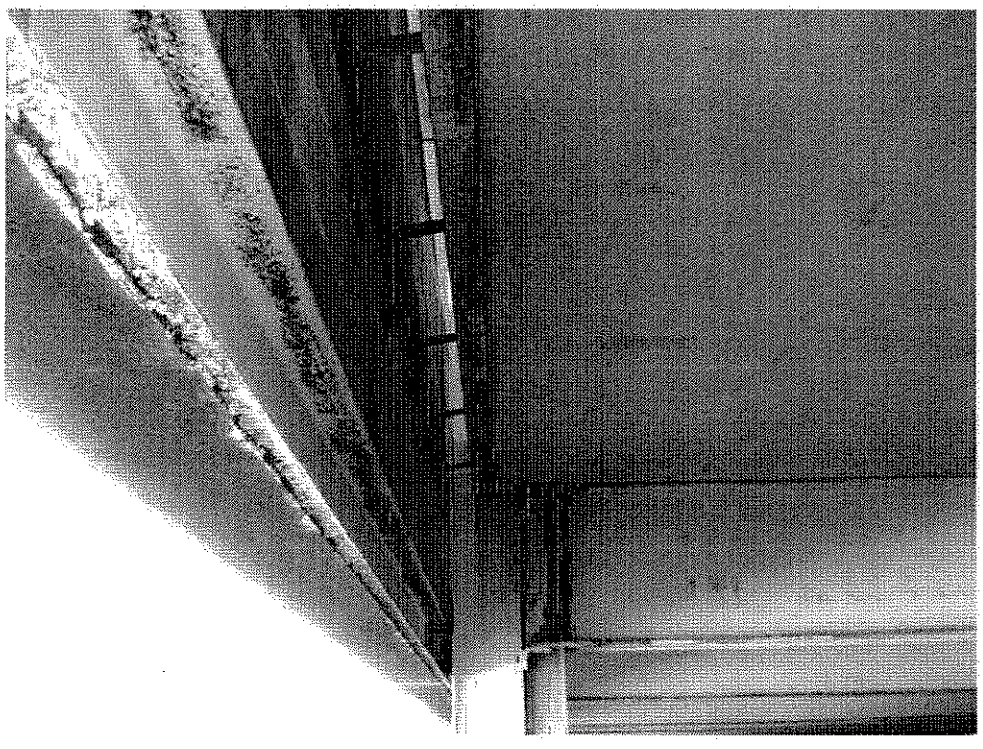
Sincerely,
JSN Associates, Inc.

[sent electronically on 03/23/11]

Matthew J. Allen, P.E.
Senior Structural Engineer



3 – Cracked end of Wall at Joint with Precast Panel (View from Grade)



4 – Support Beam and Wall Ties (View from First Floor)