ASSESSMENT of the CONDITION of and RECOMMENDATIONS for REHABILITATION and REPAIR to the BUILDING EXTERIOR

Civic Center Restoration – GTF
STPE 7(47)
Control No. 6338, O.F. #1525
2 Park Drive South
Great Falls MT 59401

April 18, 2011

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PURPOSE

The purpose of this report is to assess the work needed to fully restore the exterior of the Great Falls Civic Center building and to identify the first phase of restoration work.

BACKGROUND

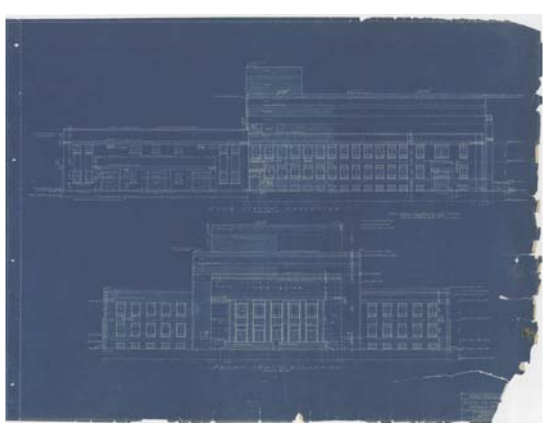
In general, the Civic Center exterior has deteriorated gradually over time and has many noticeable areas in need of repair. The most obvious items include several areas of eroded and/or missing mortar; loose and/or misaligned coping, windows and doors; and façade discoloration and cracking. The City determined that they needed a comprehensive and detailed inspection of the exterior of the building to identify restoration work items, as well as, an evaluation of methods by which the restoration could best be accomplished. The assessment will be used by the City of Great Falls to gain a better understanding of the restoration issues and costs in order to secure funds for full restoration.

ASSESSMENT PROCESS

Architectural Investigation. This is the critical first step in planning an appropriate treatment- understanding how a building has changed over time and assessing levels of deterioration and is, in fact, the primary purpose of this report. Within the framework of *The Secretary of the Interior's Standards for the Treatment of Historic Properties*, investigation is crucial for "identifying, retaining, and preserving the form and detailing of those architectural materials and features that are important in defining the historic character" of a property, whether for repair or replacement.

Historical Research. Primary historical research of the building was conducted. Newspaper articles from the period during the building's construction did not reveal anything of importance to the construction materials and methods.

Construction Documents. We reviewed the original construction drawings of the Civic Center in paper and digital formats. These drawings are not dated, however, planning for the Civic Center began in 1938 and ground was broken in 1939. The drawings reveal considerable detail about the structure of the building. The primary structure of the building is reinforced concrete. The exterior finish of the building is called out on the original drawings as "stone copings", "stone veneer" and "brick veneer". Unfortunately, while significant detail exists about the concrete structure of the building, there is no information or detailing of the attachment methods of the stone and brick veneers to the concrete structure. To our knowledge, no construction specifications exist for the original construction.



Sample of Original Blueprints

Reconnaissance. Several reconnaissance trips on and around the structure were conducted to get an overview of the problems visually noticeable and to determine the next steps of analysis.

Systematic Investigation. A detailed exterior surface investigation, sometimes called "surface mapping" was conducted with the use of a large boom lift. The fourfold purpose of this investigation was to observe the visible details of design and construction; develop questions related to evidence and possible alterations; note structural or environmental problems; and help develop plans for any further investigation. During this investigation notes were made on elevation drawings of the building and extensive photographs were taken.

Petrographic Examination. Following the systematic investigation and research, it was determined that a petrographic examination of the "stone veneer" panels needed to be conducted to quantify the extent and cause of panel damage. This petrographic examination will help determine whether the panels need maintenance, repair or replacement, and, if repair is possible what repair methods are appropriate. Petrographic examination, consisting of microscopic studies, is performed to determine air content, water-cement ratio, cement content, and general aggregate characteristics. Laboratory studies were also conducted to determine chloride content, identification of deleterious aggregates, and depth of carbonation. Petrographic examination was also conducted of the panel coating on the East building face.

Door Maintenance Technician Examination. Following the systematic investigation and research, it was also determined that additional information regarding the large main entrance doors in the East façade was needed. The services of a local door company technician were retained to investigate the door problems and solutions.

Reference Materials. An extensive array of reference materials were referred to during research. These mostly consisted of Standard, Guidelines, Case Studies and Preservation Briefs published by the U.S. Department of the Interior, National Park Service. Also referenced was the Fourth Edition, ***Technical Manual with Case Histories***, published by the Cast Stone Institute. Of the federal publications, the following have the most relevance to this project:

> **The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings.**
>
> **Preservation Brief #1: Assessing Cleaning and Water-Repellant Treatments for Historic Masonry Buildings.**
>
> **Preservation Brief #2: Repointing Mortar Joints in Historic Masonry Buildings.**
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> **Preservation Brief #15: Preservation of Historic Concrete.**
>
> **Preservation Brief #16: The Use of Substitute Materials on Historic Building Exteriors.**
>
> **Preservation Brief #35: Understanding Old Buildings the Process of Architectural Investigation.**
>
> **Preservation Brief #39: Holding the Line – Controlling Unwanted Moisture in Historic Buildings.**

Preservation Brief #42: The Maintenance, Repair and Replacement of Historic Cast Stone.

Montana State Historic Preservation Office (SHPO). Preliminary contact was made with Pete Brown, SHPO Historic Architecture Specialist, on November 8, 2010. He said he would support replacement of bad wall panels with cast stone or Glass Fiber Reinforced Concrete (GFRC). He fully supports the restoration of the exterior of the Civic Center.

ASSESSMENT OF CONDITIONS

Following is a summary of the findings of our investigations for each area of the building.

Roofing

Building roofing was excluded from the scope of work of the investigation. However, most of the roofing of the building is a single-ply membrane and not original to the building. All roofing materials have terminations that occur on the wall top cast stone.

Brick Veneer

The majority of the brick veneer on the building and the mortar joints are in very good condition. There are localized areas of brick veneer that have weathered mortar joints and there are areas where some structural displacement of the brick veneer has occurred causing slight displacement of the brickwork and diagonal cracking through the veneer faces. This problem has occurred primarily at building corners. Where it is possible to look at the interior side of the building structure in these areas of displacement and cracking there was no displacement nor cracking of the concrete structure noted. It does not appear that the brick displacement is caused by building structural movement.

Several factors could be the cause of these problem areas.

1. The brick veneer of the building was placed in very large expanses, particularly in the length of the walls. There were no expansion joints noted in any of the brick veneer wall expanses. It is very probable that with thermal and moisture expansion of the brick veneer that the only place for the brick to "give" is at the building corners where expansion caused displacement of the veneer and cracking occurred where the pressures were eventually relieved. Unrestrained sections of brickwork will expand vertically from their support and horizontally from the center of the wall towards the unrestrained corners.

   Estimating the combined movements in brickwork caused by expansion is expressed in the following formula (Technical Note #18, Brick Industry Association), where L is the length of the wall in inches:

   M_u(Unrestrained movement in inches) = (0.0005 + 0 +(0.000004 x 130))L
   Therefore M_u=0.00102L
   Evaluating the West wall of the stage fly loft, M_u=0.00102(984) = 1.004 inches of total expansion for this wall.

   For this same wall, the maximum theoretical spacing between expansion joints in a straight wall with 1/2 inch expansion joints can be estimated by the formula (Technical Note #18A, Brick Industry Association) S_e=(0.5in)(50)/0.00102x100 = 245 inches = 20' – 5" on center spacing of expansion joints. This particular wall is 82 feet long and has no expansion joints.

Additionally, there are errors in the recommended proper placement of expansion joints such as: at or near corners, at offsets and setbacks, at wall intersections, and at changes in wall heights.

There seems to be compounding errors in the lack of expansion joints and proper placement of expansion joints that has caused displacement and cracking of the brick veneer at virtually all unrestrained building corners.

Displaced Brick Corners

2. It is possible that these brick problem areas could have been caused by the migration of water behind the veneer, freezing, expanding and displacing the brick. When confined water freezes, it expands with pressures in the order of 15,000psi. It is not very probable that this is the cause since the problems occur only at building corners and there were no flashing problems noted that could account for the quantity of water it would take to cause this brick displacement and cracking.
3. The problem could also be the result of structural settlement of the building structure, but it is not possible to make this determination without extensive destructive examination.

The brick veneer on the East Façade has “pinkish” staining on it caused by migration of whatever coating was applied to the “stone veneer”. This coating was applied only to the East Façade of the building and thus the staining of the brick veneer occurs only on the East Façade. Petrographic examination of the coating indicates it is pigment.

Pink Staining on East Façade

On March 11, 2011 I observed the cutout of brick veneer and concrete structure that was being performed for some mechanical work. The brick veneer has ties to the existing concrete, but the on center spacing appears to be much greater than would be done today. One vertical row of ties was cut through, the opening was 33” wide past the ties and another row of ties was not encountered. We salvaged several sections of the removed brickwork in case these are needed during the design phase for testing or matching.

Cast Stone Veneer

The original construction drawings refer to the large areas of flat panels and ornamentation as “stone veneer” and “stone coping”, etc. These area have the appearance of limestone with a vertically, finely ridged surface. Upon further examination in areas of displaced cracking it was determined that these panels are not stone but instead are a cast concrete product commonly referred to as “cast stone”. It is not known whether it was always intended that the panel material be cast stone or whether the change from natural stone to cast stone was made during construction of the building due to stone supply issues or for economical savings.

Brief History of Cast Stone. Cast stone is just one name given to various concrete mixtures that employed molded shapes, decorative aggregates, and masonry pigments to simulate natural stone. Other common names of proprietary systems were Coignant Stone, Frear Stone and Ransome Stone. Usually, the castings were reinforced with mild steel reinforcing bars. The basic mixtures included water, sand, coarse aggregate, and cementing agents. Natural cements, portland cements, oxychloride cements, and sodium silicate based cements were all used as binding agents. Having gained popularity in the United States in the 1860s, cast stone had become widely accepted as an economical substitute for natural stone by the early decades of the 20th century. Two basic cast stone production systems were “dry tamp” and “wet cast”. The dry tamp process employed a stiff, low slump concrete mix that was pressed and compacted into molds. A decorative aggregate mix was frequently distributed only on the exterior facing of the cast units while the cores of the units were common concrete. The wet cast process used a much more plastic concrete mix that could be poured and vibrated into the molds. Because of this method of fabrication, wet cast products necessarily distributed their decorative aggregate mix through the entire unit, rather than simply an outer facing. The best historic cast stone can rival natural stone in longevity. Like any other building material, however, cast stone is subject to deterioration, which may occur in several ways:

- Separation of the facing and core layers
- Deterioration of the aggregate (uncommon)
- Deterioration or erosion of the cementing matrix
- Deterioration of the iron or steel reinforcement (rusting)
- Deterioration of cramps and anchors used in its installation

Due to the nature of the panels on the Civic Center, it is most likely that they were cast by the “dry tamp” method.

Investigation of the cast stone veneer revealed large expanses of panels with major cracking and major expanses of panels with “spider web”, very fine cracking visible on the surface. A couple loose pieces that had broken off some panels indicate the reinforcing bars in those two cases to be 1.25 inches below the exterior surface of the panel. This distance from the surface is generally considered to be too close and rusting of the reinforcement will cause spalling or cracking of the panel. Note that the reinforcing bar in the sample submitted for petrographic examination was 2.125 inches from the surface, which is an acceptable distance. It is clear that those panels with open cracks are severely damaged with severe deterioration caused by the rusting of the steel reinforcement. However, a petrographic examination was ordered to determine the serviceability of panels that do not have major open cracks. It was not apparent whether these panels were experiencing rebar corrosion or just a cosmetic damage.




Various Degrees of Cast Stone Deterioration

Spalling Panel Face

Fine Cracking

Petrographic Examination. A 4 inch diameter core was extracted from one of the cast stone panels above the Convention Center, on the West Wall of the stage fly loft wall. The core was just over 4 inches in length and the distance from the face of the panel to the concrete structure behind the core is 5.5 inches. A stereoscopic and petrographic examination using a polarized-light microscope was conducted by Material Scientists – Wiss, Janney, Elstner Associates, Inc., Northbrook, Illinois. Their report is attached as **Exhibit A**. The conclusion of their report is that several cracks radiate in different directions from the location of a corroded rebar. Two major causes for the corrosion are: 1) carbonation of the cement paste that extends virtually full depth of the concrete and 2) high chloride levels that are two to more than four times the typical corrosion threshold of uncoated reinforcing in concrete. They suspect that chloride was likely added to the concrete mix when it was originally cast to accelerate the setting. They say that corrosion of the embedded rebar is expected to continue because of the carbonation and the chloride content and that panel deterioration appears to be past what is practical to affect a lasting repair of the panels.

Panel Where Petrographic Sample Was Taken

There are bands of ornately carved or cast “stones”. All of these ornate stones appear to be in very good condition, with the exception of one which has a crack through it. It is not known whether these are actually stone or if they also are cast stones.

Ornately Carved Stone

Joints between cast stone panels were noted to be caulked joints. Upon further examination it was determined that these joints are actually mortar joints and that at some point in time a caulking material was placed directly over the top of the mortar joints. This may have been in response to noticing panel cracking and suspecting water was entering the panels at the joints.

Caulking Over the Top of Mortar Joint

The large, round, fluted "stone" columns on the East Façade are in good condition with weathered mortar joints.

Fluted Columns on East Façade

The East Façade of the building has a "pinkish" tint to it. Upon close examination it could be seen that perhaps a coating had been applied at some time in the past. This coating was scraped off and sent in for petrographic examination. The examination determined the material is pigment. So, at some time in the past a paint type product was applied only to the East Façade. The reason for the application of this coating is unknown.

Cast Panels with Pinkish Tint
Highlighted by the Area Where the Marque Sign Was Removed

Window lintels. Many of the cast stone window lintels have a steel plate under them and many do not. Most of the lintels are cracking, some severely.

Examples of Cracked Lintels

The base of the East Façade and South Façade has what looks like granite veneer. It is presumed this is also cast stone veneer. However, due to the surface pattern it is difficult to see if there is any surface cracking or crazing.

"Granite" Cast Stone Panels

Windows

The majority of the windows throughout the building have been replaced with modern, anodized aluminum windows. No concerns with the windows was brought to our attention.

Doors

The majority of the exterior doors throughout the building have been replaced with modern, anodized aluminum doors. No concerns with these doors was brought to our attention.

The original, large, main entry doors on the East Façade are dragging on the concrete stoop at times. It was brought to our attention that this seemed to show up right after the front steps were replaced, including the stoops. A local door technician has looked at these doors for us and reported that parts are no longer available for the pivot operators used on them, nor could they be replaced with modern pivots. He said the best that can be done to keep these historic doors in place is to adjust and repair them as necessary. Perhaps grinding down the concrete stoops slightly would provide more clearance at the door bottom and the dragging would not be an issue as often.

Light Fixtures

It appears that all of the light fixtures on the exterior walls are original. Several of them have broken hinges or other broken parts. It seems that they are continually breaking due to the age of the fixtures.

Ladders

There are several ladders between various roof levels on the building exterior. These fixed ladders are regulated by OSHA 3124-12R 2003. The exterior ladders do not comply with these OSHA requirements. All roof levels have access to the roofs via interior ladders, so all of the exterior ladders could be removed and access to all roof levels would still be maintained. We did not investigate the interior ladders for OSHA compliance.

Roof Ladder

RECOMMENDATIONS

General Recommendations

1. Perform all restoration work in strict compliance with Section 106 of the Historic Preservation Act and The Secretary of the Interior's Standards for the Treatment of Historic Properties, 36CFR68.
2. Submit preliminary and final design drawings to the local Historic Preservation Advisory Commission (HPAC) and the State Historic Preservation Office (SHPO) with the objective of receiving a "No Adverse Affect" determination on the restoration design.

Brick Veneer Restoration Recommendations

1. It is recommended that if full restoration is delayed that all cracks in the existing brickwork be caulked to prevent infiltration of water into and behind the brickwork. This is a stop gap measure and will not solve the problem of walls not having expansion joints, it will serve to prevent freeze/thaw damage to the existing brickwork.
2. On March 8, 2011 we salvaged several sections of brick veneer that were cutout of the wall for some mechanical work being done. These are available for use during the design phase for testing, matching, etc.
3. Repoint wall areas with weathered mortar joints.
4. Carefully dismantle brickwork at wall corners where cracking and dislocation has occurred. Salvage and clean the brick. Reconstruct wall corners using salvaged brick. This will also give us an opportunity to inspect the area for cause of brick movement other than the suspected expansion.
5. Saw cut into the brickwork vertical expansion joints at a determined spacing and at other recommended locations in the brickwork. This will change the appearance of the building very slightly due to the addition of these vertical lines each 25 feet, but they will be caulked in a color to closely match the brick. Installing these joints will solve the problems created by not having the expansion joints.
6. Clean all brickwork with mild cleaning process, in particular to remove pink staining on the East Façade and accumulated dirt and staining on all other brick areas.

Stone Veneer Restoration Recommendations

1. It is recommended that if full restoration is delayed that all cracks in the existing cast stone work be caulked to prevent infiltration of water into and behind the cast stone. This is a stop gap measure only and will not prevent further deterioration of the existing cast stone materials, it will only serve to prevent infiltration of water behind the panels and to prevent freeze/thaw damage to the existing cast stone work.
2. The laboratory testing of the cast stone on the Civic Center indicates that the deterioration of the cast stone is past what is practical to affect a lasting repair of the existing cast stone. Deterioration of the interior steel rebar cannot be stopped and therefore deterioration of the existing stone will continue over time.
3. REMOVE ALL cast stone veneer, cast lintels, cast stone copings, etc. and replace with modern cast stone to exactly match the existing cast stone panels and shapes. It is recommended that all lintels have painted, galvanized steel lintels installed underneath them. Repair/replacement of roof flashings will be required on all parapet walls in order to accomplish this work. It is recommended that the following items not be replaced: ornamental course, large slabs above entry doors, large fluted columns on the East Façade, stone window sills, and "granite" panels.
4. Glass Fiber Reinforced Concrete (GFRC) panels were considered as an alternative, but they can only be used in non-load bearing conditions (we have load bearing conditions

on this building) and the long term durability of GFRC is still untested. We do not recommend using GFRC panels.

5. Provide appropriate expansion joints in the replacement construction.
6. Since no details exist of the installation, thicknesses, etc. of the existing cast stone materials, some destructive examinations will be necessary to determine the details of the new cast stones and new attachment details will need to be developed.
7. Selective replacement of existing cast stone panels is not considered feasible. The only selection would be to replace all cast stone work on a single wall at a time.
8. Clean all new and remaining cast stone, including the large columns on the East Facade with mild cleaning process, in particular to remove pink staining on the East Façade and accumulated dirt and staining on all other areas, including construction residue.

Windows Restoration Recommendations

1. Remove perimeter window frame caulking, clean joints and provide new caulked joints.

Doors Restoration Recommendations

1. Remove perimeter door frame caulking, clean joints and provide new caulked joints.
2. Adjustment and repair of the original main entry doors on the East Façade will be an ongoing maintenance issue for the City of Great Falls. Consider grinding down the concrete stoops to allow more clearance at the bottom of the doors.

Light Fixtures Restoration Recommendations

1. We recommend that all exterior light fixtures be removed and get sent in for refurbishment. There are several companies that specialize in this type of work and with some detail provided to them could actually bid this work. Refurbishment also provides the opportunity to lamp the fixtures with modern, high-efficiency, long-life lamps.

Exterior Roof Ladders Restoration Recommendations

1. Remove all exterior roof ladders as they do not comply with current OSHA requirements.
2. Consider evaluating interior ladders for compliance with OSHA recommendations and upgrade these interior ladders if necessary to bring into compliance. Evaluation of interior ladders is beyond the scope of this contract.

COST ESTIMATE SUMMARY

ENTIRE PROJECT:

Our estimate of probable construction cost is **$3,510,457** including a contingency and Architectural and Engineering fees. This estimate includes the refurbishment of the exterior lights which is itemized below. The detailed construction estimate is attached as **Exhibit B**. This estimate is for a 2011 construction season start. Over a 20 year average construction costs have increased 4.64% per year. So, you can figure inflation of at least 5% per year that construction is delayed.

PHASED CONSTRUCTION:

It is possible to break the construction into phases if the entire project cannot be funded at one time. We have identified 4 phases with the following 2011 estimates of probably construction cost. The total of the following 4 phases exceeds the cost estimate above due to the added costs associated with the smaller phases. This list is in the order of priority due to the varying degrees of deterioration. The architectural and engineering services are spread out through the phases, but the entire design could be completed up front as a phase one. Light Fixture refurbishment for $41,500 would be a fifth phase that could be done at any time.

Fly Loft all 4 Sides	$513,370
Auditorium Walls (Except East Wall)	$1,267,415
East Façade	$1,179,851
Lower Walls, South/West/North	$1,028,666
Total of 4 Phases	**$3,989,302**

CAULKING ONLY:

If it is not possible to proceed with any construction prior to the fall of 2011, caulking of large cracks in the cast panels should be performed as recommended. It would be very difficult to identify this work in design drawings, therefore, it would be recommended that the work is performed on a time and material basis and the Architect direct the work scope on site.

Caulking	$13,000
Architect	$1,300
Total	**$14,300**

LIGHT FIXTURE REFURBISHMENT ONLY:

We received a rough quote from Crenshaw Lighting to refurbish all twenty of the exterior light fixtures. This company's information is:

Crenshaw Lighting
592 Paradise Lane
Floyd, VA 24091-2940
T(540) 745-3900
F(540) 745-3911
sales@crenshawlighting.com

Remove/Reinstall Lights, local contractor	$2,200
Packaging and Shipping	$800
Architect	$3,500
Refurbishment with contingency, O&P	$35,000
Total	**$41,500**

Exhibit A - Civic Center Exterior Walls, Laboratory Studies of Precast Concrete

1392 13th Avenue SW
Great Falls, MT 59404

A Terracon COMPANY

Telephone. (406) 453-5400
Fax. (406) 761-6655

March 8, 2011

Hessler Architects
12 Sixth Street South
Great Falls, MT 59405

Attention: Marv Hessler

Subject: Coring/Petrographic Analysis
Civic Center Precast Panels
Great Falls, Montana
NTL/Terracon Project No. C4101200

Dear Marv:

At your request, we removed a single core from an exterior wall precast concrete panel at the Great Falls Civic Center for petrographic analysis.

The exterior facing panels date from the 1930's and the panels are now exhibiting moderate to severe cracking apparently associated with reinforcing steel corrosion. The severely corroded/cracked panels have been slated for replacement. Many of the panels exhibiting less severe cracking were being considered for continued service. The petrographic investigation was to evaluate a selected panel (representing those panels exhibiting moderate cracking) to help assess the viability of keeping selected panels in service. The core we obtained was sent to our sub consultant laboratory, Wiss, Janney, Elstner of Northbrook, Illinois (WJE), for petrographic analysis and chloride testing. Carbonation of the concrete was evaluated, along with any indication of chloride induced corrosion. Also, the pink colored material deposited on the surface was observed by the petrographic laboratory.

The WJE Report of Petrographic Analysis is attached. In summary, the report concludes that observed cracking is indeed due to corrosion of the embedded reinforcing steel. The primary causes of the corrosion are 1) Carbonation of the cement paste commonly associated with concrete after many decades of service under moderate internal relative humidity and 2) High chloride level in the cement paste likely associated with a chemical accelerating admixture used to speed the rate of set for the concrete substrate and the face mix.

Since the innate characteristics of the cement paste create the primary causes of reinforcing steel corrosion and attendant cracking, the observed deterioration is expected to continue. Further, a sealing approach to mitigate on going reinforcing steel corrosion and concrete cracking will not be effective. Therefore, panel replacement will ultimately be required even for those panels only moderately impacted at present.

Please call if you have questions or if we can be of further assistance.

Sincerely,

Kenneth D. Munski, P.E.
Senior Materials Engineer

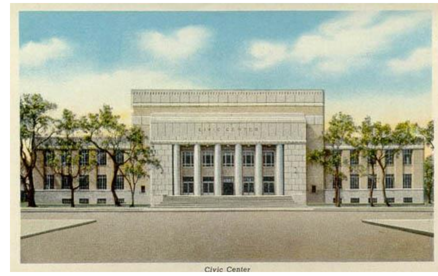
KDM/ep
Attachment

Wiss, Janney, Elstner Associates, Inc.
330 Pfingsten Road
Northbrook, Illinois 60062
847.272.7400 tel | 847.291.5189 fax
www.wje.com

Via Email: Munski, Ken D. <kdmunski@terracon.com>

February 17, 2011

Mr. Kenneth Munski
Terracon Consultants, Inc.
1392 13th Avenue SW
Great Falls, MT 59404



Civic Center depicted in 1930's, Great Falls MT
http://usgwarchives.net/mt/cascade/postcards/ppcs-cascade.html

Civic Center in recent years, Great Falls MT
http://www.panoramio.com/photo/2410015

Re: Civic Center Exterior Walls
Laboratory Studies of Precast Concrete
WJE No. 2011.0563

Dear Mr. Munski:

We have completed the laboratory studies of the concrete core and the deposit sample that you submitted to our laboratory for the Civic Center in Great Falls, Montana. The concrete core was examined petrographically and was tested chemically in two locations for chloride contents. The deposit sample was examined petrographically for components. The core is reported to represent the exterior facing panel of the Civic Center constructed in 1930's (pictured above). The laboratory studies were requested to determine the composition and characteristics of the concrete, and to evaluate its current condition and project its future performance.

Sections of the building show large cracks in the precast concrete panels caused by corrosion of the embedded reinforcing steel. Photographs you provided to us are shown in Figures 1 and 2 show some of this distress. Other areas of the building only show fine surface cracking, as shown in Figure 3, and appear in better condition. The core provided reportedly represents this better condition and the intent of this analysis is to help assess the need to replace all panels or if some panels can be repaired.

The petrographic examination was performed using methods of ASTM C856, *Standard Practice for Petrographic Examination of Hardened Concrete.*" The procedure is also applicable to other construction materials and mineral deposits. The examination was performed using stereoscopic and petrographic microscopes at magnifications ranging from 10x to 600x. Powder mounts were employed in the examination using the polarized-light microscope.

Concrete Core

The core is 4 inches long and its diameter is also 4 inches. The exposed surface of the core was formed against a finely ridged surface, and the inner surface is roughly screeded and not well densified. The outer 1/4 to 1/2 inch of the core consists of white, face mortar, and the remainder of the core consists of gray, backup concrete. The white layer is well bonded to the backup concrete. Both, mortar and concrete contain abundant, coarse size air voids that are typical of dry cast products. The air voids are common around aggregate particles, and are often interconnected.

A 3/8-inch-diameter reinforcing bar is embedded 2-1/8 from the exposed surface of the core. The surfaces of the rebar exhibit significant corrosion. Cracks radiate in all directions from the location of the rebar. The cracks appear to be caused by corrosion of the embedded reinforcing bar. The concrete is not well densified within 1 inch of the inner surface of the core. A few cracks were detected within this 1 inch zone. The cracks in this zone usually follow the areas of abundant air voids related to incomplete consolidation. There is no evidence of cracking related to any deleterious chemical reactions within the concrete or paste. (Figures 4 through 8)

Face Concrete Mix - The white facing layer is made with manufactured siliceous and calcareous sand containing quartz, limestone, and trace amounts of mica and slag. No pigment was found in the face mix. There is no indication of any problems related to the aggregate. The cement paste is white, generally hard, firm, and dense. White Portland cement was used in the mix. The water-cement ratio appears low, and it is estimated at 0.35 ± 0.03. Residual (mostly unhydrated) cement particles are frequent, and the relict (mostly hydrated) cement particles are infrequent. The paste is carbonated full depth of the face mix. Simplified, carbonation occurs due to long-term diffusion of carbon dioxide in the air into the concrete, resulting in a decrease in the pH of the concrete due to its reaction with the calcium hydroxide.

Backup Concrete Mix - The gray base concrete is made with siliceous gravel coarse aggregate having maximum nominal size of 3/8 inch. Present with the coarse aggregate are siliceous volcanic rocks and siliceous and calcareous metamorphic rocks. The particles are hard, firm, dense, rounded, and equant to elongate. Fine aggregate is natural siliceous and calcareous sand composed of the same types of rock types as those observed within the coarse aggregate and small amounts of quartz. The aggregates are uniformly distributed within the concrete. There is no evidence of any durability problems related to the aggregates.

The cement paste is generally gray, but varies from light to dark between different areas of the core. The paste is generally hard, except for lighter color areas where it is somewhat soft. The water-cement ratio appears low to moderately low, and is estimated to range from 0.30 to 0.40. The higher water-cement ratio paste is found in the light color paste in the outer half of the core. The lower water-cement ratio is prevalent in the inner half of the core. The cement paste is often scarce in the inner region of the core. The paste is fully carbonated within 3/4 inch of the outer and inner surfaces of the backup concrete and partially carbonated in the middle section of the core. Because of the great extent of the carbonation, any embedded steel is no longer protected by the concrete from possible corrosion.

Chloride Contents - The backup mix of the concrete core was analyzed chemically for acid-soluble chloride. The analyses were performed essentially according to ASTM C 1152, *Method for Acid-Soluble Chloride in Mortar and Concrete*. The results are listed in the Table below. Studies have shown that chloride contents above 0.02 to 0.03 percent by mass of concrete, depending on the cement content, can promote corrosion of embedded steel in non-carbonated concrete. Levels below this threshold can accelerate corrosion in carbonated concrete. Both chloride contents are above this threshold level and, in the presence of sufficient moisture and oxygen, may promote the corrosion of steel in the concrete.

Table—Chloride Contents

Sample	Acid-Soluble Chloride, percent by mass of sample
Below Face Mix (1/2 to 1 inch from exposed surface of core)	0.090
At Rebar Level (2 to 2-1/2" from exposed surface of core)	0.048

Deposit Sample

Received along with the core was a small zip lock bag labeled "Civic Center, Coating on some of the Panels" weighing approximately 9 grams. The bag contained reddish brown fines and small amounts of sand particles. The petrographic examination of the fines revealed that the major constituent of the fines are abundant particles of pigment; minor components are calcite and quartz. A cursory test for the presence of polymer was negative. The pigment appears to represent an inorganic paint or a color staining.

Discussion

The cracking in the panels is a result of corrosion of the embedded reinforcing steel. Regular carbon steel reinforcing bars (black bars) are passive in normal portland cement concrete because the concrete provides a desirable high pH (~13) medium and also acts as a physical barrier isolating the steel from the environment. However, black reinforcing bars are vulnerable to corrosion when the high pH of the concrete at the steel depth is lost or when chloride ions are present. Chloride from sea water or road deicers is known to penetrate the concrete cover and cause aggressive corrosion of the embedded reinforcing. Calcium chloride based chemical admixtures were added to reinforced concrete prior to the 1950's as a setting time accelerator. This practice was mostly stopped when it was found that this admixture would cause corrosion of the embedded reinforcing. Chloride contamination causes corrosion because steel is active after a threshold concentration of chloride (often called chloride threshold, C_T) is reached. Though varied from case to case, the C_T of black bars is low and typically about 0.03% by weight (1.2 lb/yd^3). The concrete sample examined contained chloride above this threshold value so the corrosion is likely chloride induced. While the near surface had slightly higher chloride than the center of the sample, it is likely that the chloride was admixed into the concrete as a set accelerator when the panels were built, possibly with more chloride added to the face mix than to the backup mix.

The typical causes of embedded steel corrosion are either chloride contamination or concrete carbonation, or both. Carbon dioxide in the air slowly penetrates the concrete and this carbonation results in loss of the favored high pH. The black bars will then corrode in the low pH concrete environment; however, this corrosion is typically at a much slower rate than chloride induced corrosion. Carbonation is a process which highly depends on the concrete moisture condition. The most favorable condition for the diffusion of carbon dioxide into concrete (carbonation) is when the concrete has a moderate internal relative humidity. Water filled pores in wet, saturated concrete (relative humidity near 100%) restrict gaseous carbonate dioxide, slowing carbonation. Cracks that expose the steel reinforcement directly to water and oxygen may pose an increased risk for corrosion of the embedded steel bars. Such cracks allow oxygen and carbon dioxide access to the steel and can result in corrosion. The lack of complete consolidation of the back face likely increased the carbonation rate and reduced concrete passivation of the embedded steel. A combination of chloride contamination and concrete carbonation has resulted in corrosion of the embedded reinforcing steel.

Conclusions

Our laboratory studies of a single concrete core indicate that the cracking present within the core is due to corrosion of the embedded reinforcing bar. Several cracks radiate in different directions from the location of the corroded rebar. There are two major causes for the corrosion; (1) carbonation of the cement paste that extends virtually full depth of the concrete, and (2) high chloride levels that are two to more than four times the typical corrosion threshold for uncoated reinforcing in concrete. A source of chloride is likely the addition of chemical admixtures to the concrete to accelerate the setting of the concrete and face mix. Drift of chlorides from deicing salts spread on the streets and sidewalks in winter could also contribute to the chloride. Additional sampling and testing could determine the source of the chloride contamination. Corrosion of the embedded steel is expected to continue because the concrete paste is carbonated and the chloride contents are well above the corrosion threshold level. Surface sealing the panels is not likely to extend their service life significantly since the carbonation and chloride is within the concrete and in contact with the reinforcing. Assuming that this core sample is representative of the moderately deteriorated panels, this panel deterioration appears to be past what is practical to affect a lasting repair of the panels.

Sincerely,

WISS, JANNEY, ELSTNER ASSOCIATES, INC.

Lidia Uznanski
Senior Associate, Petrographer

Paul D Krauss

Paul D. Krauss, P.E.
Project Manager

Storage: Thirty days after completion of our studies, the samples will be discarded unless the client submits a written request for their return. Shipping and handling fees will be assessed for any samples returned to the client. Any hazardous materials that may have been submitted for study will be returned to the client and shipping and handling fees will apply. The client may request that WJE retain samples in storage in our warehouse. In that case, a yearly storage fee will apply.

Figure 1. View of cracking on upper part of Civic Center (NTL).

Figure 2. View of cracking caused by corrosion of embedded reinforcing steel (NTL).

Figure 3. View of the fine cracks on panels that are currently in good condition (NTL).

Figure 4. Side view of the core. Cracks radiate from the corroded reinforcing bar. One fine crack to the surface is outlined in red. The irregular cracks in the photo located to the right of the (encircled) rebar and oriented parallel to the inner surface coincide with abundant air voids that are typical of dry cast concrete.

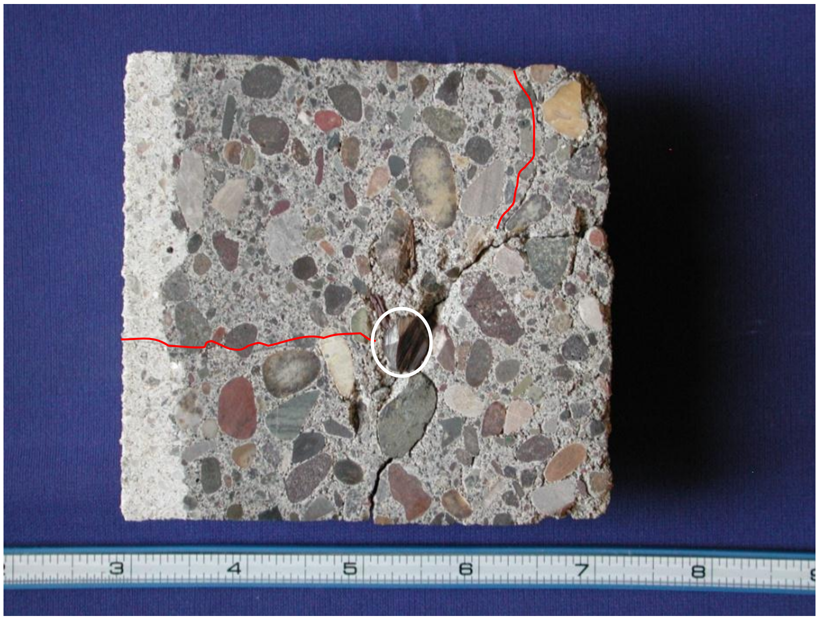


Figure 5. Lapped section of the core. Cracks radiate in all directions from the corroded reinforcing bar (encircled). The finer cracks are outlined in red.

Figure 6. View of the finely ridged, exposed surface of the face mix.

Figure 7. View of the inner, poorly densified surface of the backup concrete.

Figure 8. Section of the corroded reinforcing bar.

Exhibit B - Detailed Estimate of Probable Construction Cost

Qty	Craft@Hours	Unit	Material	Labor	Equipment	Total

Civic Center Exterior Restoration
Great Falls, Montana
Estimate: March 3, 2011 Design Stage: Investigative Design
Hessler Architects, 12 6th ST S, Great Falls, MT 59401 (406)727-2757

Qty	Craft@Hours	Unit	Material	Labor	Equipment	Total
Permits, licenses & fees						
Permit, first $1million						
Per Unit:	99@.0000	L.S.	14,227.50	0.00	0.00	14,227.50
1.00	99@.0000	L.S.	14,227.50	0.00	0.00	14,227.50
Office trailer, rentals						
Office trailer, 8' x 20', rental						
Per Unit:	99@.0000	MO	293.11	0.00	0.00	293.11
12.00	99@.0000	MO	3,517.29	0.00	0.00	3,517.29
Temporary Fencing						
Per Unit:	--@.0000	L.F.	4.73	2.88	0.00	7.60
1800.00	--@.0000	L.F.	8,505.00	5,178.60	0.00	13,683.60
Safety nets, nylon, 4" mesh, rectangular						
Per Unit:	99@.0000	SFSA	13.07	0.00	0.00	13.07
2000.00	99@.0000	SFSA	26,145.00	0.00	0.00	26,145.00
Scaffold, Erection and Takedown - East tall wall and all auditorium fly loft walls only						
Per Unit:	99@.0000	JOB	0.00	94,500.00	0.00	94,500.00
1.00	99@.0000	JOB	0.00	94,500.00	0.00	94,500.00
Scaffolding Rental - quote $16,000/month						
Per Unit:	99@.0000	MO	16,800.00	0.00	0.00	16,800.00
8.00	99@.0000	MO	134,400.00	0.00	0.00	134,400.00
Clean up, progressive						
Per Unit:	27@.0000	JSF	0.00	0.00	0.00	0.31
50000.00	27@.0000	JSF	0.00	0.00	0.00	15,500.00
Clean up, final						
Per Unit:	28@.0000	JSF	0.00	0.00	0.00	0.23
50000.00	28@.0000	JSF	0.00	0.00	0.00	11,500.00
Clean up, glass, SF of glass						
Per Unit:	29@.0000	SF	0.00	0.00	0.00	0.35
8120.00	29@.0000	SF	0.00	0.00	0.00	2,842.00
Debris boxes, 36 CY						
Per Unit:	99@.0000	LOAD	475.39	0.00	0.00	475.39
16.00	99@.0000	LOAD	7,606.20	0.00	0.00	7,606.20

Qty	Craft@Hours	Unit	Material	Labor	Equipment	Total
Office expense, general						
Per Unit:	99@.0000	JSF	0.09	0.00	0.00	0.09
50000.00	99@.0000	JSF	4,725.00	0.00	0.00	4,725.00
Superintendent						
Per Unit:	--@.0000	MO	0.00	7,428.75	0.00	7,428.75
9.00	--@.0000	MO	0.00	66,858.75	0.00	66,858.75
Small tools						
Per Unit:	99@.0000	JSF	0.08	0.00	0.00	0.08
50000.00	99@.0000	JSF	4,200.00	0.00	0.00	4,200.00
Consumable supplies						
Per Unit:	99@.0000	JSF	0.08	0.00	0.00	0.08
50000.00	99@.0000	JSF	4,200.00	0.00	0.00	4,200.00
Materials Testing						
Per Unit:	--@.0000	LS	0.00	0.00	0.00	5,000.00
1.00	--@.0000	LS	0.00	0.00	0.00	5,000.00
Demolition of Brick and Cast Stone						
Brick Demolition includes cleaning brick for reuse						
Per Unit:	--@.0000	SF	0.00	9.03	1.41	10.44
2604.00	--@.0000	SF	0.00	23,514.12	3,663.83	27,177.95
Cast Stone Demolition						
Per Unit:	--@.0000	CF	0.00	4.81	1.41	6.22
5509.00	--@.0000	CF	0.00	26,492.78	7,751.16	34,243.94
Forklift Rental - 45' Lift						
Per Unit:	--@.0000	MO	0.00	0.00	1,890.00	1,890.00
12.00	--@.0000	MO	0.00	0.00	22,680.00	22,680.00
Crane Rental with operator 1/2 time						
Per Unit:	--@.0000	MO	0.00	3,713.85	4,200.00	7,913.85
6.00	--@.0000	MO	0.00	22,283.10	25,200.00	47,483.10
Concrete sawing						
Sawing concrete wall, 8"						
Per Unit:	21@.3900	LF	5.59	24.54	0.00	30.12
632.00	21@246.4	LF	3,530.35	15,508.33	0.00	19,038.68
Demolition accessories						
Dump charges, concrete, high						
Per Unit:	99@.0000	CY	56.30	0.00	0.00	56.30

Qty	Craft@Hours	Unit	Material	Labor	Equipment	Total
475.00	99@.0000	CY	26,742.98	0.00	0.00	26,742.98
Brick veneer						
Veneer, face brick, select modular						
Per Unit:	39@.1300	SF	7.25	10.59	0.00	17.84
2604.00	39@338.5	SF	18,865.98	27,588.08	0.00	46,454.06
WALLS OVER ONE STORY 10%						
Per Unit:	--@.0000	--	0.00	0.00	0.00	4,645.00
1.00	--@.0000	--	0.00	0.00	0.00	4,645.00
MODULAR BRICK 15%						
Per Unit:	--@.0000	--	0.00	0.00	0.00	7,664.00
1.00	--@.0000	--	0.00	0.00	0.00	7,664.00
Masonry and stone specialties						
Stone, custom Cast Stone 4" thick						
Per Unit:	46@.6160	CF	63.00	47.24	15.23	125.46
5624.00	46@3464.	CF	354,312.00	265,674.95	85,625.40	705,612.35
Add for Lintel Work						
Per Unit:	39@.8760	CF	0.00	71.38	22.57	93.95
504.00	39@441.5	CF	0.00	35,975.02	11,377.80	47,352.82
Temporary Waterstops						
Per Unit:	--@.0000	L.F.	2.71	1.89	0.00	4.60
1626.00	--@.0000	L.F.	4,404.83	3,073.14	0.00	7,477.97
Masonry wall ties & reinforcing						
Masonry reinforced, truss, 6" wide						
Per Unit:	39@.0000	LF	0.73	0.00	0.00	0.73
651.00	39@.0000	LF	478.49	0.00	0.00	478.49
Masonry wall finishes						
Masonry, steam clean						
Per Unit:	39@.0200	SF	0.36	1.63	0.00	1.98
48900.00	39@978.0	SF	17,457.30	79,584.75	0.00	97,042.05
Mask Windows for cleaning						
Per Unit:	--@.0000	SF	0.05	0.36	0.00	0.41
8120.00	--@.0000	SF	426.30	2,898.84	0.00	3,325.14
Masonry pointing and waterproofing						
Masonry repointing, brick						
Per Unit:	39@.0560	SF	0.56	4.57	0.00	5.12
13659.00	39@764.9	SF	7,601.23	62,387.48	0.00	69,988.72

Qty	Craft@Hours	Unit	Material	Labor	Equipment	Total
Iron, miscellaneous						
Expansion bolt, 1/2" & Panel Mounting Plates						
Per Unit:	34@.1800	Ea	4.65	16.18	0.00	20.83
2352.00	34@423.3	Ea	10,940.33	38,056.54	0.00	48,996.86
Steel Lintels						
Per Unit:	--@.0000	L.F.	0.00	0.00	0.00	8.90
504.00	--@.0000	L.F.	0.00	0.00	0.00	4,485.60
Add for galvanizing						
Per Unit:	99@.0000	#	1.62	0.00	0.00	1.62
1008.00	99@.0000	#	1,629.94	0.00	0.00	1,629.94
Plastic roofing						
Roof, elastomeric membrane, 1/16"						
Per Unit:	41@3.640	SQ	234.09	301.98	0.00	536.07
50.00	41@182.0	SQ	11,704.35	15,099.00	0.00	26,803.35
Roofing, sheet metal, custom fabricated						
Roof flashing miscellaneous						
Sheet metal, fabricated, pre-finished color						
Per Unit:	42@.0900	L.F.	18.90	7.14	0.00	26.04
1626.00	42@146.3	L.F.	30,731.40	11,609.64	0.00	42,341.04
Clean out existing window caulking for recaulking						
Per Unit:	--@.0000	LF	0.00	1.89	0.00	1.89
5278.00	--@.0000	LF	0.00	9,975.42	0.00	9,975.42
Caulking, gun grade						
Caulk, elastomeric, for concrete						
Per Unit:	03@.0200	LF	2.71	1.89	0.00	4.60
5980.00	03@119.6	LF	16,199.82	11,302.20	0.00	27,502.02
Backing rods						
Backing rod, polyethylene, 1/2"						
Per Unit:	03@.0200	LF	0.25	1.89	0.00	2.14
702.00	03@14.04	LF	176.90	1,326.78	0.00	1,503.68
Architecture and Engineering Fees, 640hrs Full-Time Inspection During Reconstruction						
Per Unit:	--@.0000	--	0.00	0.00	0.00	377,370.00
1.00	--@.0000	--	0.00	0.00	0.00	377,370.00

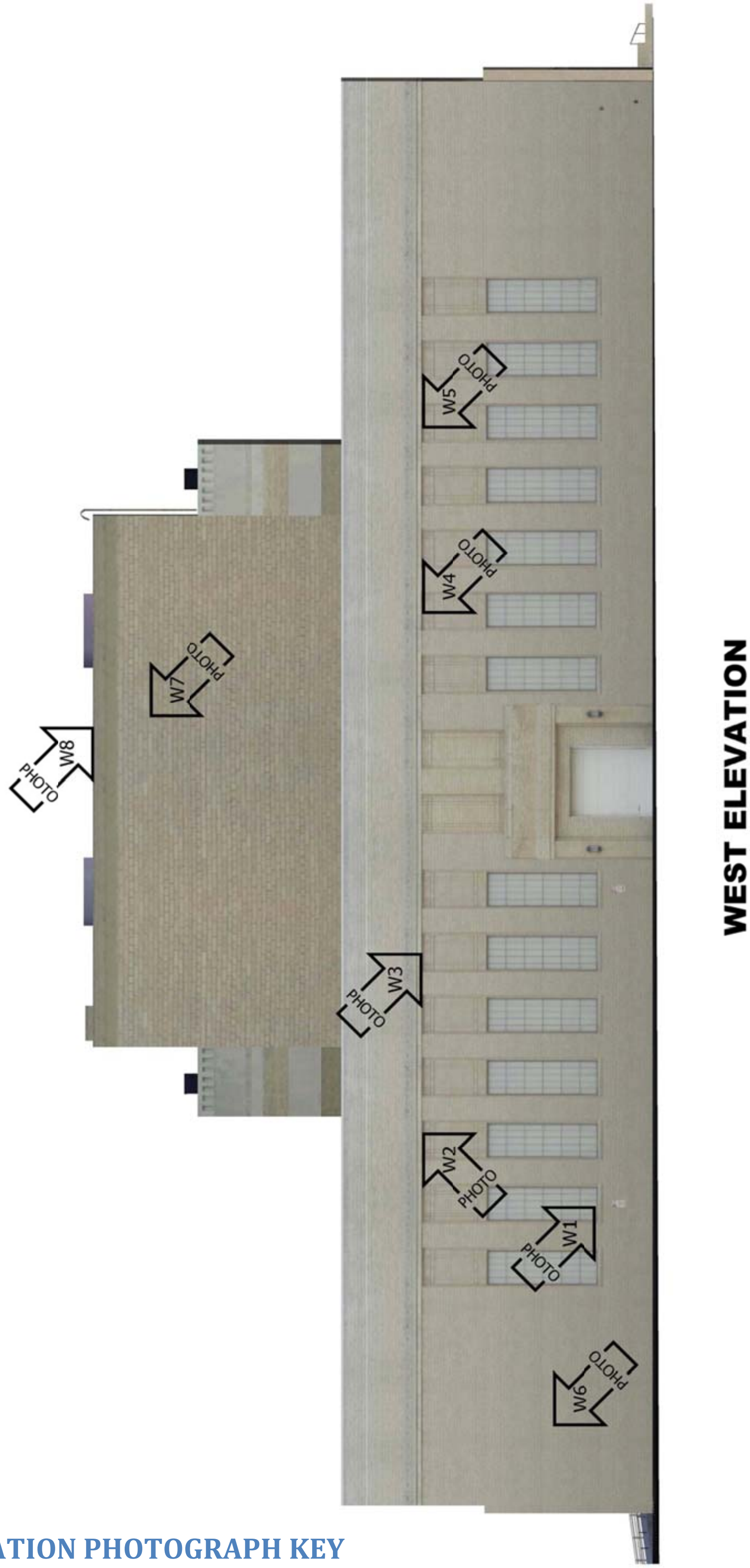
Qty	Craft@Hours	Unit	Material	Labor	Equipment	Total
Total Manhours, Material, Labor, and Equipment:						
	7119.1		712,728.19	818,887.51	156,298.19	1,687,913.89
Total Only (Subcontract) Costs:						429,006.60

Subtotal:	2,116,920.49
27.00% Overhead:	571,568.53
15.00% Contingency:	403,273.35
10.00% Profit:	309,176.24
Estimate Total:	3,400,938.61
2.00% Tax on the Contract Price (1% Tax, 1% Bond)	68,018.77
Grand Total:	3,468,957.38

This Estimate assumes the project will commence during the 2011 construction season as a single project. For an estimate of costs for a phased construction approach, see Page 15 of the report.

This Estimate does NOT include the cost to refurbish the exterior light fixtures, see Page 15 of the report for those costs.

Exhibit C - Existing Condition Photographs



WEST ELEVATION PHOTOGRAPH KEY

Photo W1 – Typical Window Sill Weathered Mortar Joint

Photo W2 – Typical Cracked Lintel Block

Photo W3 – Typical Window Weathered Caulking Joint

Photo W4 – Typical Weathered Mortar Joints

Photo W5 – Typical Cracked Lintel and Weathered Mortar Joints

Photo W6 – Brick Cracking

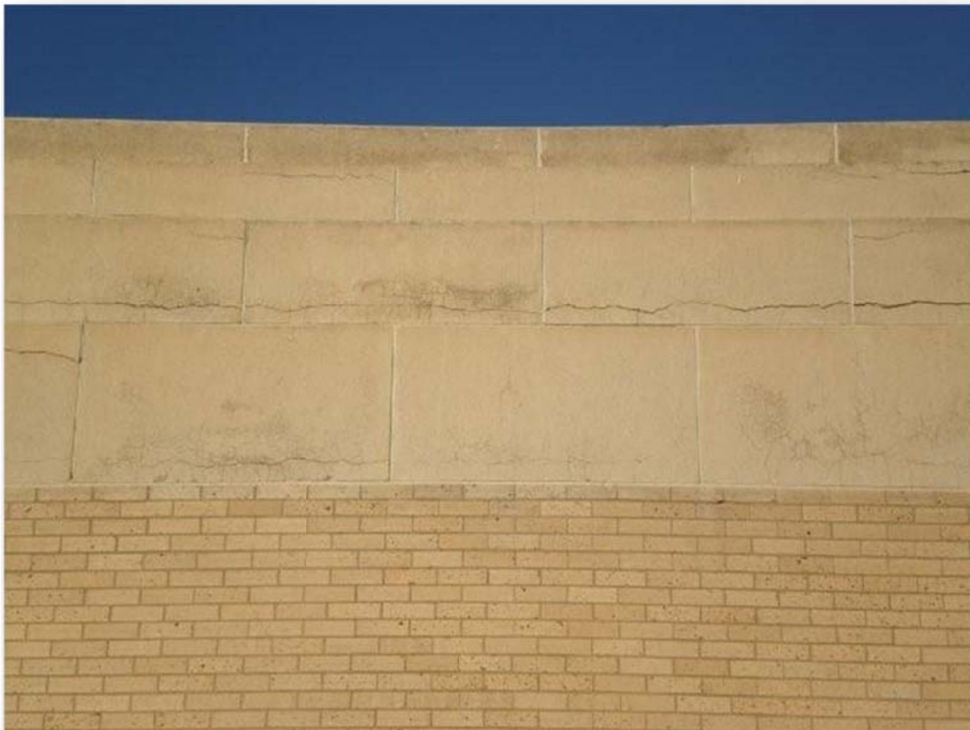


Photo W7 – Typical Cracking Cast Panels

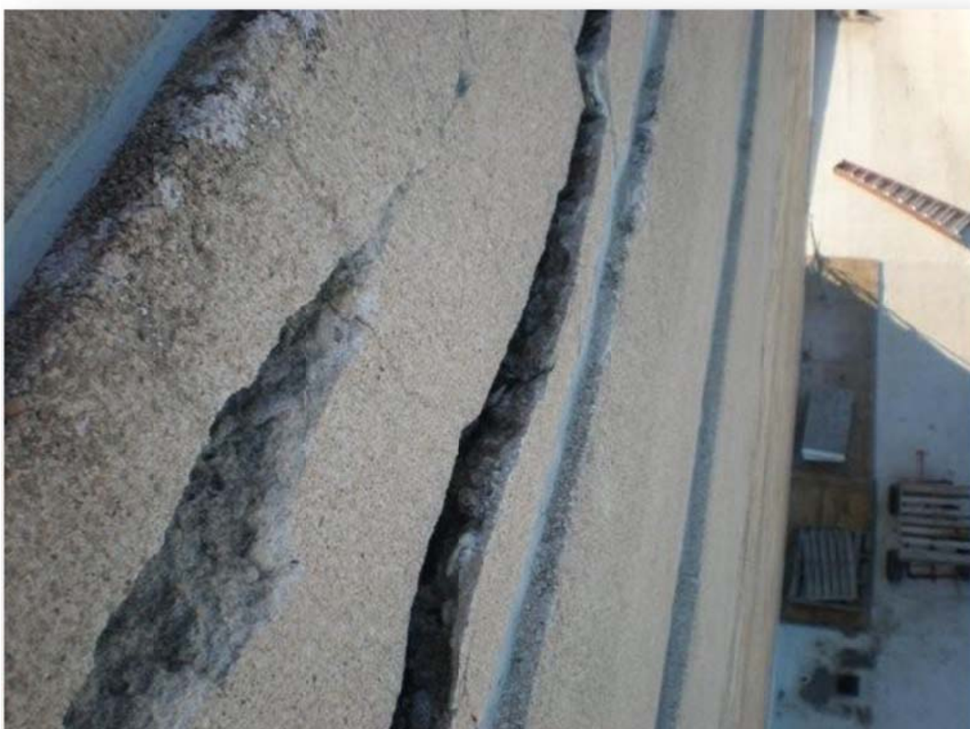
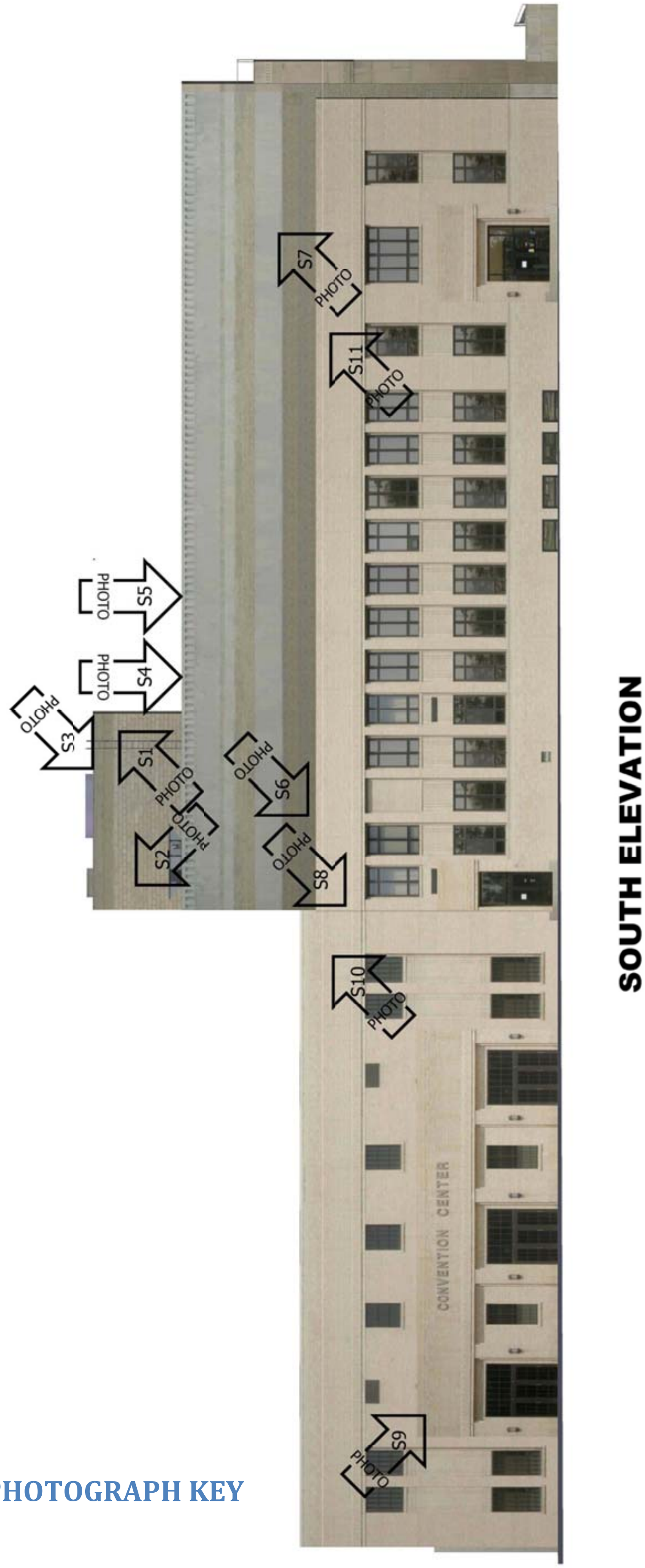


Photo W8 – Large Open Cast Panel Cracks



SOUTH ELEVATION PHOTOGRAPH KEY

Photo S1 – Typical Cracking Cast Panels

Photo S2 – Cracking & Displaced Brick

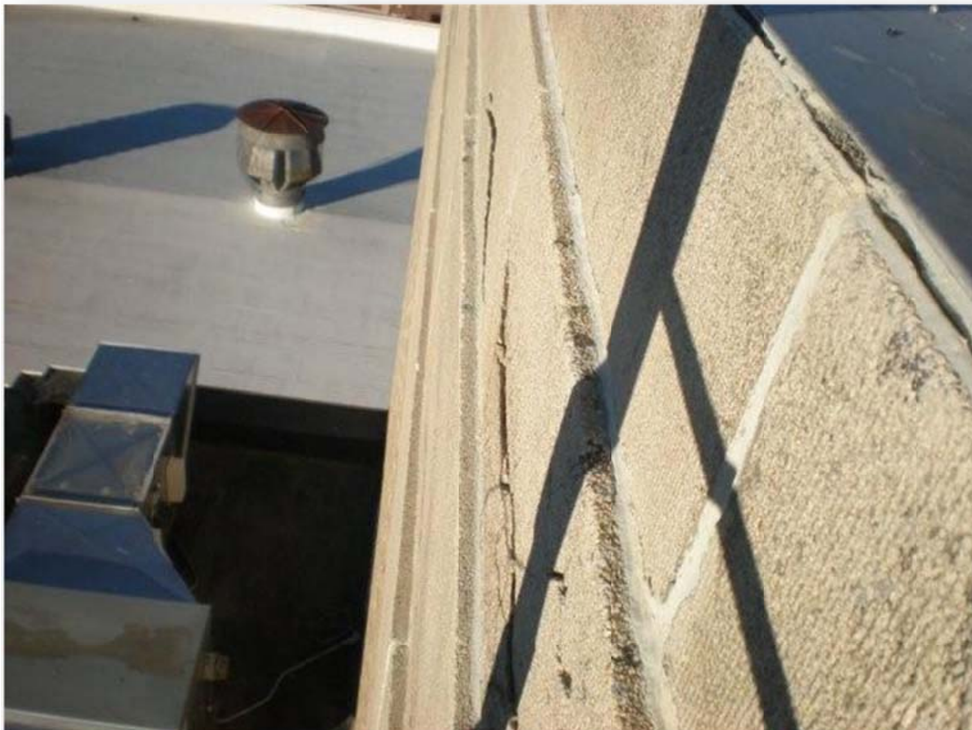


Photo S3 – Typical Cracking Cast Panels

Photo S4 – Large Open Cast Panel Cracks

Photo S5 – Typical Cracking Cast Panels

Photo S6 – Cracked Cast Window Sill

Photo S7 – Typical Cracking Cast Panels

Photo S8 – Typical Weathered Mortar Joint

Photo S9 – Typical Cracking Cast Panels

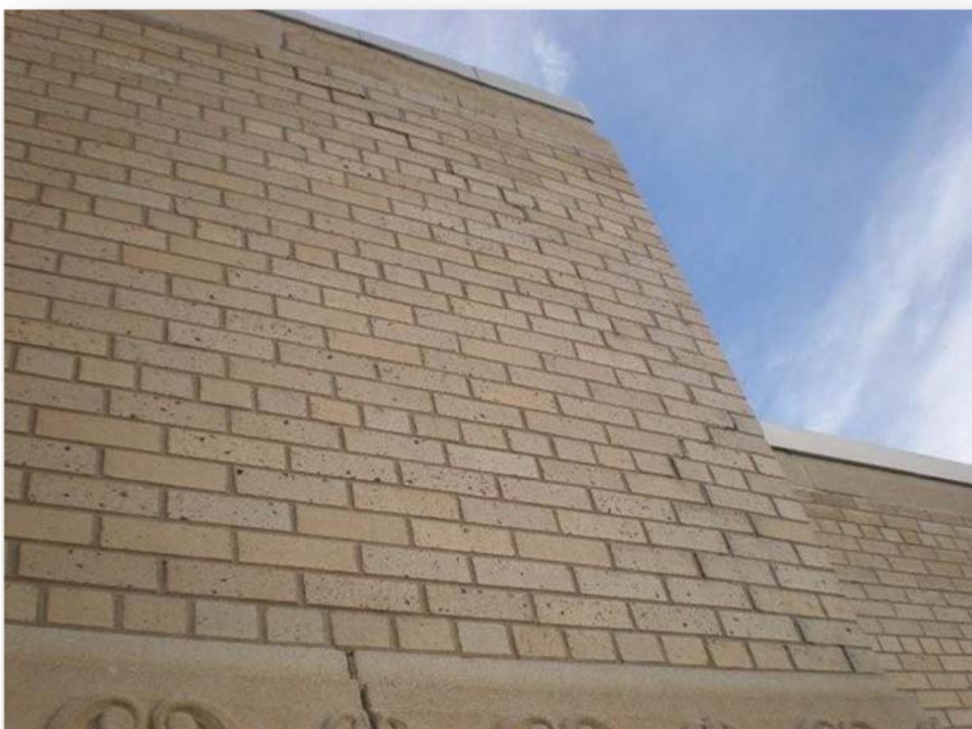
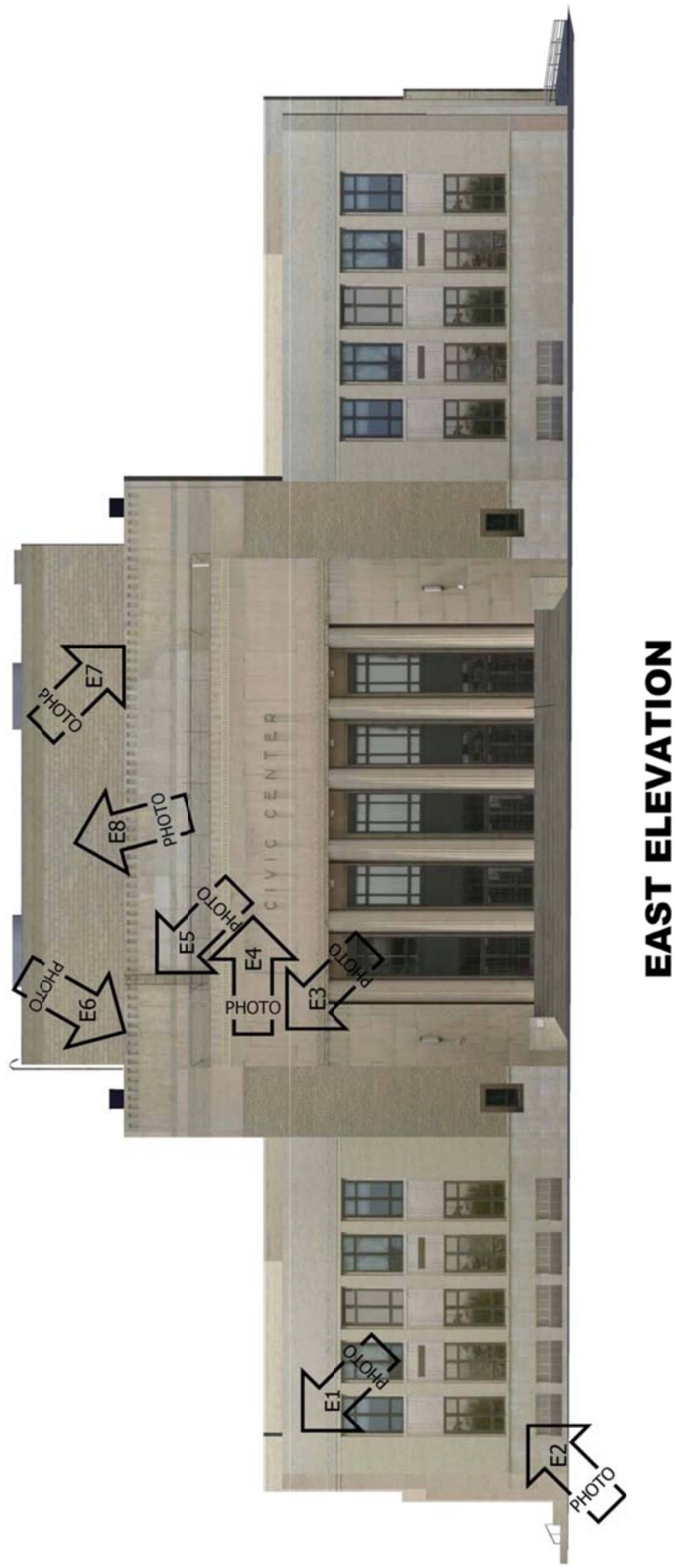


Photo S10 – Cracked & Displaced Brick

Photo S11 – Typical Cracking Cast Panels at Parapet Level



EAST ELEVATION PHOTOGRAPH KEY

Photo E1 – Cracked and Displaced Brick

Photo E2 – Typical Weathered Mortar Joint

Photo E3 – Typical Cracking Cast Panels

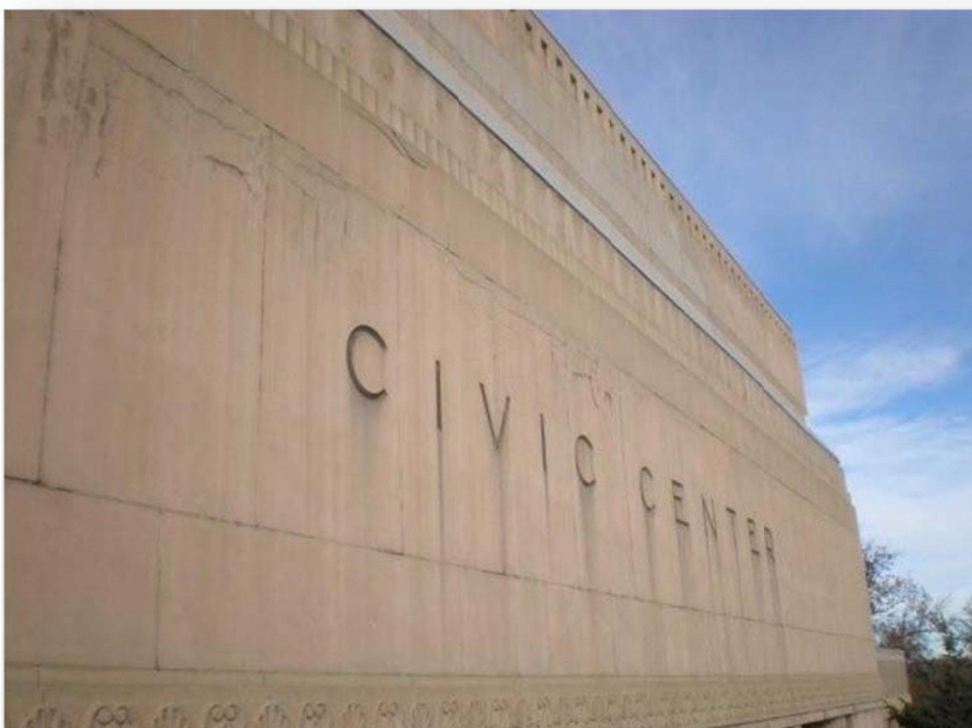


Photo E4 – Typical Cracking Cast Panels

Photo E5 – Typical Cracking Cast Panels

Photo E6 – Typical Cracking Cast Panels

Photo E7 – Typical Cracking Cast Panels

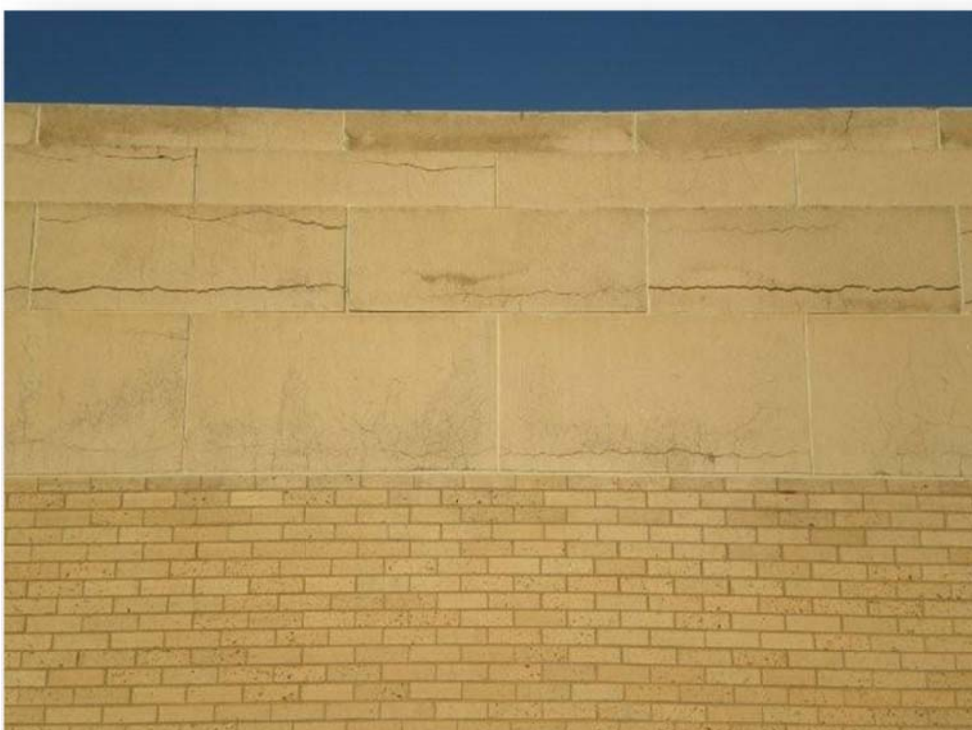
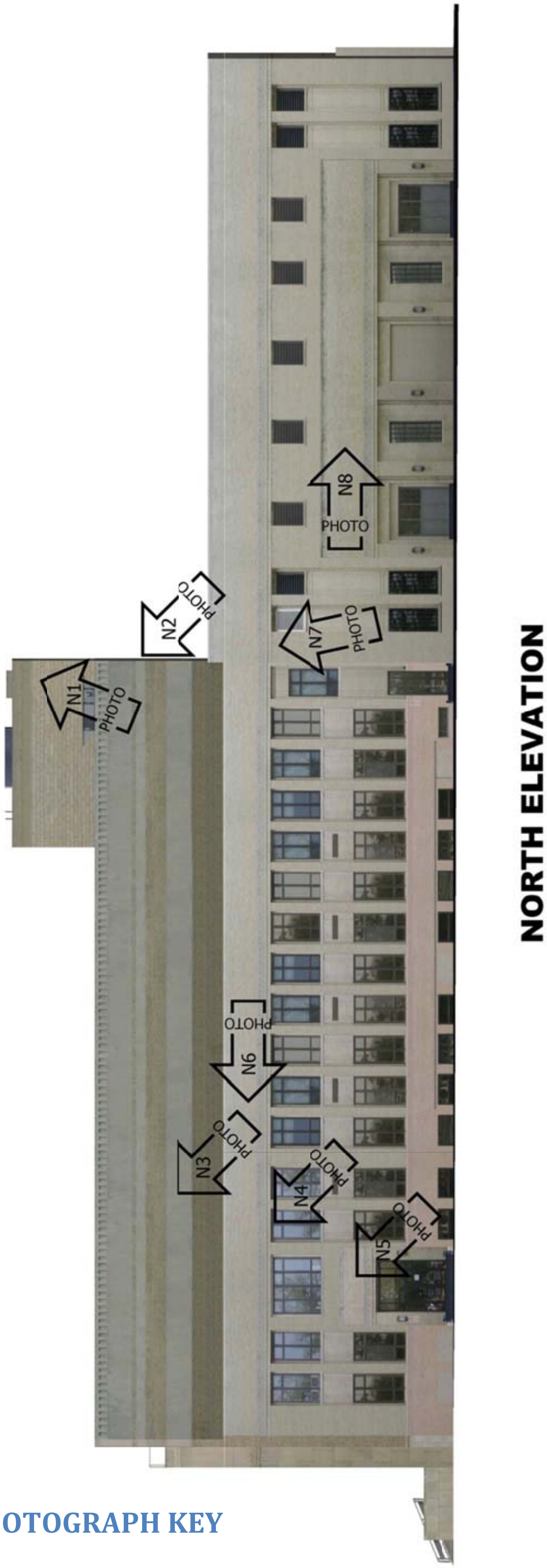


Photo E8 – Typical Cracking Cast Panels



NORTH ELEVATION PHOTOGRAPH KEY

Photo N1 – Typical Cracking Cast Panels & Displaced Brick

Photo N2 – Typical Cracking Cast Panels

Photo N3 – Typical Cracking Cast Panels

Photo N4 – Typical Cracked Window Lintel

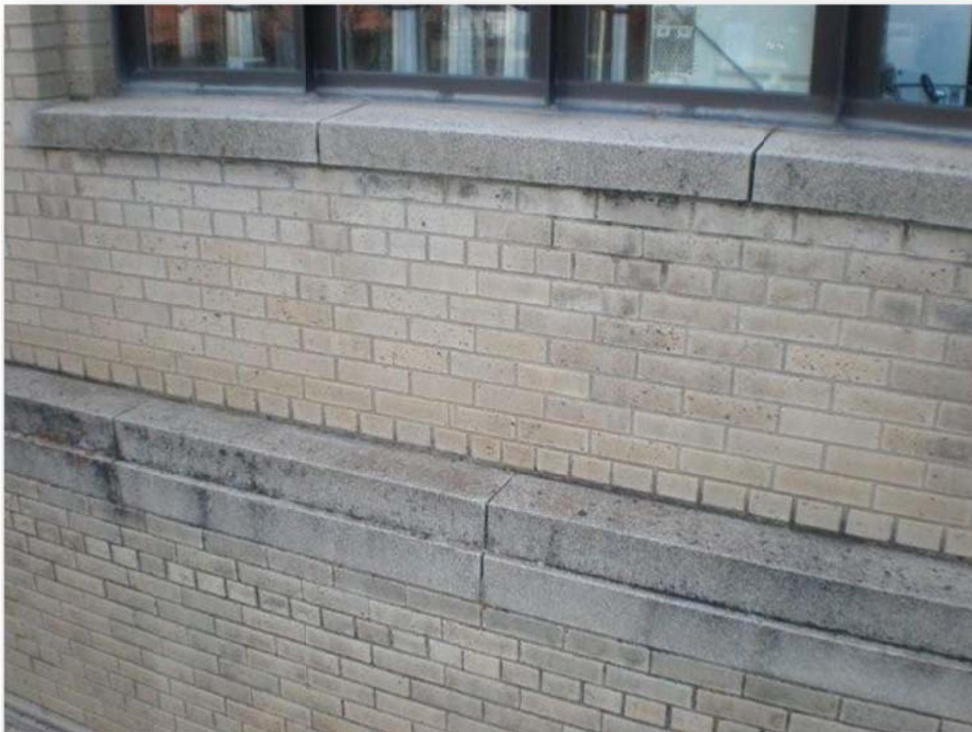


Photo N5 – Typical Weathered Mortar Joints

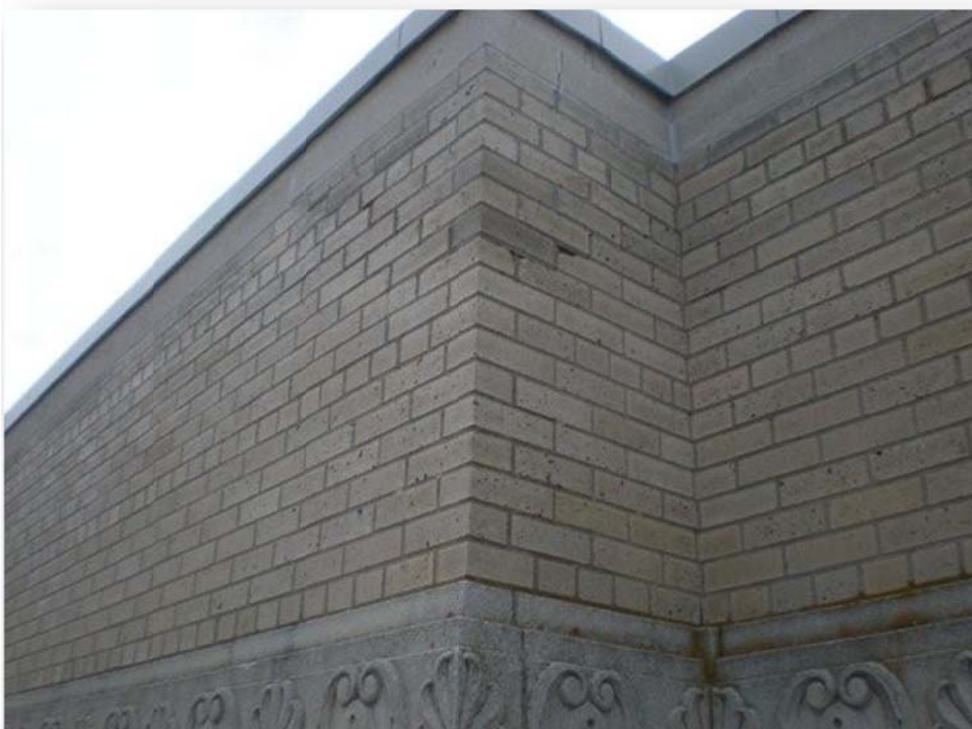


Photo N6 – Typical Weathered Mortar Joints & Displaced Brick

Photo N7 – Typical Cracking Brick & Weathered Mortar Joints

Photo N8 – Typical Weathered Mortar Joints

Exhibit D – Standards and Guidelines for Historic Structure Preservation and Rehabilitation

HISTORIC DESIGNATION

The Civic Center building was listed on the National Register of Historic Places on February 19, 1993 as a Contributing Building in the *Great Falls Railroad Historic District*, Smithsonian Number 24CA0335. The building was designed by Architects George Shanley and Johannes Van Teylingen as a Public Works Administration (PWA) project. It is an excellent example of twentieth century Art Deco style on a monumental scale. Ground was broken in 1939, therefore the building is approximately 72 years old.

Any construction work on the Civic Center requires compliance with Section 106 of the Historic Preservation Act and must comply with **The Secretary of the Interior's Standards for the Treatment of Historic Properties,** 36CFR68. The following *Standards for Preservation* and *Guidelines for Preserving Historic Buildings* are from the above Standards:

STANDARDS FOR PRESERVATION AND REHABILITATION

1. A property will be used as it was historically, or be given a new use that maximizes the retention of distinctive materials, features, spaces, and spatial relationships. Where a treatment and use have not been identified, a property will be protected and, if necessary, stabilized until additional work may be undertaken.
2. The historic character of a property will be retained and preserved. The replacement of intact or repairable historic materials or alteration of features, spaces, and spatial relationships that characterize a property will be avoided.
3. Each property will be recognized as a physical record of its time, place, and use. Work needed to stabilize, consolidate, and conserve existing historic materials and features will be physically and visually compatible, identifiable upon close inspection, and properly documented for future research.
4. Changes to a property that have acquired historic significance in their own right will be retained and preserved.
5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.
6. The existing condition of historic features will be evaluated to determine the appropriate level of intervention needed. Where the severity of deterioration requires repair or limited replacement of a distinctive feature, the new material will match the old in composition, design, color, and texture.
7. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.
8. Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.
9. New additions, exterior alterations, or related new construction will not destroy historic materials, features, and spatial relationships that characterize the property. The new work shall be differentiated from the old and will be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property and its environment.
10. New additions and adjacent or related new construction will be undertaken in a such a manner that, if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

GUIDELINES FOR PRESERVING OR REHABILITATING HISTORIC BUILDINGS

Introduction

In **Preservation**, the options for replacement are less extensive than in the treatment, Rehabilitation. This is because it is assumed at the outset that building materials and character-defining features are essentially intact, i.e, that more historic fabric has survived, unchanged over time. The expressed goal of the **Standards for Preservation and Guidelines for Preserving Historic Buildings** is retention of the building's existing form, features and detailing. This may be as simple as basic maintenance of existing materials and features or may involve preparing a historic structure report, undertaking laboratory testing such as paint and mortar analysis, and hiring conservators to perform sensitive work such as reconstituting interior finishes. Protection, maintenance, and repair are emphasized while replacement is minimized.

In **Rehabilitation**, historic building materials and character-defining features are protected and maintained as they are in the treatment Preservation; however, an assumption is made prior to work that existing historic fabric has become damaged or deteriorated over time and, as a result, more repair and replacement will be required. Thus, latitude is given in the **Standards for Rehabilitation and Guidelines for Rehabilitation** to replace extensively deteriorated, damaged, or missing features using either traditional or substitute materials. Of the four treatments, only Rehabilitation includes an opportunity to make possible an efficient contemporary use through alterations and additions.

Identify, Retain, and Preserve Historic Materials and Features

The guidance for the treatment **Preservation and Rehabilitation** begins with recommendations to identify the form and detailing of those architectural materials and features that are important in defining the building's historic character and which must be retained in order to preserve that character. Therefore, guidance on ***identifying, retaining, and preserving*** character-defining features is always given first. The character of a historic building may be defined by the form and detailing of exterior materials, such as masonry, wood, and metal; exterior features, such as roofs, porches, and windows; interior materials, such as plaster and paint; and interior features, such as moldings and stairways, room configuration and spatial relationships, as well as structural and mechanical systems; and the building's site and setting.

Stabilize Deteriorated Historic Materials and Features as a Preliminary Measure

Deteriorated portions of a historic building may need to be protected though preliminary stabilization measures until additional work can be undertaken. ***Stabilizing*** may include structural reinforcement, weatherization, or correcting unsafe conditions. Temporary stabilization should always be carried out in such a manner that it detracts as little as possible from the historic building's appearance. Although it may not be necessary in every preservation project, stabilization is nonetheless an integral part of the treatment **Preservation;** it is equally applicable, if circumstances warrant, for the other treatments.

Protect and Maintain Historic Materials and Features

After identifying those materials and features that are important and must be retained in the process of **Preservation or Rehabilitation** work, then ***protecting and maintaining*** them are addressed. Protection generally involves the least degree of intervention and is preparatory to other work. For example, protection includes the maintenance of historic materials through treatments such as rust removal, caulking, limited paint removal, and re-application of protective coatings; the cyclical cleaning of roof gutter systems; or installation of fencing, alarm systems and other temporary protective measures. Although a historic building will usually require more extensive work, an overall evaluation of its physical condition should always begin at this level.

Repair (Stabilize, Consolidate, and Conserve) Historic Materials and Features

Next, when the physical condition of character defining materials and features requires additional work, ***repairing*** by ***stabilizing, consolidating, and conserving*** is recommended. **Preservation** strives to retain existing materials and features while employing as little new material as possible. Consequently, guidance for repairing a historic material, such as masonry, again begins with the least degree of intervention possible such as strengthening fragile materials through consolidation, when appropriate, and repointing with mortar of an appropriate strength. Repairing masonry as well as wood and architectural metal features may also include patching, splicing, or otherwise reinforcing them using recognized preservation methods. Similarly, within the treatment **Preservation**, portions of a historic structural system could be reinforced using contemporary materials such as steel rods. All work should be physically and visually compatible, identifiable upon close inspection and documented for future research.

Limited Replacement In Kind of Extensively Deteriorated Portions of Historic Features

If repair by stabilization, consolidation, and conservation proves inadequate, the next level of intervention involves the ***limited replacement in kind*** of extensively deteriorated or missing *parts* of features when there are surviving prototypes (for example, brackets, dentils, steps, plaster, or portions of slate or tile roofing). The replacement material needs to match the old both physically and visually, i.e., wood with wood, etc. Thus, with the exception of hidden structural reinforcement and new mechanical system components, substitute materials are not appropriate in the treatment **Preservation**. Again, it is important that all new material be identified and properly documented for future research. If prominent features are missing, such as an interior staircase, exterior cornice, or a roof dormer, then a Rehabilitation or Restoration treatment may be more appropriate.

Replace Deteriorated Historic Materials and Features

Following repair in the hierarchy, **Rehabilitation** guidance is provided for ***replacing*** an entire character defining feature with new material because the level of deterioration or damage of materials precludes repair (for example, an exterior cornice; an interior staircase; or a complete porch or storefront). If the essential form and detailing are still evident so that the physical evidence can be used to re-establish the feature as an integral part of the rehabilitation, then its replacement is appropriate. Like the guidance for repair, the preferred option is always replacement of the entire feature in kind, that is, with the same material. Because this approach may not always be technically or economically feasible, provisions are made to consider the use of a compatible substitute material.

It should be noted that, while the National Park Service guidelines recommend the replacement of an entire character-defining feature that is extensively deteriorated, they never recommend removal and replacement with new material of a feature that, although damaged or deteriorated, could reasonably be repaired and thus preserved.

Design for the Replacement of Missing Historic Features

When an entire interior or exterior feature is missing (for example, an entrance, or cast iron facade; or a principal staircase), it no longer plays a role in physically defining the historic character of the building unless it can be accurately recovered in form and detailing through the process of carefully documenting the historical appearance. Although accepting the loss is one possibility, where an important architectural feature is missing, its replacement is always recommended in the **Rehabilitation** guidelines as the *first* or preferred, course of action. Thus, if adequate historical, pictorial, and physical documentation exists so that the feature may be accurately reproduced, and if it is desirable to re-establish the feature as part of the building's historical appearance, then designing and constructing a new feature based on such information is appropriate. However, a *second* acceptable option for the replacement feature is a new design that is compatible with the remaining character-defining features of the historic building. The new design should always take into account the size, scale, and material of the historic building itself and, most importantly, should be clearly differentiated so that a false historical appearance is not created.

END OF ASSESSMENT REPORT