University of Central Florida

Colbourn Hall Building Analysis

February 2014

SCHENKELSHULTZ ARCHITECTURE | CLANCY & THEYS CONSTRUCTION COMPANY | TLC ENGINEERING FOR ARCHITECTURE | WALTER P MOORE

Executive Summary

This Section summarizes the Phase I and Phase II recommendations for the project. Phase I items are related to the exterior skin, structure, and critical life safety items. Phase II items are related to less critical life safety items and MEP items. See the full report for details on each of these items, and the following section for cost related to these items.

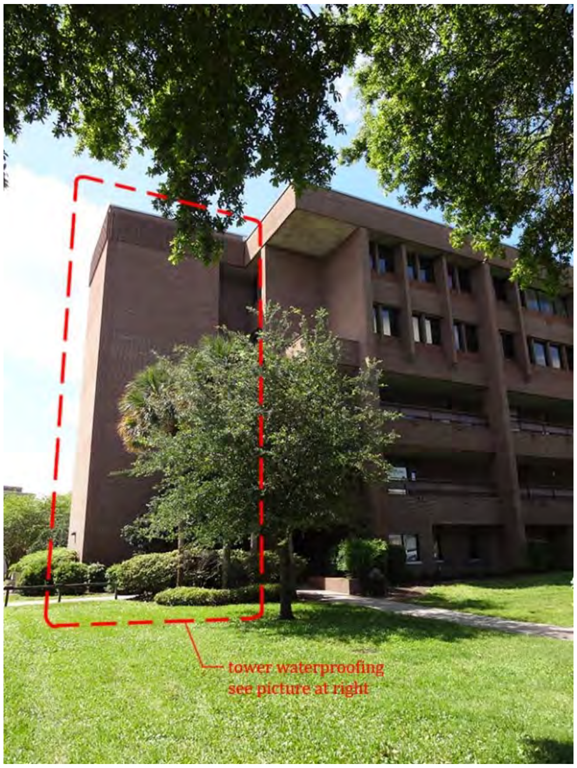
Phase I

Architectural

During the selective demolition/investigation of the building skin, it was discovered that the building skin has been constructed using improper materials and construction techniques. Specifically, there is no vapor barrier on the entire building skin, there is no waterproofing membrane on the middle portion of the building, there is no building insulation on the project at all, the backup material behind the brick is untreated gypsum board in the middle of the building and 4" unreinforced CMU at the towers, and the lintel flashing is improperly installed behind this gypsum board backup. These deficiencies all need to be addressed to ensure the proper waterproofing and indoor air quality within the building.

1. MAIN BUILDING - At the middle of the building, we recommend the complete removal of the exterior skin, including the brick and sheathing, and replacement of the brick at the columns at roof parapet over a properly installed backup system including cavity wall insulation, waterproof membrane, densglass backup, and cold formed framing structural metal studs tied to the existing building steel. The existing windows and brick between columns from level 2 to level 5 will removed and replaced with a curtainwall system, see renderings on the following pages. The second and third floor existing exterior circulation will now become interior circulation which will need additional fan coil units in the ceiling to condition the space. It should be noted that this solution will reduce the building's peak energy use tonnage by roughly 12.6 tons, saving the University approximately $2,200.00 per year in energy cost.
2. TOWERS - At the towers at the ends of the building which contain non-conditioned mechanical/electrical rooms, non-conditioned stairs, and non-conditioned restrooms, we have two options related to the exterior skin:
    a. OPTION 1 - this option is to remove the brick and 4" non-reinforced CMU backup, and replace it with a properly installed backup system including cavity wall insulation, waterproof membrane, densglass backup, and cold formed framing structural metal studs tied to the existing building steel. This has the advantage of having a complete new exterior skin which has the desired vapor barrier, building insulation and waterproofing.
    b. OPTION 2 – this option is to pin the brick to the backup structure using helical ties, and reinforce the 4" CMU backup structure as described in the structural section. This option avoids the demolition of the towers, but does not address the lack of waterproofing and vapor barrier at these portions of the building. However, as these towers are currently non-conditioned ventilated space, this may be acceptable to the University.

See pictures and diagrams on the following pages which illustrate this scope.



towers

tower waterproofing – deteriorating and not consistently applied, no vapor barrier, no insulation

tower waterproofing – deteriorating and not consistently applied, brick ties not embedded in mortar

main building


deteriorating substrate, flashing,
no insulation, no vapor barrier

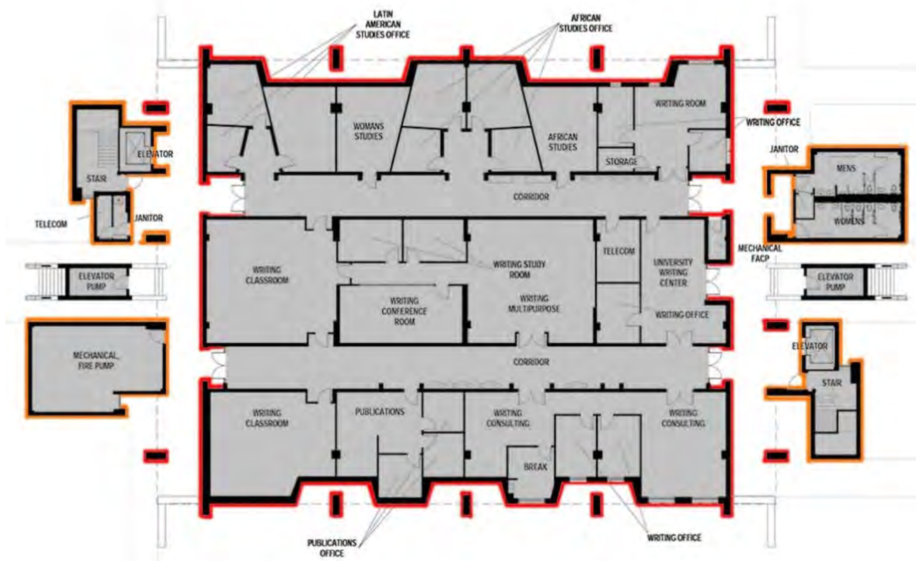
gypsum wallboard used as backup (not an appropriate material) with no asphaltic coating, deteriorating

flashing is behind gypsum wallboard but should be in front of substrate

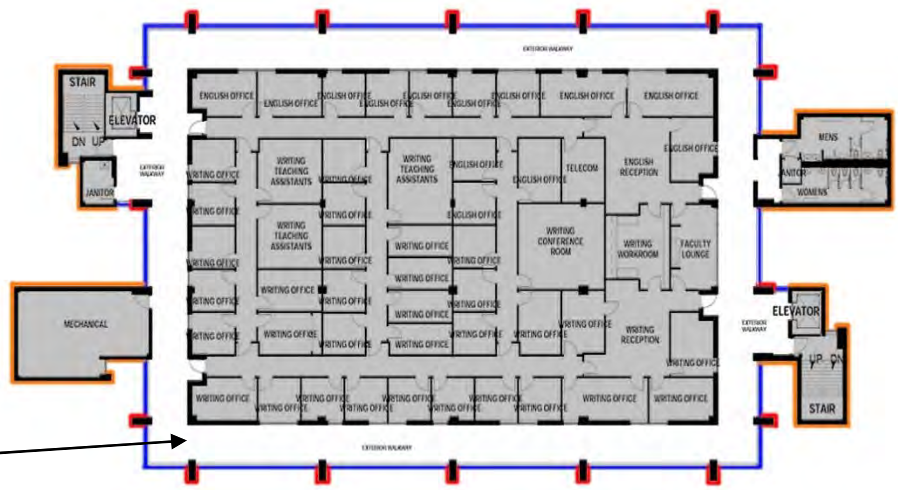
no insulation

no vapor barrier

LEVEL 1

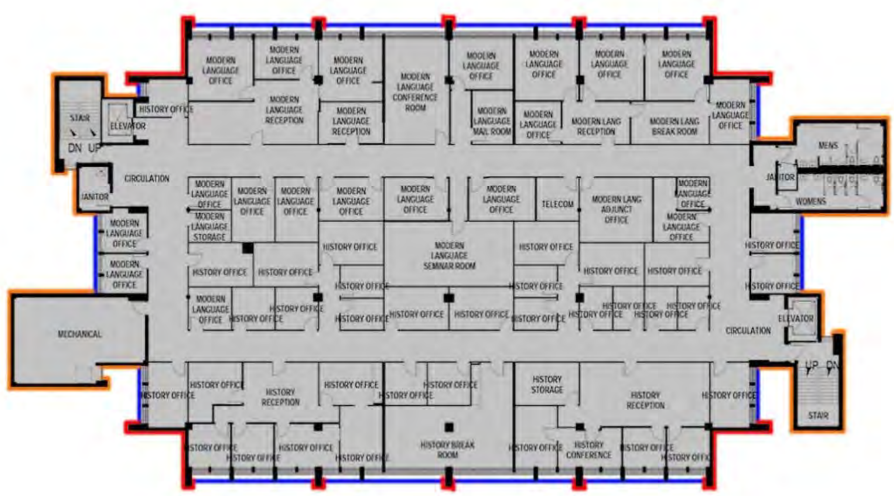


LEVELS 2, 3



new interior corridor

LEVELS 4, 5



new glazing

new brick

new or pinned brick

Colbourn Existing

light brick indicates new brick *(does not represent final brick color)*

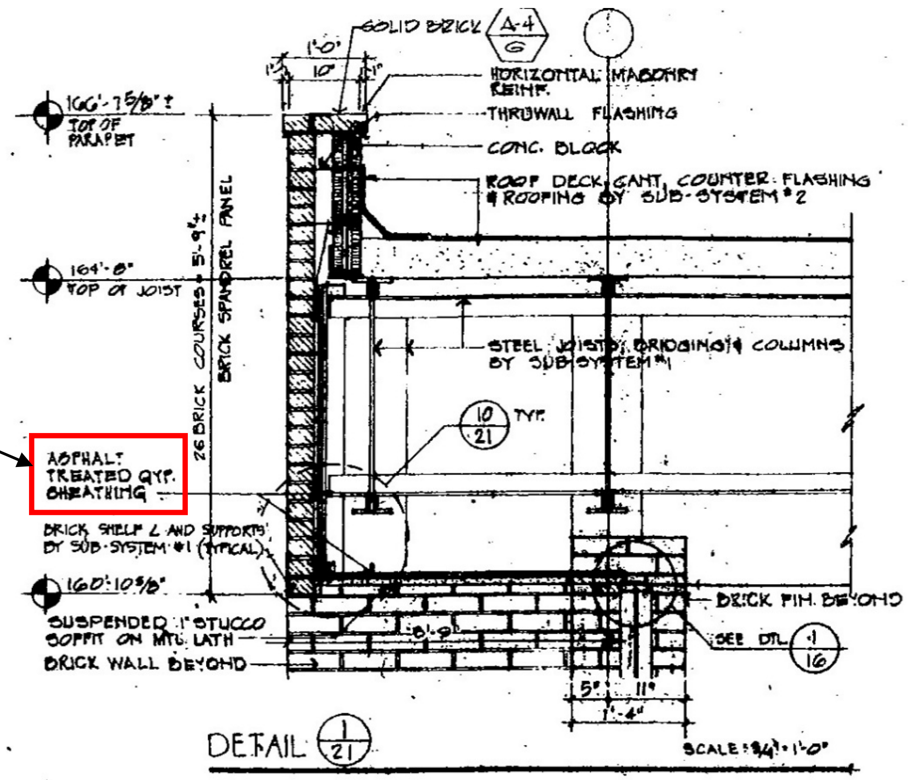
dark brick indicates new brick or pinned brick

new curtainwall

Colbourn Proposed

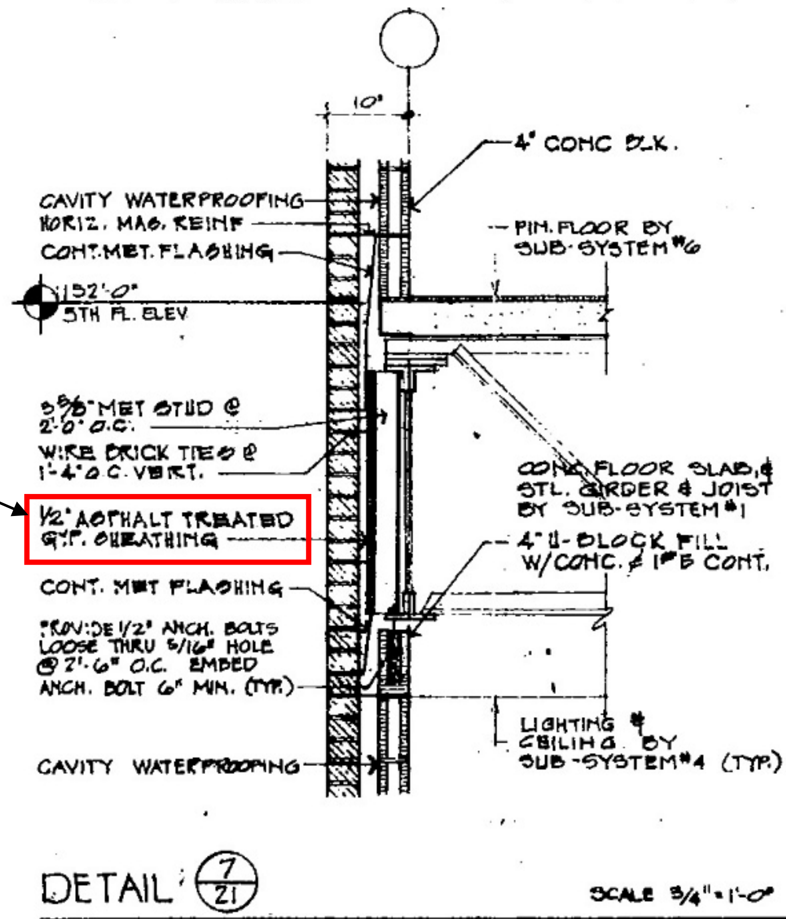
Main Building Section

no asphalt in existing construction



Tower Section

no asphalt in existing construction



Phase I, continued

Structural

1. Strengthen Structural Components
    a. Strengthen/reinforce 6-inch CMU backup walls at Levels 1, 2 and 3.
    b. Strengthen/reinforce 4-inch CMU backup walls at Levels 4 and 5.
    c. Strengthen/reinforce 4-inch CMU backup walls at attached towers.
        i. Option: Remove brick veneer and replace with new brick veneer supported by new steel frame.
    d. Strengthen/reinforce window and exterior door openings on all levels.
    e. Repair corroded steel framing below exterior corridors.
    f. Strengthen/reinforce web and chord members of joist girders and joists that are part of moment-resisting frames.
2. Building Enclosure Façade Rehabilitation
    a. Review façade, particularly at parapet wall areas, for loose brick units and remove until permanent repairs can be made.
    b. Remove and replace failed brick with post-installed anchors.
    c. Repoint failed mortar joints.
    d. Remove mortar inside existing expansion joints. Install new vertical expansion joints at attached towers.
    e. Repair corroded shelf angles.
    f. Install horizontal expansion joints at all shelf angles with underlying brick courses.
    g. Repair corroded steel backup supports for brick masonry veneer at projected areas of façade.
    h. Supplement tack welds of vertical steel angles supporting veneer at projected areas of façade.
    i. Remove brick veneer at open corridor projected areas of façade and install new brick cavity wall system (see Architectural).
    j. Install post-installed brick anchors at all tower façade areas (see Architectural).
    k. Install new windows/curtainwall and exterior doors complying with requirements of the current building code.
3. Miscellaneous
    a. Repair concrete distress at treads, risers and landings of exterior stairs at east and west ends of building.

Life Safety

1. If a sprinkler system is not immediately added, add smoke detectors where they are missing (5th floor in particular).
2. Install additional fire strobes (5th floor in particular).
3. Replace handrails at exterior convenience stairs connecting levels 1 and 2.

Phase II

Life Safety and ADA

1. Install a complete sprinkler system throughout the entire building.
2. Fix level 2 exit signage in the Digital Research Department to point to the proper exit from this space.
3. Upgrade the lighting in the exit corridors and exit stairs to provide code compliant emergency battery backup lighting.
4. Where not in compliance, relocate fire alarm pull stations within the natural path of egress or within 5' of exit doorways.
5. Relocate main switchboard in the first floor mechanical room, or provide a second means of egress from this room.
6. Relocate electrical to new dedicated electrical rooms on each floor, or provide newer and smaller mechanical equipment within existing mechanical rooms to allow proper code required electrical panel and equipment clearances.
7. Add fire extinguishers in suites without them, such as the CAH Student Affairs Suite on the second floor.
8. Upgrade the restrooms and drinking fountains to be ADA compliant.

Architectural

1. Clean building exterior; re-caulk existing expansion joints.
2. Upgrade handrails within stairs to have the proper extensions at landings and be made of brushed aluminum per UCF Standards.
3. Upgrade stair finishes to a non-slip finish.
4. Renovate suites with combustible material (wood paneling) to non-combustible materials.

Mechanical/Plumbing

1. Replace all mechanical systems to meet UCF Standards and equipment clearance requirements.
2. Reconfigure mechanical systems to allow for proper condensate trap and drainage.
3. Install outside air and return air ducts to the existing or new units.
4. Replace the chilled water booster pump, with BAS interface.
5. If the heating system stays hot water, remove the boiler and associated piping; install a new high efficiency condensing boiler with new controls, valves, and BAS interface.
6. Install a fully ducted return air system throughout all floors.
7. Replace all internally lined supply and return ductwork with externally insulated ductwork.
8. Install exhaust ventilation in janitor closets.
9. Replace all plumbing fixtures with low-flow fixtures.

Electrical

1. Provide power submeters for new main switchboard, mechanical panel, lighting panel, exterior lighting and plug loads to be tied into BAS system.
2. Provide surge suppression device for existing switchboard, new switchboard, panelboards, fire alarm circuits, and site lighting circuits.
3. Provide new exterior standby generator with automatic transfer switch for life safety and optional loads.
4. Provide new dedicated circuiting for emergency lighting and exit lighting.

5. Rewire existing branch circuits to provide dedicated neutral; or, provide multi-pole breakers where branch phase conductors share a neutral to meet NEC requirements.
6. Upgrade existing energy inefficient lights. Add occupancy sensors for automatic lighting control.
7. Upgrade fire alarm system to current UCF Standards to include mass notification system, Class A wiring.

End of Executive Summary

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UCF Colbourn Hall - Renovations

Phase I - Facility Assessment

Cost Analysis

Date: February 18, 2014

Priority 1 = Critical, Priority 2 = Potentially Critical, Priority 3 = Necessary, Priority 4 = Recommended

Item	Priority	Description of Work	Quantity	Unit	Unit Price	Totals	Duration
1	1	Remove exterior skin including back-up wall system and replace with a new light gauge back-up wall system, waterproofing membrane, insulation, and either brick veneer or glass curtain wall system per the executive narrative. (This option will include the structural reinforcing of the CMU back-up wall system and pinning of the brick of the existing stair, elevator, mechanical, and restroom towers)	65,000	sf	$ 89.50	$ 5,817,500	10 mos
2	2	Replace the complete exterior skin including back-up wall system and replace with a new light gauge back-up wall system, waterproofing membrane, insulation, and brick at the stair, elevator, mechanical, and restroom towers, in lieu of structural reinforcing and brick pinning	22,500	sf	$ 13.50	$ 303,750	incl above
3	1	Add new fire alarm devices as required per code including smoke detectors	1	ls	$ 50,000	$ 50,000	incl above
4	2	Replace exterior stair railing system at convenience stairs	2	ea	$ 15,000	$ 30,000	incl above
5	3	Concrete repairs at the exterior convenience stairs	2	ea	$ 10,000	$ 20,000	incl above
6	3	Upgrade the existing restrooms to meet current ADA requirements (General a complete replacement of all plumbing and interior finishes)	5	sets	$ 125,000	$ 625,000	Additional 2 mos Total of 12 mos
7	4	Complete replacement of all mechanical and electrical systems along with the replacement of all interior finishes	80,000	sf	$ 89.25	$ 7,140,000	Additional 2 mos
8	4	Add emergency generator system including new generator enclosure	125	kw	$ 1,225	$ 153,125	incl above
9	4	Elevator Replacement	2	ea	$ 150,000	$ 300,000	incl above
10	4	Construct a new separate fire pump room	400	sf	$ 125	$ 50,000	incl above

* All of the above rough order of magnitude budgets include a 12% contingency, however they do not include any design or engineering services fees.

** Due to the requirement to replace the entire exterior skin we recommend the relocation of all tenants while the work is being completed. Those cost are **not** included in the above budgets.

*** See the attached preliminary overall time frame schedule

SCHENKELSHULTZ ARCHITECTURE CLANCY &THEYS CONSTRUCTION COMPANY TLC ENGINEERING FOR ARCHITECTURE WALTER P MOORE

UCF Colbourn Hall - Renovations

Phase I - Facility Assessment

Time Frame Schedule

Date: Feburary 18, 2014

<table>
<tr><th></th><th colspan="9" align="right">2014</th><th colspan="4" align="left">2015</th></tr>
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Project Overview

At the request of the University of Central Florida, SchenkelShultz Architects, Walter P Moore Structural Engineers, TLC Engineering for Architecture, and Clancy & Theys Construction Company were hired to perform a Building Analysis of the Colbourn Hall project. This analysis includes the review of the Structural, Exterior Skin (minus roof), Life Safety, Architectural, Mechanical, Electrical, and Fire Protection systems of the existing facility. Additionally we have reviewed the building for deficiencies related to the current UCF Standards 2013. This report summarizes these findings, and makes recommendations for corrections to conditions where, in our professional judgment, we believe that they need to be made. We have organized this report into sections based on discipline as listed below. We have attempted to format the options and costs so that the University can independently evaluate each item and its respective cost, and build a strategy for enhancement and repair based on the University priorities for the future use of the building.

This report is organized into the following sections:

Section I:	Executive Summary
Section II:	Order of Magnitude Cost
Section III:	Project Overview
Section IV:	Building Condition Analysis
Section V:	Structural Analysis
Section VI:	Life Safety and ADA Analysis
Section VII:	UCF Standards Analysis
Section VIII:	Proposed replacement Mechanical, Electrical, and Fire Protection systems
Section IX:	Revit Plans, Reflected Ceiling Plans, and Elevations

Individual action items are listed under each individual Analysis section. These items have been classified into the following categories:

- PRIORITY 1 – Critical (Immediate Need) – items in this category require immediate action to correct a safety hazard, to stop accelerated deterioration of a building element, or to return the facility to normal operation.
- PRIORITY 2 – Potentially Critical (First Year Need) – items in this category will become critical if not corrected within approximately a year and include potential safety hazards, repair of rapidly deteriorating items, and items causing intermittent building interruptions.
- PRIORITY 3 – Necessary (Second to Fifth Year Need) – items in this category include repair of items with predictable unacceptable deterioration where, if left unaddressed, will cause potential building downtime or higher costs of replacement in the future.
- PRIORITY 4 – Recommended (Sixth to Tenth Year Need) – items in this category are not necessary for the basic function of the building, but will provide a substantial improvement to the existing building conditions and/or reduce long-term maintenance costs.

It is noted that this report follows three separate reports on the project conducted over the past +/- 2 years. The first report by The Raad-Tannous Engineering Group, Inc provides a limited structural analysis of the facility; this report is dated December 3, 2012 and is titled “Visual Structural Assessment & Analysis of Existing Building”. The second report by AMEC E&I provides an asbestos analysis of the facility; this report is dated April 9, 2013 and is titled “Report of Limited NESHAP Asbestos Survey”. The third report by this ISES Corporation provides a general conditions report of the facility; this report is dated December 1, 2011 and is titled “Colbourn Hall Facility Condition Assessment”.

Colbourn Hall building description

Colbourn Hall at the University of Central Florida in Orlando was built in 1974. The project houses several departments in the College of Arts and Humanities (CAH), including the English Department, the Writing & Rhetoric Department, the History Department, the Modern Languages Department, Humanities & Digital Affairs, Woman's Studies, Latin American Studies, Judaic Studies, the CAH Student Affairs, and the CAH Technical Support Group. The building's primary function is that of an office building, with limited classroom space on the first and second floors.

The building is a five story steel, concrete, and masonry structure of approximately 82,000 gsf. The vertical circulation (exit stairs and elevators), mechanical and electrical rooms, and restrooms are constructed on the east and west ends of the building apart from the main occupied spaces of the building. The second and third floors have an exterior balcony wrapping the core office and classroom spaces. The interior of the project has a combination of gypsum board walls and modular partition walls, acoustic tile ceilings and gypsum board ceilings, with primarily carpeted floors. The roof, reportedly installed in 2006, is a flat modified bitumen built-up roof that we have been told is satisfactory with no signs of roof leaks or water infiltration – an analysis of the roof is not a part of this report. The site is landscaped with grass, planting beds, shrubs, bushes, and other ornamental trees that blend with the surrounding campus.

Mechanically, the existing building is being conditioned by five (5) chilled water multi-zone air handling units (AHU's) with hot water heat, each serving independent floors. The AHU supply fans are controlled using variable frequency drives (VFD's). The existing AHU's utilize the existing campus chilled water distribution loop. One base mounted end-suction tertiary pump is being used to circulate chilled water from the campus chilled water loop to all five (5) AHU's. The pump is currently located in the second floor mechanical room adjacent to the AHU and exterior wall and is controlled by a VFD. Heating hot water is being produced by a single 1380 MBH natural gas Patterson-Kelley Thermific boiler which is currently located in the 4th level mechanical room. The existing control system was pneumatic; however, has been semi-retrofitted with electronic direct digital control (DDC) devices. The multi zone control dampers are pneumatic, while the heating hot water valves, chilled water valves and outside air dampers have been retrofitted with electronic actuators.

Electrically, the existing building currently has its service entrance electrical equipment located on the ground floor co-mingled with the chilled water pump rooms, air handling equipment, and fire pump. With the exception of a few new panels in the first floor mechanical room which were added for the first floor renovations a few years ago, the rest of the equipment appears original to the building. There is an enclosed transformer yard with two pad-mounted utility transformers fairly close to the building on the west end. There are stacked rooms tagged as janitor's/emergency equipment rooms on the west end of the building; they have mop sinks in there as well as telephone backboard and punch down blocks for telephone lines. The fire alarm system is a Simplex 4100 Series with a Simplex 4009 IDNET NAC Extender, and a 4-zone slave/dialer. The system does not have mass notification. The building is non-sprinklered, but does have fire alarm notification, area smoke detectors, and manual pull stations.

Building Analysis

Structure

In December 2013 and January 2014, a detailed structural analysis based on significant exploratory observations was conducted on the facility. Thirteen (13) exploratory openings were made in the brick masonry façade in various locations around the building to examine the structural supports and backup waterproofing of the brick. Two footings were excavated and measured to verify their sizes and depths. Seven (7) locations were opened on the interior walls of the building to non-destructively test the exterior CMU walls for the presence of vertical reinforcing steel. Additional visual inspections from within accessible ceiling spaces and from lifts from the exterior of the building were performed. This testing has given us a solid representation of the structural conditions of the building upon which we have based the recommendations in this report.

In speaking with the Florida Building Commission in Tallahassee, we have confirmed that there is no requirement in the current building code to upgrade the overall building lateral systems to comply with the wind design requirements of the current code in the project, no matter the amount of money spent on the building for improvements. However, our evaluation of typical moment-resisting frames has shown that the capacity of some joists and joist girder members is exceeded when analyzing the frames per the design requirements of the current code. Accordingly, we have herein recommended reinforcing of some chord and web members in the joists and joist girders that are part of the moment-resisting frames.

Our analysis of the building enclosure facade found a significant number of deficiencies related to the brick masonry cladding. These include inadequate or missing brick ties to the backup structure, inadequate structural reinforcement of the backup CMU walls, inadequate bracing of exterior CMU/brick walls on the second and third floors, inadequate support at door and window openings, corrosion of some steel members at the second and third floor exterior corridors, some questionable welds of steel members at the exterior corridors and high soffit locations, loose and spalling brick at the high brick parapets, and cracks within the brick cladding which are allowing water infiltration into the building. Many details of the as-built construction were observed that do not comply with the building code and industry standards and that do not conform to the requirements of the design drawings. While there is no immediate danger posed by these structural items (other than repair of the loose brick at the parapet level), the structural issues related to the building enclosure facade are significant and are not easily repaired. This report goes into detail on all of these items under the "Structural Analysis" section, and offers recommendations to solve each of these issues.

Life Safety

Architecturally, the building has relatively minor deficiencies related to Life Safety. The building is 40 years old, and as such was constructed to the building codes of the time which had different Life Safety than the requirements in today's codes. None of the Architectural Life Safety deficiencies themselves pose an imminent safety problem needing immediate repair. However, if more comprehensive building renovations become a part of the project scope, then we would recommend addressing as many of these life safety issues as possible. This report goes into detail on all of these items under the "Life Safety Analysis" section.

A similar scenario exists for Mechanical, Electrical, and Fire Protection Life Safety items. While many code deficiencies were noted with these systems, they would require considerable expense to fix; and as they were constructed to meet building codes at the time and have worked for decades in their current form, they are a lower priority than the recommended building skin and structural items. The electrical distribution equipment is extremely old and in fair to poor condition. Because there are numerous code violations, it is recommended to replace the equipment with new equipment in dedicated electrical rooms. Since the fire alarm system is original to the building as well, and there are noted code deficiencies, it is recommended that this system be upgraded to meet current UCF standards. It is also recommended that the egress lighting in the building be verified and upgraded to comply with current codes. Lighting upgrades to the remaining building, while not a code issue, are recommended in order to be much more energy efficient. Additionally, current codes require any building 3 stories or greater to have automatic fire sprinkler systems - the building is currently non-sprinklered.

Building Condition Analysis

The Building Condition Analysis reviews non-Life Safety items related to the Architectural, Mechanical and Electrical scope. Architecturally, as you would expect for a 40 year old building, the facility has many items related to age and maintenance that need repair. The most significant Architectural item relates to the waterproofing behind the brick skin at the core areas of the building over the exterior balconies and high soffits– our investigations found that the backup to the brick is regular ½" gypsum wallboard fastened directly to the building steel with no vapor barrier, no insulation and no waterproofing coating – the gypsum wallboard has significant deterioration due to a very small (1/2" to 1") cavity that is often filled with brick mortar. There is not an easy solution to repair this condition – our recommended solution is to remove the brick and reinstall the backup with waterproofing in a watertight manner. Another significant item is the exterior handrails on the second and third floors which have serious corrosion in many locations, potentially compromising their function. Other architectural items are related to the age of the materials throughout the building, and the cleaning of the exterior façade. This report goes into detail on all of these items under the "Building Condition Analysis" section.

Mechanically, the HVAC systems in the building are approaching the end of their life and are expected to need replacement in the next several years. The AHU units use a plenum return (not allowed by current UCF Standards) with interior lined supply ducts (not used in today's construction practice for interior air quality reasons). The fifth floor of the building has no supply or return diffusers in the ceilings, instead supplying and returning air through the building's original ceiling tile grid. Part of this report recommends replacing the existing HVAC system with a new Chilled Beam HVAC system – this allows for smaller AHUs and smaller ductwork, which may allow the existing mechanical room to have the proper clearances from electrical panels (avoiding the creation of new electrical rooms, which would have to take space from the existing offices and have considerable cost in relocation of these items).

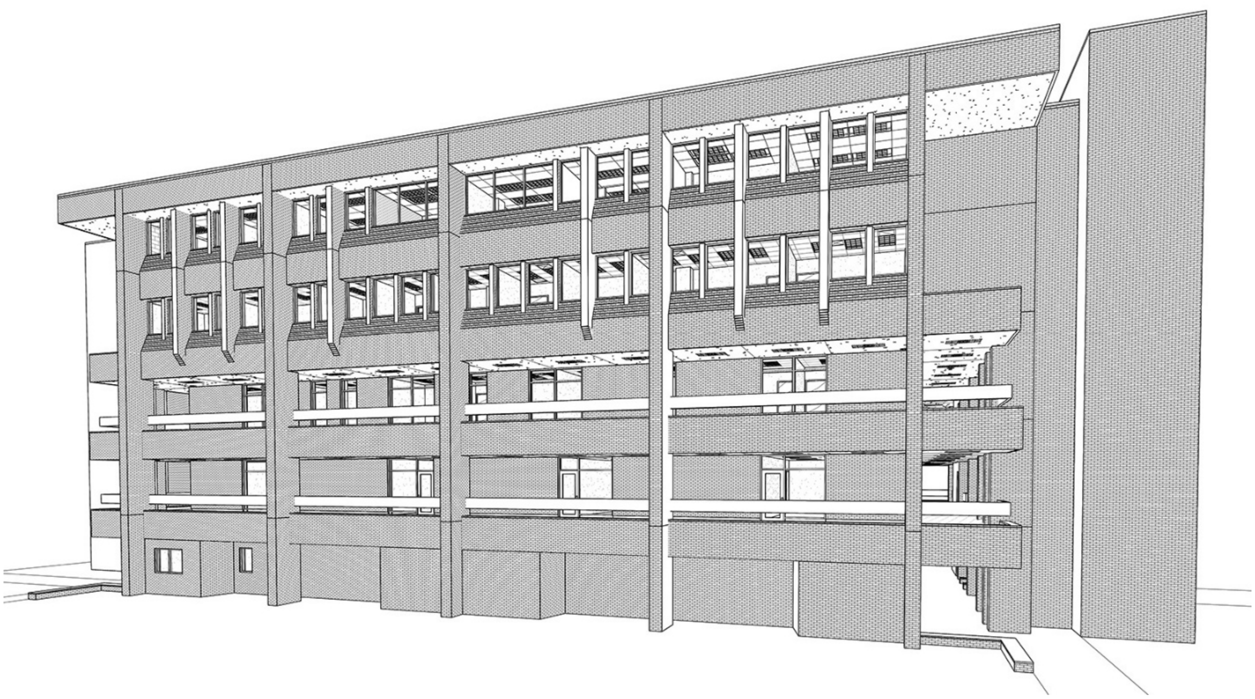
We understand that funding for these renovations is limited. However, we feel that considerable improvements can be made to the interior planning of the building which can provide a better quality working environment for the building occupants. Therefore, we have included descriptions of new ME/FP systems in our report with prices of these options so that the University can understand the cost magnitude of interior and systems renovations.

UCF Standards

In addition to a review of the building for the condition of the facility and its systems, we have also reviewed the building related to any deficiencies from the UCF Standards 2013. These standards list the University's construction requirements for new construction. These items typically exceed the Florida Building Code and Florida Fire Prevention Code requirements, and variances can be obtained for them with good reason and prior approval from UCF Facilities and Safety. None of these items are necessary for Life Safety compliance, but are often "good practice" to keep the facility in its most safe and maintainable condition. This report goes into detail on all of these items under the "UCF Standards" section.

REVIT

During the Architectural analysis of the building, SchenkelShultz created a detailed Architectural Revit model of the project. This model can be used to illustrate the building's floor plans, reflected ceiling plans, building sections, and building elevations. Revit is also a three dimensional software, so perspectives and renderings can also be generated using the Revit model (see below). This Revit model, which can also be exported to CAD files, will be made available for use by UCF, and will form the starting point for the documentation of any renovations for the building as the project moves forward.



Architectural Revit Model, Perspective

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Summary

This report summarizes an analysis of the Architectural, Mechanical and Electrical components of the building which are not related to Life Safety or UCF Standard items. These items include general maintenance and condition of items, waterproofing items, etc. Photos of each item are located in the Building Condition Appendix and are referred to by number throughout this report. Items are classified into PRIORITY categories as described in the Executive Summary; PRIORITY 1 items are CRITICAL, PRIORITY 2 items are POTENTIALLY CRITICAL, PRIORITY 3 items are NECESSARY, and PRIORITY 4 items are RECOMMENDED.

Building Analysis - Architectural

I. Overview – in general, it was observed that the building, as expected for a facility of its age, has many maintenance and condition items which we would recommend correcting or improving. The primary concern is the lack of vapor barrier, waterproofing, and building insulation in the entire exterior skin system. There are also several deficiencies with the current building code (not related to Life Safety) that we have listed in this analysis.

II. Exterior Skin Waterproofing, Towers (Stairs, Elevators, Restrooms, Mechanical) – see pictures A1, A2, and A3
   a. The building façade enclosure consists of a cavity wall system. The cavity depth was noted to vary significantly at different areas of the facility from ½-inch to 9-inches at different façade areas. At the tower locations the CMU backup was not consistently treated with asphalt coating as specified in the design drawings (see details in the Executive Summary), and the locations with asphalt coating were deteriorating significantly. This could lead to water intrusion issues in the future, especially if cracking in the brick skin worsens over time. Additionally there is no vapor barrier or building insulation at these locations.
   b. PRIORITY 2 - This is not an item that can be easily corrected. As described in the Executive Summary, we have two options:
      i. OPTION 1 - this option is to remove the brick and 4" non-reinforced CMU backup, and replace it with a properly installed backup system including cavity wall insulation, waterproof membrane, densglass backup, and cold formed framing structural metal studs tied to the existing building steel. This has the advantage of having a complete new exterior skin which has the desired vapor barrier, building insulation and waterproofing.
      ii. OPTION 2 – this option is to pin the brick to the backup structure using helical ties, and reinforce the 4" CMU backup structure as described in the structural section. This option avoids the demolition of the towers, but does not address the lack of waterproofing and vapor barrier at these portions of the building. However, as these towers are currently primarily exterior elements, this may be acceptable to the University.

III. Exterior Skin Waterproofing, Main Building – see pictures A4, A5, and A6
   a. The building façade enclosure consists of a cavity wall system. The cavity depth was noted to vary significantly at different areas but in general were very tight at the main building (approximately ½") which in many cases the air cavity was filled with mortar rendering the air cavity useless. Waterproofing of the structural steel façade backup consisted of gypsum sheathing shingled over an asphalt faced copper flashing (Photo S46). The gypsum sheathing was not asphalt treated as specified in the design drawings (see details in the Executive Summary). The specified asphalt facing was intended as a

moisture barrier. The joints between adjacent gypsum boards were not taped against water infiltration; moisture deterioration and caking of this material was noted at multiple locations, particularly at the projected façade areas of the Level 2 and Level 3 exterior open corridors (Photo S47). The asphalt faced copper flashing was not installed over the full height of the wall cavity (Photo S48).

b. PRIORITY 2 – This is not an item that can be easily improved – we recommend the complete removal of the exterior skin, including the brick and sheathing, and replacement of the brick at the columns at roof parapet over a properly installed backup system including cavity wall insulation, waterproof membrane, densglass backup, and cold formed framing structural metal studs tied to the existing building steel. The existing windows and brick between columns from level 2 to level 5 will removed and replaced with a curtainwall system. The second and third floor existing exterior circulation will now become interior circulation which will need additional fan coil units in the ceiling to condition the space. See the Executive Summary for additional diagrams and images describing this scope of work.

IV. General Building Cleaning and Maintenance – see pictures A7 to A12

a. PRIORITY 3 – the condition of the building is not very good. The interior of the building appears fairly clean, but the exterior of the building does not appear to have been cleaned in the recent past. Many areas that require cleaning are difficult to reach, such as high soffits, high brick steps, and the exterior windows. The interior and exterior should all be fully cleaned on the building's regular maintenance schedule. This list includes, but is not limited to:

i. Cleaning of exterior soffits
ii. Cleaning of exterior brick ledges
iii. Cleaning and repair of interior coatings on exposed columns
iv. Replacement of window film in damaged areas
v. Cleaning of exit stairs, with consideration for a new floor finish such as epoxy or rubber landings/treads/risers.
vi. Cleaning of Janitor/Telecom Rooms

V. Exterior Handrails – see pictures A13 to A16

a. PRIORITY 2 – the exterior handrails are made of painted steel tubes and C channels. The channels and tubes were designed in a way that allows water to collect on the top surface of the steel – this has contributed to the degradation of the paint coating and some rusting of these components. In addition, several of the handrail connections have serious corrosion, to the point where there may be failure in the joints of the handrails. A temporary solution for these components is to clean, repair, and paint them to prevent further rusting. A more permanent solution would be to replace the handrails with new ones which comply with the current UCF Standards and are not a painted material (aluminum, stainless steel, etc) to avoid the need for long term maintenance. This replacement primarily applies to the handrails on the east and west exterior convenience stairs where the deterioration is most prevalent.

b. PRIORITY 2 – the existing brick curb underneath the handrail is missing several bricks around the second floor walkway. We recommend that these bricks be replaced.

VI. Level 2 and 3 Exterior Walkways, standing water – see pictures A19 to A20

a. PRIORITY 3 – the exterior walkways of the project have standing water during rain events, due to improper sloping of the walkways to the scupper drains. The second floor has a relatively newly installed elastomeric coating which has helped to contain leaks, but the third floor does not have this coating. This problem is a design flaw with the building – it is not good design practice to have an exterior walkable area over interior space due to the difficulty of waterproofing the system. The quick solution to this issue is to apply an elastomeric traffic coating to the third floor, to fix other related problems with the handrails that are causing water intrusion, and to maintain these systems for the duration of the building's life. However, our primary recommendation is to enclose these corridors with glazing and convert them to interior conditioned corridors (see Executive Summary for additional information).

VII. Restroom Conditions – see pictures A19 and A20
   a. PRIORITY 2 – the restrooms in the project are in sore need of remodeling. Their condition is poor. The tile and grout appears dirty, which we believe is not from lack of cleaning but from the age of the building. The entries to the restrooms and several of the fixtures do not meet current ADA clearances – see the Life Safety Analysis for more information. As there are more fixtures than required for this building type (see Life Safety Analysis), it is possible to remodel these restrooms and gain space by eliminating fixtures. These restroom improvements will provide a significant increase in the building occupant's health and welfare.
   b. ASBESTOS – PRIORITY 2 - our investigations did not search for asbestos in any way. However, the April 9, 2013 Asbestos report by AMEC notes on pages 5 and 6 that trace amounts of asbestos were found in the grout in the restrooms. We suggest that the recommendations by AMEC related to this item be followed.

Building Analysis - Mechanical

I. Mechanical Space Ventilation – see picture A10
   a. PRIORITY 2 – ASHRAE Standard 62.1 Table 6-4. The Colbourn Hall janitor closets are currently not exhausted. Per Table 6-4, janitor closets are required to be exhausted at a rate of 1 CFM per square foot. To correct this issue, individual cabinet type inline fans should be installed and ducted to the exterior of the building. The fans are required to be sized for 1-CFM per square foot.

II. Building Envelope – see pictures A3 and A6
   a. PRIORITY 3 – FBC Energy Conservation Section 502.1.1.1 and ASHRAE Standard 90.1 Table 5.5-1. The existing Colbourn Hall exterior walls are not insulated. Per Table 502.1.1.1 (2) of the FBC, walls are required to have a thermal resistance valve of R-19 (U-0.052) or better. Per Table 5.5-1 of ASHRAE 90.1 walls are required to have a thermal resistance value of R-13 (U-0.077) or better. The more stringent of the two codes, R-19 would apply. To meet the Energy Conservation Code, insulation will need to be applied to the exterior walls so that the wall assembly meets the more stringent of the two insulation requirements indicated above, R-19.

III. Mechanical Air Handling Unit Access – see picture M1
   a. PRIORITY 3 - FBC Mechanical Section 306.1 Access for maintenance and replacement. There is not adequate coil pull access or a means of removal for any of the five (5) existing AHU's. Per Section 306.1, "Appliances shall be accessible for inspection, service, repair and replacement without disabling the function of a fire-resistance-rated assembly or removing permanent construction, other appliances, venting systems or any other piping or ducts not connected to the *appliance* being inspected, serviced, repaired or replaced." To allow for replacement of the equipment, double doors with a

removable center column would need to be installed or mechanical OA louvers can be installed large enough to allow for removal of the equipment. Providing proper access for maintenance is more difficult and would require relocation of the AHU and an entire reconfiguration of the room. This report also discusses replacement of the entire HVAC system with a Chilled beam approach. If this recommendation is implemented, the mechanical room would be used to house possibly smaller 100% OA units and could allow for proper clearance for maintenance and accessibility.

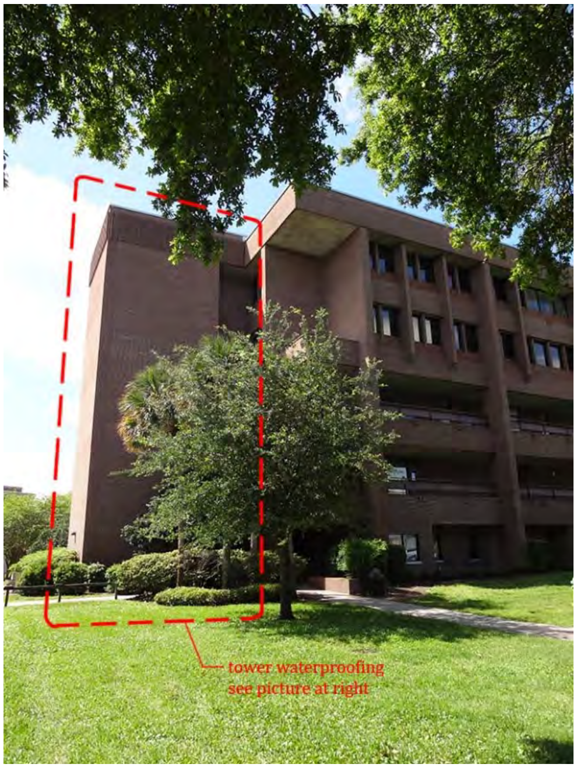
IV. Mechanical Ventilation – see pictures M2 and M3
   a. PRIORITY 3 – FBC Mechanical Section 403.2 and Table 403.3. The 5th floor AHU has no means of balancing ventilation (outside air volume) which results in either over ventilation or under ventilation. Per Section 403.2, "The minimum outdoor airflow rate shall be determined in accordance with Section 403.3. Ventilation supply systems shall be designed to deliver the required rate of outdoor airflow to the *breathing zone* within each *occupiable space*." To correct this issue, the outside air and return air should be ducted to the air handling unit and a means of balancing, via. OA motorized two position damper and manual RA damper, shall be installed.

V. Mechanical Condensate Disposal – see picture M4
   a. PRIORITY 3 – FBC Mechanical Section 307.2.4. The condensate trap height is not correct per the manufacturer's requirements for a draw-through air handling unit configuration. Per Section 307.2.4, "Condensate drains shall be trapped as required by the *equipment* or *appliance* manufacturer." There are two approaches to allow for proper trapping of condensate. One, the AHU can be raised and placed on base rails high enough to allow for a proper trap height. Two, the condensate trap can be constructed in the mechanical hub drain to allow for the piping to drop below the slab.

Building Analysis - Electrical

I. Lighting in Mechanical Rooms
   a. PRIORITY 4 – NFPA 70, NEC 300.22 Wiring in Ducts, Plenums, and Other Air Handling Spaces; NFPA 90.A 4.3.11.4 Air-Handling Unit Room Plenum; the fifth floor mechanical room is currently used as a plenum space. NEC 300.22.(B) requires that the light fixtures used in such a space. The existing light fixtures currently are open lamp pendant mounted incandescent fixtures. It is recommended that these be replaced with gasketed vaportight fixtures to comply with the NEC.

Appendix A – Building Condition Photographs



A1 – tower waterproofing – see A2, A3

A2 – tower waterproofing lacking

A3 – tower waterproofing lacking – cavity waterproofing coating, small air space, no insulation

Appendix A – Building Condition Photographs

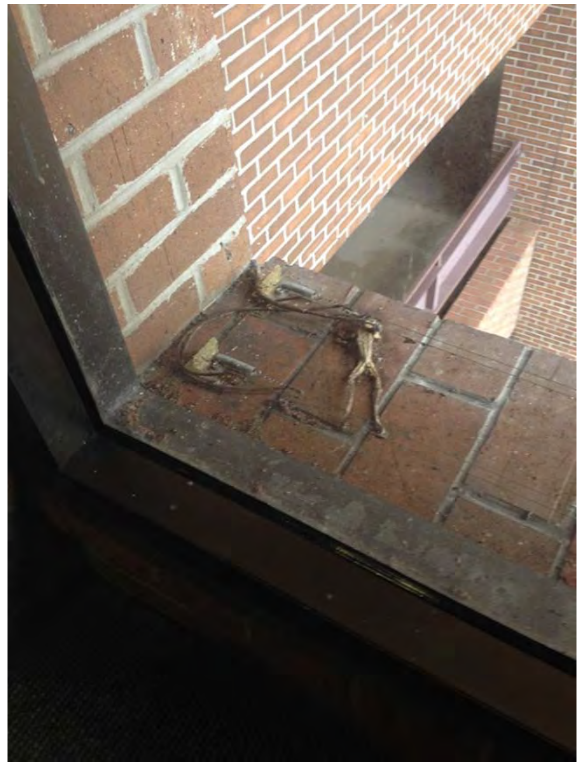
A4 – main building waterproofing – see A5, A6

A5 – main building waterproofing lacking

A6 – main building waterproofing lacking – gwb with no waterproof coating, small air space

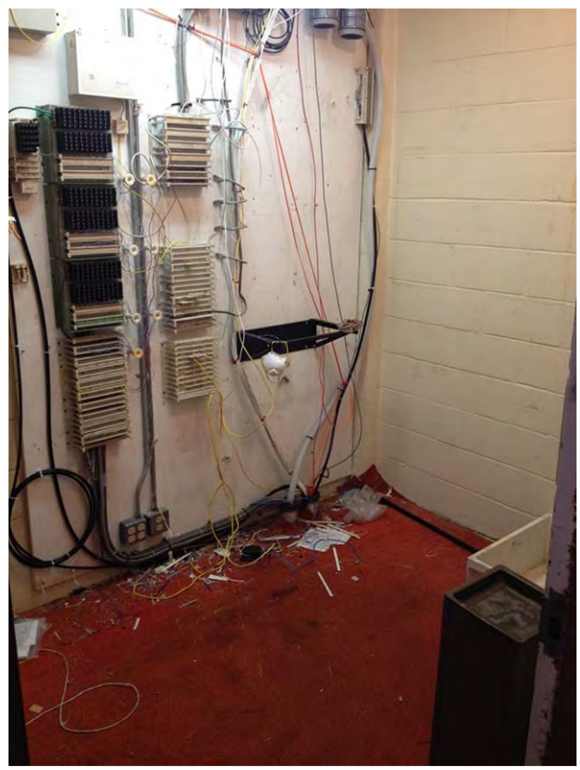
Appendix A – Building Condition Photographs

A7 – exterior soffit and brick maintenance



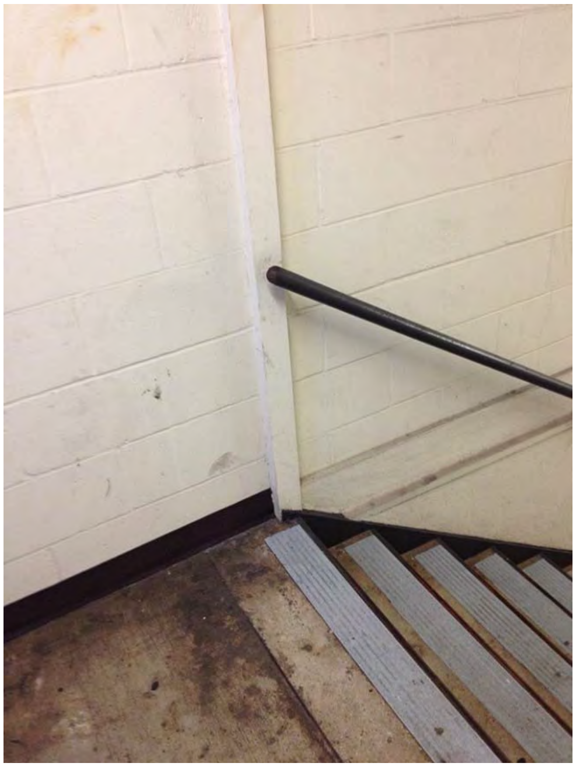
A8 – exterior maintenance, window cleaning

A9 – column maintenance and repair



A10 – Janitor/Telecom cleaning

Appendix A – Building Condition Photographs



A11 – stair condition

A12 – window film peeling, needs replacement

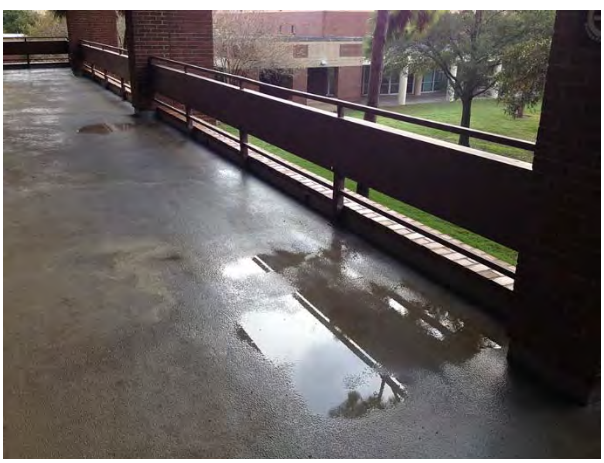
A13 – handrail corrosion

A14 – handrail corrosion

Appendix A – Building Condition Photographs

A15 – handrail base brick missing (several places)

A16 – handrail standing water



A17 – standing water

A18 – standing water

Appendix A – Building Condition Photographs

A19 – restroom, hole in wall, patch

A20 – restrooms

Appendix A – Building Condition Photographs

M1 – insufficient AHU coil pull clearance

M2 – level 5 OA intake w/ no balancing

M3 – level 5 AHU return air opening

M4 – Level 5 condensate p-trap

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Summary

This report summarizes an assessment of the building enclosure façade system and structural components of the building. Photos of each item are located in the Structural Analysis Appendix and are referred to by number throughout this report. Exhibits are also included in the Appendix. Items are classified into three categories of PRIORITY 1 – Critical, PRIORITY 2 – Potentially Critical and PRIORITY 3 - Necessary. Items in the first category require immediate action to correct a safety hazard, to stop accelerated deterioration of a building element, or to return the facility to normal operation. Items in the second category will become critical if not corrected within approximately a year and include potential safety hazards, repair of deteriorating items, and items causing intermittent building interruptions. Items in the third category include repair of items with predictable unacceptable deterioration where, if left unaddressed, will cause potential building downtime or higher costs of replacement in the future.

Objective

I. The objectives of the recently performed assessment were as follows:
   a. Review available drawings, reports, and construction documents relevant to the building enclosure façade system and structural components of the building;
   b. Evaluate the existing condition of the building enclosure façade through visual observations, non-destructive testing, and exploratory openings;
   c. Analyze the wind load capacity of the existing structural steel frame of the building, exterior walls and window and door openings;
   d. Provide schematic recommendations to repair observed distress and deficient façade and structural components.

Document Review

I. As part of the assessment, the following documents were reviewed to develop a better understanding of the building façade and structure:
   a. Architectural and structural drawings for the building prepared by Paras Associates and entitled Second Bid Package with an issue date of 2/19/73.
   b. Visual structural assessment report by The Raad-Tannous Engineering Group, Inc. dated December 3, 2012.

Building and Façade Description

Construction of the five-story Colbourn Hall facility commenced circa 1973 and was reported to have been performed in multiple phases by different general contractors. The core area of the building is currently used for office and classroom space. Four attached tower structures at the corners of the building are used for mechanical rooms, restrooms, and pedestrian access via elevators and stairs. Additional pedestrian access from Level 1 to Level 2 is provided by two stairs at the east and west ends of the building. Exterior open corridor walkways are located at the Level 2 and Level 3 building perimeters. There is a corbelled or stepped façade section at Level 4 and Level 5 of the core building area. Figure 1 shows a representative annotated isometric elevation of the facility.

The primary structural components of the building include roof and floor open web steel joists and joist girders, elevated concrete slabs on metal deck, tube steel columns, and isolated column footings and continuous wall footings. The building appears to have been designed and constructed to resist lateral wind loads with roof and floor diaphragms that collect wind loads from the exterior cladding and transfer the loads to moment resisting frames consisting of steel joists and joist girders, tube steel columns and isolated column footings.

The building façade typically consists of a cavity wall system with brick veneer and aluminum framed punched windows. Gravity loading from the brick veneer is supported by continuous shelf angles attached at the main core area of the building. The out-of-plane lateral load resisting system for the brick façade varies at different areas of the building; generally consisting of ladder reinforcement and metal ties attached to concrete masonry units (CMU) and miscellaneous steel framing structural backup systems, respectively.

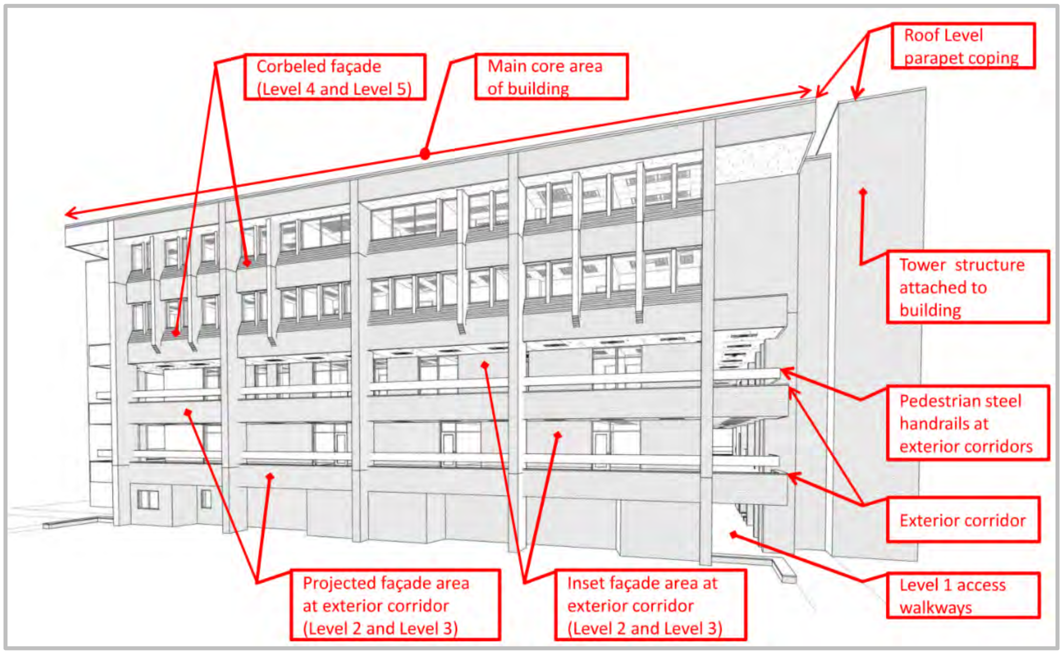

Figure 1. Representative elevation of UCF Colbourn Hall (north elevation as shown)

Background

I. Miscellaneous façade and structural repairs and condition assessments of Colbourn Hall were performed previously. The most recent assessment was performed by The Raad–Tannous Engineering Group, Inc. (RTEG) during June and October, 2012. It is our understanding that the assessment was prompted by concerns of deficient construction based on conditions encountered during 2012 renovations on Level 1. The findings of this assessment were documented in RTEG's report dated December 12, 2013. The report identified various existing constructed conditions relating to the building enclosure façade and structural components that either did not conform to information provided in the original construction drawings, did not appear to comply with requirements of the 2010 Florida Building Code or otherwise required repair in the opinion of RTEG.

Description of Survey

I. Walter P Moore engineers performed visual observations of the existing façade and structural components of the building on December 17, 18, 19, 20, 23 and 24, January 3, and February 1, 2014. Clancy & Theys Construction Company personnel assisted with access equipment to conduct observations, façade exploratory openings, footing excavations, and selective removal of gypsum wallboard finishes. Our field evaluation of the existing building façade systems consisted of the following tasks.

a. Visual observations of the brick veneer and façade components were conducted at each exterior elevation of the building using binoculars from adjacent walking surfaces.
b. Close-up observations and exploratory openings were performed at selected façade areas using ladders and aerial lift equipment operated by Clancy & Theys.
c. The brick veneer was observed for evidence of problem conditions, including erosion, cracking, chipping, staining, and spalling.
d. Where accessible, the mortar joints were observed for erosion, staining, cracks, and separations.
e. A total of thirteen exploratory openings were performed as part of the façade assessment.
f. At the exploratory openings, the following items were observed:
    i. The condition and construction of the brick veneer;
    ii. Size, type, and general condition of the metal shelf angles where applicable;
    iii. Presence and condition of the brick ties and structural backup systems;
    iv. Presence and condition of the waterproofing systems; and
    v. Evidence of previous water infiltration.

Field assessments of structural components included observation and documentation of column footings, joist girders, joists and columns in numerous areas on all floors throughout the building. Lay-in acoustical ceiling tile were temporarily removed to provide access to the structural components for visual observation and documentation. While documenting these components from above the ceiling line, we observed other conditions such as window head support conditions and discontinuous CMU backup walls. Two column footings were partially excavated to allow for visual review, documentation and non-destructive testing.

Observations made during the field assessment were recorded by means of field notes and photographs. Representative photographs showing typical distress conditions identified during the field observations are provided in the Appendix for additional reference.

Definitions

The definitions of terms used in this report are given below. Note that when terms are applied to an overall system, certain portions of the system may be in a different condition.

GOOD: Component is in a “like new” condition requiring no rehabilitation and is performing its function as intended.

FAIR: Item is in sound condition and performing its function. The component is exhibiting some signs of normal wear and tear. Some incidental rehabilitation work may be recommended.

POOR: Component is performing adequately at this time but the component’s rate of deterioration has begun to accelerate.

FAILED: Component has either failed or cannot be relied upon to continue performing its original function. Repair or replacement is required. Item exhibits deferred maintenance. Repair, replacement, or maintenance is required to prevent further deterioration.

Observations

I. The exterior surfaces of the brick veneer were visually reviewed from the adjacent walking surfaces and through up-close exploratory openings. Brick veneer and mortar joints, structural backup substrates, and waterproofing elements of the façade were reviewed and documented. The primary structural members that comprise the gravity and lateral load carrying systems in the core area of the building and in one of the attached tower structures were visually reviewed from a ladder. Joist girders, joists, steel beams and columns located in various areas of the structure were reviewed and documented. Miscellaneous conditions such as discontinuous CMU backup walls and window head support conditions were observed while reviewing the primary structural members above the suspended ceiling. General observations for the components reviewed and documented during this assessment are provided below.

   a. Brick Masonry Veneer - The exterior skin of the building façade consisted of a brick masonry cladding system that was in generally fair condition. Miscellaneous distress conditions including loose overhead brick, deflection, cracking, and spalling, were noted at various façade locations.

      Locations of loose and missing brick were noted at the top course of brick below the parapet coping cap at the attached tower structures (Photos S1 and S2). At the northwest attached tower structure a cracked brick section was able to be readily dislodged by hand (Photos S3 and S4). The wood nailer attaching the parapet coping cap was fastened to the top course of failed brick thereby potentially resulting in a loss of uplift capacity at this area (Photo S5). Lateral and vertical deflection of the brick coping at the exterior corridor projected façade was observed at multiple locations, including above the Level 1 access walkways (Photos S6 and S7). Potentially loose overhead brick were observed at isolated locations of the bottom brick courses above the shelf angles at the Level 2 exterior corridor façade above the Level 1 access walkways (Photo S8). Brick cracking varying in width from 1/64-inch to 1/4-inch was observed at multiple locations (Photos S9 to S11). Brick face spalls were observed at isolated façade locations (Photos S11 and S12). The horizontal joint between this spalled brick and shelf angle leg was filled with rigid mortar rather than a flexible sealant, thereby providing inadequate allowance for volumetric movement of the brick wall.

   b. Mortar - The brick masonry units are bonded together as an integral wall system using mortar, which also provides weather protection to the cavity wall system components behind the exterior wall. The brick mortar joints were observed to be in generally fair condition (Photo S13) with isolated locations of cracked mortar joints (Photo S14).

      Separated mortar joints were noted at the Level 2 and Level 3 exterior corridor façade and at the bed joint between the fourth to fifth brick courses below the top of the roof parapet (Photos S6 to S7 and Photos S15 to S17). Through-wall flashing noted in the brick bed joints at these locations appears to have acted as a bond-breaker preventing adequate brick-to-brick adhesion through the mortar joint.

   c. Structural Backup Systems - Structural backup systems were intended to transfer the gravity and lateral loads from the brick masonry veneer back to the main structural framing of the building. The structural backup systems for the veneer were noted to vary and be constructed with inconsistent quality at different areas of the building. Figure 2 provides an annotated diagrammatic representation of the typical façade gravity and lateral structural backup systems observed during this assessment.

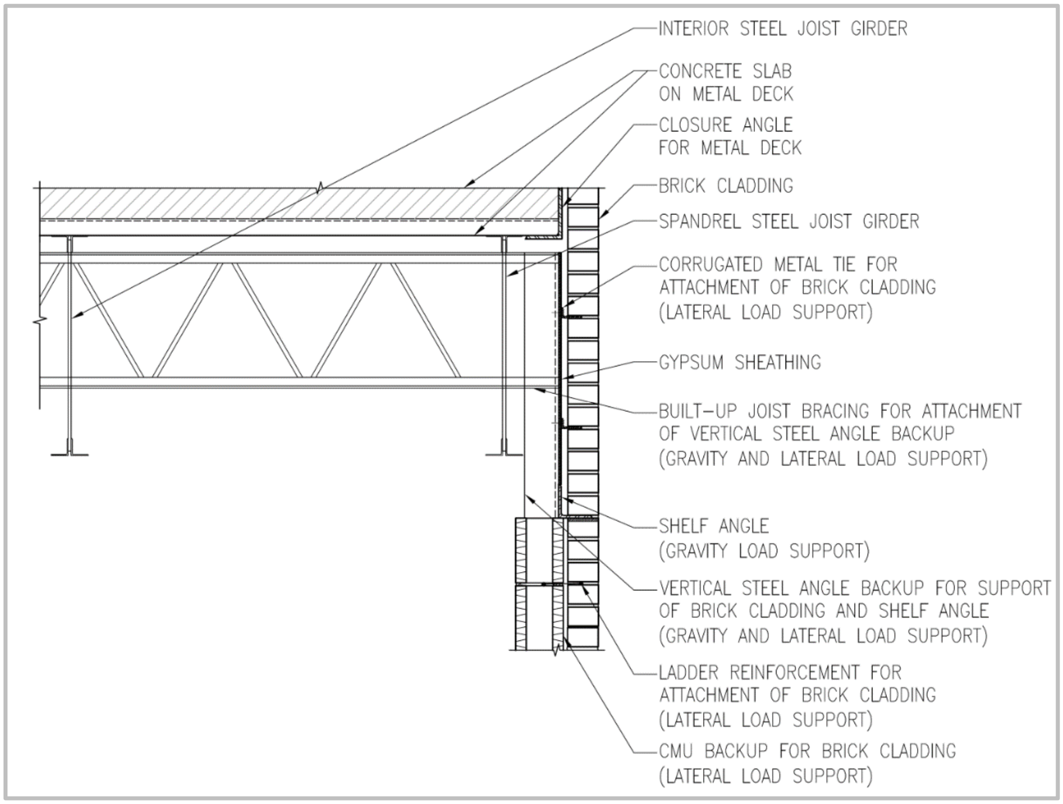

Figure 3. Diagrammatic representation of the typical façade gravity and lateral structural backup systems.

d. Brick Masonry Support for Gravity Loads - The gravity load supports were noted to vary from steel shelf angles at the main core area of the building to continuous brick stacking at the attached tower structures. Continuous brick stacking refers to the condition where the veneer is supported only at the base of the wall.

   The shelf angles were typically welded to vertical steel angle structural supports. An approximate 9-inch span at the base of the backup vertical steel angles was typically noted to be cantilevered to the connection point of the horizontal shelf angles. This cantilevered span of the backup vertical steel angles was not braced back to the building's main structural framing to mitigate rotational deflection of the angles. However, rotational deflection of the shelf angles was not observed.

   Exploratory openings at selected main building core façade areas were performed at various shelf angle locations that exhibited steel corrosion and cracking of the adjacent brick veneer (Photo S18). This was done to identify the underlying causes of these distress conditions and the general as-built construction at these façade locations. Corrosion buildup and interlayer delamination of the shelf angles were observed at the majority of exploratory openings (Photos S19 and S20). Field thickness measurements of the shelf angle leg at Exploratory Opening 1 indicated that the delaminated steel sections had expanded to approximately twice the thickness of the cleaned steel substrate (Photos S21 and S22). These corrosion induced expansion forces at the shelf angles have likely contributed to the observed brick and mortar cracking distress.

An approximate 5-inch section of discontinuous spliced shelf angle was noted at Exploratory Opening 3 (Photos S23). Moderate corrosion distress was noted at this shelf angle section; additionally, the outbound 4-inches of the vertical leg of the angle had been removed during the original construction to allow for field fit-up purposes. Rotational deflection of the base brick course above this discontinuous shelf angle section was also noted (Photos S24).

Exploratory openings and non-destructive testing performed at the attached tower structures did not reveal shelf angles at these locations. This finding indicates that the brick gravity loads at these locations are likely supported by stacking of the brick over the full height of the tower structures.

e. Brick Masonry Support for Lateral Loads - Lateral wind loads are resisted by brick wall ties attached to structural backup systems. Corrugated metal ties fastened to vertical steel angles or metal studs, wire tie loops welded to steel tube columns, and ladder reinforcement ties embedded in the backup CMU wall were all observed during the assessment.
    i. Vertical Steel Angles - Field observations indicated that vertical steel angles were used for the structural backup system in some sections of the façade. The brick masonry backup angles were typically spaced at approximately 17-inches on center and were connected back to the structure one of the following two ways.
        1. Angles were attached to built-up joist bracing assemblies spanning perpendicular to the brick masonry veneer using steel tab plate welded connections (Photo S25).
        2. Angles were tack welded to the metal deck steel closure angle and the bottom chord of the spandrel joist girder (Photo S26).

    Figure 3 shows an annotated photographic representation of the typical façade backup vertical steel angle framing.

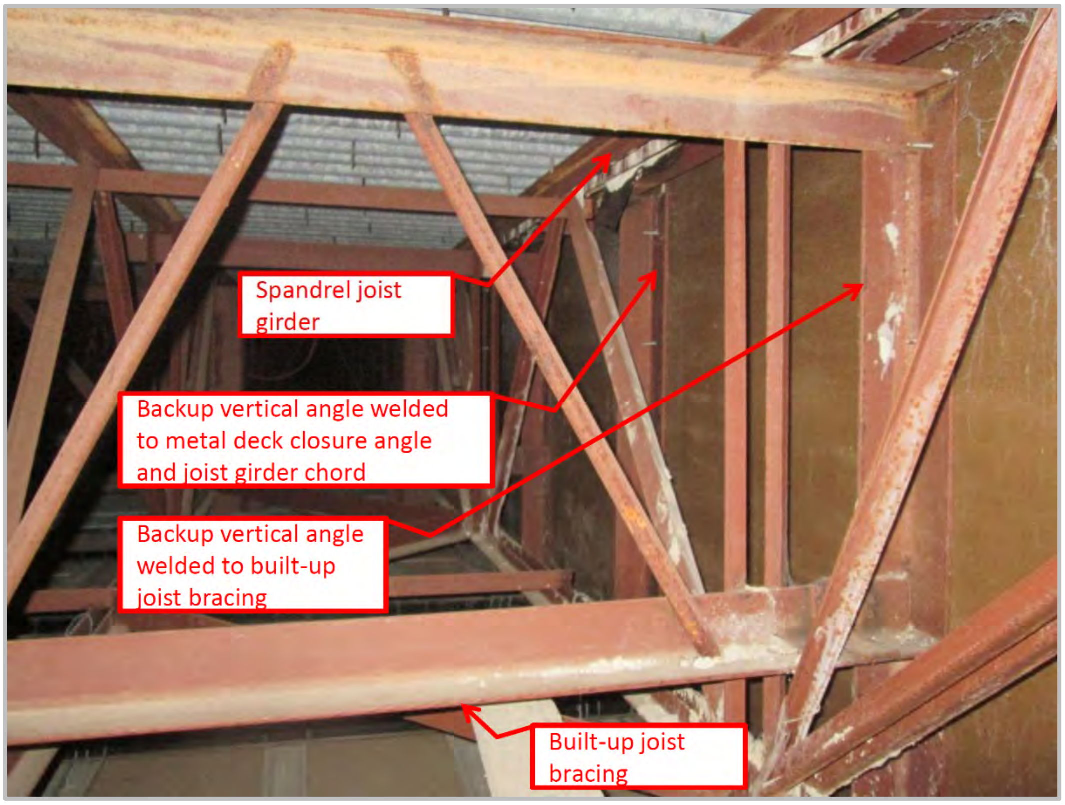

Figure 3. Photographic representation of the typical façade backup vertical steel angle framing

ii. Metal Studs - Cold-formed steel studs serve as the brick masonry structural backup system at Exploratory Opening 6 located at the attached tower at the northeast corner of the building (Photo S29). The metal studs at this location were spaced at approximately 24-inches on center and were fastened to horizontal metal tracking; the metal tracking was fastened to the top and bottom chords of the spandrel joist (Photo S30). The cold-form stud and track framing at this exploratory opening was noted to be in fair condition.

iii. CMU - Observations of CMU backup walls were able to be made from the interior of the building by temporarily removing ceiling tile, from the Level 2 exterior corridor at an access panel and at a façade exploratory opening. Visual review of the backup walls was not possible from many of the interior locations where ceiling tile was temporarily removed because of gypsum wallboard that extended above the ceiling to the floor slab above. This was the case at all locations where access to the backup walls was attempted on Levels 2 and 3. The observations were limited to wall sections proximate to the points of access. The backup walls observed on these levels were comprised of 6" CMU as noted on the drawings. The backup walls on Levels 2 and 3 occur at the inset walls at the exterior corridors (Photo S72). Consistent with the information shown on the drawings, we found that these walls are not full-height walls continuous from floor-to-floor.

A Level 1 veneer backup wall on the north side of the building was observed from façade Exploratory Opening 1 (Photo S73). The top course of masonry in the backup wall had not been grouted as called for in the design drawings (Photo S74). Anchor rods hung from joist bottom chords were set in the top masonry course as shown in the architectural drawing details. However, these connections provided no lateral restraint to the tops of the backup walls since the top courses of masonry had not been grouted.

Another section of a Level 1 veneer backup wall was reviewed from the Writing Classroom located at the southwest corner of the building. The top course of masonry in this section of the wall was grouted (Photo S75) and a vertical reinforcing bar was observed. Anchor rods hung from joist bottom chords were embedded in the top course per the design drawings. Although this backup wall contained vertical reinforcement and a grouted top course of masonry, we were told by Clancy & Theys that this wall was reinforced and grouted during recent building renovations.

The top of a Level 3 veneer backup wall on the north side of the building was accessed through an access panel in the exterior corridor soffit (Photo S76). Anchor rods hung from joist bottom chords had been embedded in the top course of masonry which had been grouted in the section observed.

The design drawing details specify 4” CMU backup walls at Levels 4 and 5. Short CMU walls are located below the punched windows on these levels (Photo S78). The drawings indicate that full-height CMU backup walls are located at the corners of both levels. One of these walls on Level 4 was reviewed from above the ceiling. The top course of masonry in this wall was not grouted. We also reviewed one of the backup walls on Level 5 from above the ceiling and the top course of this wall was grouted. The interior face of the short CMU walls below the punched windows is exposed at the east and west ends of both floors.

The design drawings indicate that the mechanical, restroom and stair/elevator towers at the four corners of the building have veneered construction with CMU backup walls. The interior face of the CMU backup wall is exposed inside the mechanical tower but concealed by finishes inside the restroom and stair/elevator towers. Measurements of the width of the backup wall inside a mechanical room were made at existing holes in the face shell of individual masonry units. These measurements indicated that the backup wall is constructed from 4” concrete masonry units. Inside the same mechanical room the ends of masonry units were exposed at a corner where the backup wall jogs around a steel column (Photos S79 and S80). These masonry units were 4” wide.

Exploratory openings at both the core building and attached tower structure revealed that a fluid-applied asphaltic dampproofing system was typically applied to the exterior face of the CMU backup walls (Photo S31).

f. Brick Ties - Multiple types of brick tie attachments were noted during the review, including corrugated metal ties at vertical steel angles and metal studs, wire ties at structural steel columns, and ladder reinforcement ties at CMU wall backup systems. A description of the various brick tie observations follows.

Corrosion of the corrugated metal ties was noted at multiple exploratory openings, particularly at the projected facades of the Level 2 and Level 3 open corridors (Photo S32). Additionally, multiple locations where corrugated metal ties were either not installed or turned down for embedment in the brick masonry bed joints were noted (Photos S33 and S34). Corrugated metal ties attached to the vertical steel angle backups were typically spaced at approximately 18 inches on center vertically and 17 inches on center horizontally. Corrugated metal ties attached to the metal studs at the attached tower structure façade at Exploratory Opening 6 were spaced at approximately 29 inches on center vertically and 24 inches on center horizontally.

Wire ties attaching the brick masonry to steel columns were noted at Exploratory Openings 5, 7 and 10. A missing welded wire tie was noted at Exploratory Opening 5 (Photo S35). Corroded wire ties and a broken welded connection were noted at Exploratory Opening 7 (Photos S36 and S37). The wire ties at Exploratory Opening 10 were in generally fair condition (Photo S38).

Horizontal masonry ladder reinforcement was utilized to tie the brick masonry to the CMU backup walls. Ladder reinforcement ties attached to the Roof Level slab were also noted at the areas adjacent to the parapet wall. Multiple locations were noted where the ladder reinforcement ties were either not embedded or were only partially embedded in the bed joint of the brick masonry (Photos S39 to S41).

Non-destructive testing indicated that the ladder reinforcement spanning between Exploratory Openings 12 and 13 was discontinuous; further review determined that an approximate 10-foot section of the ladder reinforcement projecting from the face of the CMU wall at this area had been cut during original construction (Photo S41).

g. Doors and Windows - The design drawing details indicate that the doors and windows in the inset wall at the exterior corridors of Levels 2 and 3 (Photo S81) are anchored at the jambs into the brick veneer and are braced back to floor joists at the head. Connection of the window frames at the sills to the existing concrete curbs is also likely. The heads of these doors and windows were not accessible from the building interior due to gypsum wallboard that extended from the ceiling line to the floor slab above. Destructive testing was not performed at door or window jambs. However, RTEG reported that door and window frames are anchored into the hollow brick veneer.

Wind loads on doors and windows appear to be currently transferred into the brick veneer and, where adequate connection of the veneer to the backup wall exists, to the unreinforced CMU backup walls.

Small brick pilasters separate the punched windows on the exterior elevations of Levels 4 and 5 (Photo S82). Observations performed above the ceiling revealed that the pilasters are unreinforced. The connection of the windows to the structural framing at the window head was also reviewed while performing observations above the ceiling (Photo S83). Small vertical angles are welded to and hung from the bottom chords of joists located above the windows (Photo S84). These vertical angles are welded to and support a small steel channel. It appears that the window frames are attached to this channel at the head of the windows.

No destructive testing was performed at the jambs or sill of the windows to evaluate the window connections in these areas. The design drawings indicate that the windows are set on solid brick sills supported by a short 4" CMU wall.

The sealants and weatherproofing gaskets at the exterior doors and windows were noted to be in generally fair condition with isolated failure locations (Photo S45). These systems will require maintenance and/or repair in the near future.

h. Sealants - Joint sealants were observed at brick masonry veneer expansion joints, through-wall penetrations, and transitions to metal louvers and windows (Photos S42 to S44). In general, the sealant at these areas was noted to be in a failed condition. The façade sealant typically exhibited either cohesive tears due to material reversion or adhesive failures, and appears to have generally exceeded its serviceable life. In some cases, mortar was observed within the depth of expansion joints. This renders the expansion joints ineffective.

i. Cavity Wall Waterproofing - The building façade enclosure consists of a cavity wall system. The cavity depth was noted to vary significantly at different areas of the facility from 1/2-inch to 9-inches at different façade areas.

   Waterproofing of the structural steel façade backup consisted of gypsum sheathing shingled over an asphalt faced copper flashing (Photo S46). The gypsum sheathing was not asphalt treated as specified in the design drawings (see Detail 2/A-21). The specified asphalt facing was intended as a moisture barrier. The joints between adjacent gypsum boards were not taped against water infiltration; moisture deterioration and caking of this material was noted at multiple locations, particularly at the projected façade areas of the Level 2 and Level 3 exterior open corridors (Photo S47). The asphalt faced copper flashing was not installed over the full height of the wall cavity (Photo S48).

   Weep holes for drainage of incidental moisture that enters the cavity wall were not installed during the original construction as required by the design drawings. Detail 10/A-21 calls for weep holes at a spacing of 4'-0" above shelf angles. Isolated locations of post-installed weep holes have been installed; however, vegetative growth was noted in the majority of these locations (Photo S49). Additionally, mortar droppings were noted in the cavity walls at several exploratory openings that may inhibit free drainage of the cavity wall.

j. Exterior Stairs – The exterior stairs at the east and west ends of the building were reviewed. Deterioration of the surfaces of stair treads, risers and landings was observed on both stairs. Distress features included spalling and cracking. The east stair appears to have undergone some differential settlement.

k. Foundation - Two column footings in the core area of the building were exposed to study the as-built construction of the building (see Exhibit X-14). Clancy & Theys excavated the overburden soils at the footings to partially expose the concrete foundations for visual review and testing.

i. Exterior Footing - An exterior column footing on the north side of the building was partially exposed so that the top surface of the footing and one side face could be observed (Photos S50 and S51). No signs of unsound or distressed concrete were observed on the exposed surfaces. The overall plan dimensions of the footing are approximately 8 feet by 7 feet. The thickness of the footing was 32 inches and the top of the footing was approximately 46 inches below prevailing grade.

   A section of the north exterior wall footing was also exposed when the exterior footing was excavated (Photo S52). The depth of the wall footing was approximately 12 inches at this location whereas Detail 4/S-2 of the design drawings indicates an 8 inch deep typical wall footing. Brick veneer is stacked on two courses of CMU which bear on the top of the continuous wall footing whereas the referenced detail shows the brick veneer extending down to and bearing on the top of the wall footing.

ii. Interior Footing - Excavations at an interior column footing partially exposed the top surface of the footing and one side face (Photos S53 and S54). No signs of unsound or distressed concrete were observed on the exposed surfaces. The overall plan dimensions of the footing are approximately 12 feet by 12 feet. The footing thickness was 32 inches and the top of the footing was located 34 inches below the top of the slab-on-grade.

In summary, the footprint of the two columns appears to correspond well with the graphical depiction of these footings on Sheet S-3 Foundation Plan. Specifically, the size of the footings approximated by scaling of the foundation footprints outlined on Sheet S-3 is consistent with our field measurements of the excavated footings.

l. Structural Steel Frame (Core Area of Building) - Acoustical ceiling tile were temporarily removed throughout the building in various areas of each floor to review and document the existing tube steel columns, joist girders, joists and metal deck (Photo S55). In many locations where ceiling tile was removed, especially at the perimeter of the building, the structural framing was obstructed because of gypsum wallboard that extended from the ceiling line to the floor slab above. It is estimated that over 200 ceiling tile were temporarily removed during our review of the structural framing. Please refer to Exhibits EX-14 through EX-18 for the locations of our above-ceiling observations.

   i. Columns - Approximately fifteen columns were reviewed in detail during the field assessment. Each of these were 10”x10” tube steel columns (Photo S56). Ultrasonic thickness (UT) testing was performed to non-destructively evaluate the wall thickness of each of these columns. Refer to the section *Non-Destructive Evaluation* for information on this testing.

   ii. Joists and Joist Girders - Detailed measurements of joist and joist girder top and bottom chords and web members were made with a tape measure and a digital caliper (Photos S57 to S59). Joist girder top and bottom chords and web members consisted of double angles. The vertical web members at both ends of the joist girder spans were steel plates. Joist top and bottom chords consisted of double angles. Joist web members were either double angles or folded angles and the vertical web members at both ends of the joist spans were steel plates. Joist tags were found on several of the joists we reviewed (Photo S60). These tags were used to research the likely Steel Joist Institute (SJI) designation of the existing joists.

Structural connections of the joists and joist girders to their supporting columns were documented (Photo S61). Joists and joist girders located along the column lines were connected to the columns at both the top and bottom chord (Photos S62 and S63). The welded connections of the top and bottom chords to the columns indicates that the connections were designed to resist bending moments. The roof level joist girders and joists were different than the joists and joist girders in all other areas of the building in that they did not have moment-resisting connections to their supporting columns.

The elevated floors consist of concrete on 1-1/2" steel form deck. An existing penetration through the Level 2 floor slab permitted measurement of the thickness of the elevated floor slab. The total thickness of the slab was approximately 4-1/4" at this location.

Steel columns, joists, joist girders and steel deck were observed at three different locations below exterior corridors on Level 2 and Level 3 (Photo S64). Corrosion of these components from long-term water intrusion was observed at each of the three locations (Photos S65 and S66). Section loss due to corrosion of the columns, joists and joist girders appeared to be limited. Isolated areas of metal deck exhibited extensive corrosion damage (Photos S67 and S68). It is important to note that we only observed corrosion of columns, joists, joist girders and steel deck in areas under the Level 2 and Level 3 exterior corridors during our field survey.

m. Structural Steel Frame (Attached Towers) - The primary steel framing inside a typical mechanical tower room was reviewed (Photos S69 to S71). Like the core area of the building, columns in the tower reviewed are tube steel members. The tower floor framing differed from the joist/joist girder floor framing in the core area of the building. Instead the floor framing structure in the tower consisted of wide-flange steel beams. Beam-to-column joints have moment-resisting connections with the bottom flange, web and top flange of the beams welded to the columns. It appears that the main wind force resisting system of the towers consists of moment-resisting frames as found in the main building.

Exploratory Openings Summary

I. Exploratory openings were performed at selected façade locations using ladders and aerial lift equipment operated by Clancy & Theys. These exploratory openings were performed for up-close assessment of the existing condition and as-built construction of the brick masonry façade system components. A total of thirteen exploratory openings were performed as part of this assessment at the north, south, and west elevations.

While observations made at the exploratory openings have been highlighted previously in the *Observations* section of this report, the following provides a summary of the conditions encountered during our field review.

The exploratory opening assessment indicates that the type and quality of façade construction varied significantly at different areas of the facility. Multiple types of structural and waterproofing distress conditions were noted, including the following:

a. Loose overhead brick
b. Brick cracking and/or spalling
c. Mortar cracking and/or separation due to through-wall flashing as bond breaker in masonry bed joint
d. Corroded shelf angles and structural steel framing
e. Corroded corrugated metal ties
f. Unengaged corrugated metal brick ties
g. Missing corrugated metal or wire ties
h. Corroded wire ties
i. Failed weld at wire ties
j. Unengaged ladder reinforcement ties
k. Failed sealant
l. Inadequately flashed cavity wall waterproofing

Exhibit EX-0 provides a summary table of the distress conditions encountered at each exploratory opening. Exhibits EX-01 through EX-13 show representative photographs of the observed conditions at Exploratory Opening 1 through Exploratory Opening 13.

Non-Destructive Evaluation

I. In addition to visual observations of the column footings, CMU backup walls and building columns, limited nondestructive testing was performed in an effort to locate embedded reinforcing steel in the footings and backup walls and evaluate the wall thickness of tube steel columns.

a. Short Pulse Radar (SPR) - Commonly known as ground penetrating radar, SPR is a non-destructive technique that emits a short pulse of electromagnetic energy, which is radiated into the medium being evaluated. When this pulse strikes an interface between layers of materials with different electrical properties, part of the wave reflects back, and the remaining energy continues to the next interface. SPR evaluates the reflection of electromagnetic waves at the interface between two different dielectric materials. The penetration of the waves into the medium is a function of the media relative dielectric constants (ε). If a material is dielectrically homogeneous, then the wave reflections will indicate a single thick layer.

SPR is particularly effective for evaluating the presence and location of steel reinforcement in existing concrete and concrete masonry structures. This is because of the very different dielectric properties of concrete and steel. Concrete is a low conductivity, non-metallic medium that is ideal for SPR signal propagation. Steel on the other hand is highly conductive and therefore completely reflects the SPR signal. It is this reflection that identifies embedded steel reinforcement.

i. Column Footings - The SPR scanning at the two column footings exposed proved to be ineffective in locating existing reinforcing steel on this project. The shallow subsoils in both areas appeared to have a high moisture content which resulted in the footing concrete being in a relatively saturated condition. Water in the free pores of concrete elements attenuates the SPR signal, limiting the effective depth of the scan.

ii. CMU Backup Walls – SPR scanning was performed on the interior surface of backup walls in the core area of the building (Photo S77), in a mechanical tower room and in a stair tower. The testing was performed to non-destructively evaluate whether vertical cells were grouted with reinforcing steel (see Exhibits EX-14 through EX-18). None of the scans detected grouted cells or vertical reinforcing steel in the CMU backup walls.

b. Ultrasonic thickness (UT) gauges make instant digital measurements of material thickness by transmitting high frequency ultrasonic pulses into a material. The gauges then measure the time taken for an echo to be received from the back wall. UT gauges use this data along with the sound velocity of the material being measured to determine the thickness of the material.

UT thickness gauge measurements of tube steel columns revealed that the wall thickness of the columns varied. UT readings of columns on Level 3, Level 4 and Level 5 ranged from approximately 0.35” to 0.37”. Wall thickness readings ranging from approximately 0.31” to 0.63” were obtained from measurements of Level 1 and Level 2 columns.

Lateral Wind Load Analysis

I. Overview – A lateral wind load analysis of the building was performed based on information obtained during our field assessment and a review of the available design documents. Typical moment-resisting frames in the north-south and east-west directions of the building were analyzed. In addition, a review of the Florida Building Code requirements for existing buildings undergoing renovations was conducted.

a. Lateral Analysis - We began our evaluation by comparing the design wind pressure criteria shown on the design drawings with the pressures that would be calculated based on the 2010 Florida Building Code. We found that the pressures calculated from the 2010 code are lower than those shown on the design drawings and result in approximately 40 percent lower lateral forces at the foundations.

We proceeded to analyze a typical interior frame in the north-south direction and a typical interior frame in the east-west direction of the building using the ETABS structural engineering analysis and design software package. The structural member sizes used in the analysis were based on field measurements taken during our site assessment. The steel strength used in the analysis for the joists and joist girders was based on the ASTM A36 steel specification given in the design criteria notes found in the design drawings. The yield strength of the columns used for the analysis was based on laboratory tensile testing of steel coupon samples excised from three interior columns. The gravity loading used was based on field measurements of the floor decks and the current occupancy of the building. In order to investigate the impact of several unknown conditions, a series of analysis models were created.

We then proceeded to check the capacities of the structural members and the lateral drift of the frames based on the wind design requirements of the 2010 Florida Building Code.

The analysis revealed that the columns and footings are adequate for effects of the imposed wind loading and that the lateral displacement of the frames does not exceed serviceability limits. The analysis also identified overstressed members in several of the joists and joist girders that are part of the moment-resisting frames. Overstressed members included bottom chord locations at the ends of joists and diagonal web members.

b. Building Code Review - The RTEG report states that the 2010 Florida Building Code requires that buildings must be made to comply with the requirements of the current building code whenever renovations, the cost of which exceeds 50 percent of the value of the building, are performed. They state further that should renovations of Colbourn Hall proceed and the building brought up to comply with the current code, substantial remediation of the building envelope will be required. The report also states that braces may need to be installed along existing column lines to resist lateral wind loads mandated by the current code.

The 2010 Florida Building Code: Existing Building code was reviewed specifically for any provisions in-place requiring upgrading existing buildings so that they comply with the requirements of the current code. The code refers to Substantial Improvement of structures in various places. The code defines Substantial Improvement as "any repair, reconstruction, rehabilitation, addition or improvement of a building or structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the improvement or repair is started." Our code review found that all references to Substantial Improvement triggering an upgrade of the entire structure to meet requirements of the current code apply only to the Flood Hazard Area provisions of Section 1612 of the FBC.

Following our review, we contacted the State of Florida to ask whether renovations to an existing building in excess of 50 percent of the value of the building would trigger a requirement to have the entire building brought into compliance with the current building code. We spoke to Mo Madani with the Florida Building Commission. Mr. Madani is the Florida Building Code Technical Unit Manager.

Mr. Madani told us that there is no longer a so-called 50 percent rule concerning upgrading buildings undergoing renovations to comply with the wind design requirements of the current building code. He confirmed that buildings located in flood hazard areas must be made to comply with the flood design requirements of the current building code when work in excess of 50 percent of the value of the building is done in any one year. Mr. Madani advised that the 2001 FBC did contain a 50 percent rule requirement that pertained to wind design upgrade to existing buildings, but that this requirement was removed in the 2004 FBC.

Based on our review of the 2010 Florida Building Code (FBC): Existing Building and discussions with the Florida Building Commission, it is our understanding that existing buildings undergoing renovations in excess of 50 percent of the value of the building are not required by the state to be brought into compliance with the wind design requirements of the current building code.

Discussion and Repair Recommendations

I. The following text summarizes the findings of our assessment and discusses applicable sections of referenced codes, standards, and guidelines relevant to the distress conditions observed and analysis of existing structural components. Schematic repair recommendations are also provided.

   a. Strengthen Structural Components

      i. PRIORITY 1: The discontinuous 6-inch CMU backup walls at Levels 1, 2 and 3 are unreinforced and are not adequately connected/braced back to the structure. Analysis of the existing walls for the wind design requirements of the 2010 FBC demonstrates that the walls do not have adequate structural capacity. The backup walls should be reinforced. The following schematic repair is provided for preliminary pricing purposes.

         1. Remove existing interior finishes to access inside face of 6" CMU wall.
         2. Cut vertical slots in face shell of CMU at 48" on center and insert one vertical rebar in each slot positioned at center of masonry unit with standard hook in U-block course. Grout vertical cells solid.
         3. Install one continuous rebar in ungrouted course of U-block at top of walls. Grout solid.
         4. Install continuous steel angle along top of wall anchored into U-block course.
         5. Install horizontal angle between top chords of steel joists above at a spacing of 48" on center.
         6. Install diagonal angle brace from continuous angle at top of wall to horizontal angle installed between joists.
         7. Install vertical angle between diagonal brace and horizontal angle.
         8. Install continuous steel angle along base of wall anchored into bottom course of masonry at a spacing of 12" on center.
         9. Install continuous steel angle on underside of floor slab and through-bolt to horizontal leg of angle installed in the previous step at a spacing of 48" on center.

      ii. PRIORITY 1: The full-height 4-inch CMU backup walls at the corners of the core area of the building on Levels 4 and 5 are unreinforced and are not adequately connected/braced back to the structure. Analysis of the existing walls for the wind design requirements of the 2010 FBC demonstrates that the walls do not have adequate structural capacity. The backup walls should be reinforced. The following schematic repair is provided for preliminary pricing purposes.

         1. Install vertical angle frame reinforcing consisting of two angles with steel base plate extending from the floor to the top of the wall at 48" on center.
         2. Anchor angle frames to wall at 32" on center vertically.
         3. Install horizontal angle between top chords of steel joists above at each angle frame.
         4. Install diagonal angle brace from top of each angle frame to horizontal angle installed between joists.
         5. Install vertical angle between diagonal brace and horizontal angle.
         6. Through-bolt angle frame base plate to steel plate installed on underside of slab with two through-bolts.

      iii. PRIORITY 1: The 4-inch CMU backup walls at the attached towers are unreinforced and are not adequately connected/braced back to the structure. Analysis of the existing walls for the wind design requirements of the 2010 FBC demonstrates that the walls do not have adequate structural capacity. The following schematic repair to reinforce these walls and connect/brace them back to the structure is provided for preliminary pricing purposes only. The backup walls should be reinforced. The following schematic repair is provided for preliminary pricing purposes.

1. Install vertical angle frame reinforcing consisting of two angles with steel base plate extending from the floor to the top of the wall at 48" on center.
2. Anchor angle frames to wall at 32" on center vertically.
3. Install horizontal angle between steel beams above at each angle frame.
4. Install diagonal angle brace from top of each angle frame to horizontal angle installed between beams.
5. Install vertical angle between diagonal brace and horizontal angle.
6. Through-bolt angle frame base plate to steel plate installed on underside of slab with two through-bolts.

iv. ALTERNATE: An alternative to reinforcing the existing backup walls at the attached towers is to remove the existing brick veneer and construct a new brick veneer with a new support frame. The existing CMU backup walls would no longer be required to resolve wind loads acting on the veneer. The following is a schematic description of this alterative retrofit of the tower veneer and is provided for preliminary pricing purposes.

1. Remove the existing brick veneer
2. Install vertical steel tube columns at the corners of the towers and at a spacing of 12 feet between corners. Columns should bear on top of the existing wall footing, extend to the top of the tower, and be welded to the existing slab closure angles at each level.
3. Install horizontal steel tubes between vertical tubes at each level.
4. Install brick shelf angles on steel frame at each elevated floor.
5. Infill steel tube framing with cold-formed steel stud framing.
6. Install new brick veneer.

v. PRIORITY 1: The doors and windows at the exterior corridors on Levels 2 and 3 are anchored to the brick veneer which transfers wind loads acting on the doors and windows to the unreinforced CMU backup wall. Analysis of the existing walls for the wind design requirements of the 2010 FBC demonstrates that the door and window openings in the CMU backup wall do not have adequate structural capacity. The backup walls should be reinforced at all door and window openings. The following schematic repair is provided for preliminary pricing purposes.

1. Remove existing interior finishes to access inside face of 6" CMU wall.
2. Cut vertical slots in face shell of CMU at first two cells at each jamb.
3. Install vertical rebar in each slot positioned at center of masonry unit with standard hook in U-block course. Grout vertical cells solid.

vi. PRIORITY 1: Punched windows at Levels 4 and 5 appear to be anchored to unreinforced brick pilasters at the jambs, the top of an unreinforced 4" CMU wall at the sill, and to a steel channel that is connected to the bottom chord of a joist by vertical angles at the head. These existing support conditions are not adequate for resolving the wind loads required by the 2010 FBC. Installation of new structural components are recommended to provide a suitable point of attachment for the windows. The following schematic repair to reinforce the structure for support of new windows is provided for preliminary pricing purposes.

1. Install vertical steel channels with steel base plates on either side of each brick pilaster extending from the floor to the top of the pilaster.
2. Install horizontal steel channel between new vertical channels at location of window sill and window head.
3. Through-bolt vertical channel base plates to steel plate installed on underside of slab with two through-bolts.
4. Install horizontal angle between top chords of steel joists above at top of each new vertical channel.
5. Install diagonal angle brace from top of each new vertical channel to horizontal angle installed between joists.
6. Install vertical angle between diagonal brace and horizontal angle.

vii. PRIORITY 1: Structural steel framing and metal deck below the Level 2 and 3 exterior corridors exhibit corrosion deterioration due to long-term water intrusion. Corroded steel should be cleaned to the bare substrate, reviewed by a structural engineer, and coated if the degree of section loss is determined to not impact the code mandated structural load capacity requirements; otherwise, structural strengthening may be required.

viii. PRIORITY 1: The surfaces of treads, risers and landings at the exterior stairs on the east and west ends of the building exhibited distress. These surfaces should be repaired with a concrete repair mortar following an engineered repair detail.

ix. PRIORITY 1: Analysis of typical moment-resisting frames for the wind design requirements of the current building code resulted in overstress of some chords and webs of joists and joist girders. These locations can be reinforced with steel plates, rods and/or angles to bring the joists and joist girders into compliance with the wind design requirements of the current code. It is important to note that the strength of the steel angles that comprise the joists and joist girders could exceed the material strength indicated in the design drawings which would impact the number of locations needing to be reinforced. This can be evaluated by laboratory tensile testing of steel coupon samples excised from the joists/joist girders.

b. Building Enclosure Façade Rehabilitation

i. PRIORITY 1: Loose brick sections were noted at multiple locations around the building, particularly at the parapet wall areas. A qualified restoration contractor should be engaged to review these areas and remove loose brick sections for life safety purposes until permanent repairs can be implemented.

ii. PRIORITY 1: Miscellaneous areas of brick masonry distress including loose brick, cracking, and spalling were observed. Additionally, the top four courses of brick at the parapet were noted to be debonded from the underlying brick courses due to the presence of through-wall flashing at these areas. Failed brick should be removed and replaced in kind with post-installed anchors. ACI 530/ASCE 5/TMS 402 Building Code Requirements for Masonry Structures, otherwise known as the Masonry Standards Joint Committee (MSJC) Code, requires the following in Section 2.1.2.4, "the maximum spacing between ties shall be 36 in. (914 mm) horizontally and 24 in. (610 mm) vertically." Additionally, depending on the type of anchor, the minimum number of required wall ties per square foot of wall should also be installed.

iii. PRIORITY 3: Isolated locations of failed mortar were noted during the assessment. Failed mortar joints should be repointed to restore the adhesive bond between the brick elements and minimize water intrusion into the cavity wall.

iv. PRIORITY 3: Mortar was observed inside the depth of brick expansion joints. This condition renders expansion joints ineffective. Mortar inside existing expansion joints should be removed to allow expansion of the veneer at these joints as intended. In addition, new vertical expansion joints should be installed at select corners of the attached towers.

v. PRIORITY 1: Corroded shelf angles were noted at the core area of the building. The corrosion distress of these shelf angles has resulted in section loss and a corresponding reduction in gravity load capacity to support the brick cladding at these areas. Shelf angles exhibiting corrosion should be cleaned to the bare substrate, reviewed by a structural engineer, and coated if the degree of section loss is determined to not impact the code mandated structural load capacity requirements; otherwise, structural strengthening may be required.

vi. PRIORITY 1: A rigid mortar joint was generally installed beneath the shelf angles and the underlying brick course. Minor brick spalling was noted at isolated locations due to load stress transfer from the overhead shelf angle through the rigid mortar joint to the brick. This condition was primarily evident at the top course of bricks for the projected columns directly beneath the shelf angle supports. Horizontal expansion joints with an appropriate compressible fill or sealant material should be installed at all shelf angles with underlying brick courses to allow for shelf angle deflection and thermal volumetric expansion of the brick. *Applicable Industry Standard Reference: Technical Notes on Brick Construction 18A – Accommodating Expansion of Brickwork recommends that "Structures that support the brick wythe on shelf angles, usually done for each floor, must have horizontal expansion joints under each shelf angle."*

vii. PRIORITY 1: Widespread corrosion was noted at the structural steel backup supports for the brick masonry veneer, primarily at the projected façade sections of the core area of the building. The corrosion distress of these structural steel backup systems has resulted in section loss and a corresponding reduction in structural load capacity of the structural backup. Structural steel backup members at the projected façade areas exhibiting corrosion should be cleaned to the bare substrate, reviewed by a structural engineer, and coated if the degree of section loss is determined to not impact the code mandated structural load capacity requirements; otherwise, structural strengthening may be required.

viii. PRIORITY 1: Vertical steel angles supporting brick masonry veneer at projected areas of the façade were tacked welded to metal deck closure angles and the joist bottom chords. Tack welds are typically used for construction fit up purposes and are generally not designed for long term structural loading. These tack welded connections should be supplemented and strengthened.

ix. PRIORITY 1: The quality of the brick tie installations was noted to vary significantly at different areas of the building; multiple locations of missing brick ties were also noted. Corroded and unengaged wall ties were observed at multiple façade areas thereby reducing the capacity of these elements to restrain the brick wall against out-of-plane lateral loads. Due to the inconsistency of the construction quality noted during this review, installation of post-installed anchors at all façade areas should be done in accordance with the requirements of MSJC Section 2.1.2.4 as referenced previously.

x. PRIORITY 1: Various façade locations were noted with brick cavity depths greater than 6 inches. These extended brick cavities may result in reduced capacity of the wall ties to transfer lateral loading to the structural backup systems. Supplemental wall ties should be installed to reduce the tie spacing at these locations. Alternatively, larger wall ties may be installed. *Applicable Industry Standard Reference: Technical Notes on Brick Construction 21 – Brick Masonry Cavity Walls recommends that the "cavity or air space between wythes should be between 2 in. (50 mm) and 4 1/2 in. (114 mm) … Air spaces greater than 41/2 in. (114 mm) do not allow the normally prescribed ties to properly transfer lateral loads. Air spaces different from these can be used, but care in design and construction would be required. If larger air spaces are used additional ties and/or thicker ties may be necessary."*

xi. <u>OPTION: Re-skin Building</u> The current building façade enclosure system at the Colbourn Hall facility consists of a cavity wall with an exterior brick veneer that is intended to serve as the principle drainage plane against bulk rainwater. Incidental water that migrates into the cavity should ideally run down the inside face of the brick cladding and exit through weep holes at the base brick course. The cavity waterproofing at the CMU backup walls was in generally fair condition. However, the cavity waterproofing and vapor barrier at the steel angle backup areas was generally non-continuous and exhibited failed components; this condition was primarily evident at the open corridor projected façade areas at the core area the building. Additionally, lack of weep holes has likely resulted in trapping of water that enters the cavity. These conditions have resulted in ongoing water infiltration into these areas and corrosion of the structural steel framing. Removal of the existing brick veneer and installation of an adequately designed waterproofing system with new brick cladding should be considered to mitigate water infiltration and provide adequate drainage capacity of the cavity wall systems. The cavity wall waterproofing should be continuously installed over the structural steel backup systems and should include a sheathing layer overlain with an appropriate water resistant barrier, shelf angle flashing, and weep holes.

xii. PRIORITY 1: New windows and doors complying with the requirements of the current building code should be installed in strengthened window and door openings.

This report has been prepared to assist Schenkel Shultz Architects understand the nature and type of distress investigated in this study and determine a future course of action. Walter P Moore assessed specific issues relevant to the distress and other miscellaneous conditions observed on the Colbourn Hall facility on the campus of the University of Central Florida in Orlando.

Walter P Moore has no direct knowledge of, and offers no warranty regarding the condition of concealed construction or subsurface conditions beyond what was revealed in our review. Any comments regarding concealed construction or subsurface conditions are our professional opinion, based on engineering experience and judgment, and derived in accordance with current standard of care and professional practice.

Various other non-structural and cosmetic damage unrelated to this assessment may have been observed throughout the structure, some of which are discussed in general in this report. However, a detailed inventory of all cosmetic and non-structural damage was beyond the scope of our assessment. Comments in this report are not intended to be comprehensive but are representative of observed conditions. In this study we performed a review of concealed conditions at specific locations. We also performed analysis of specific structural components/systems to check the adequacy of the components/systems to carry the imposed loads. These analyses were based on information contained in the available design drawings and observations made during our field survey. Repair recommendations discussed herein are schematic and will require additional engineering design for implementation.

We have made every effort to reasonably present the various areas of concern identified during our site visits. If there are perceived omissions or misstatements in this report regarding the observations made, we ask that they be brought to our attention as soon as possible so that we have the opportunity to fully address them in a timely manner.

This report has been prepared on behalf of and for the exclusive use of Schenkel Shultz Architects and their direct client. This report and the findings contained herein shall not, in whole or in part, be disseminated or conveyed to any other party or used or relied upon by any other party, in whole or in part, without prior written consent.

End of Structural Analysis

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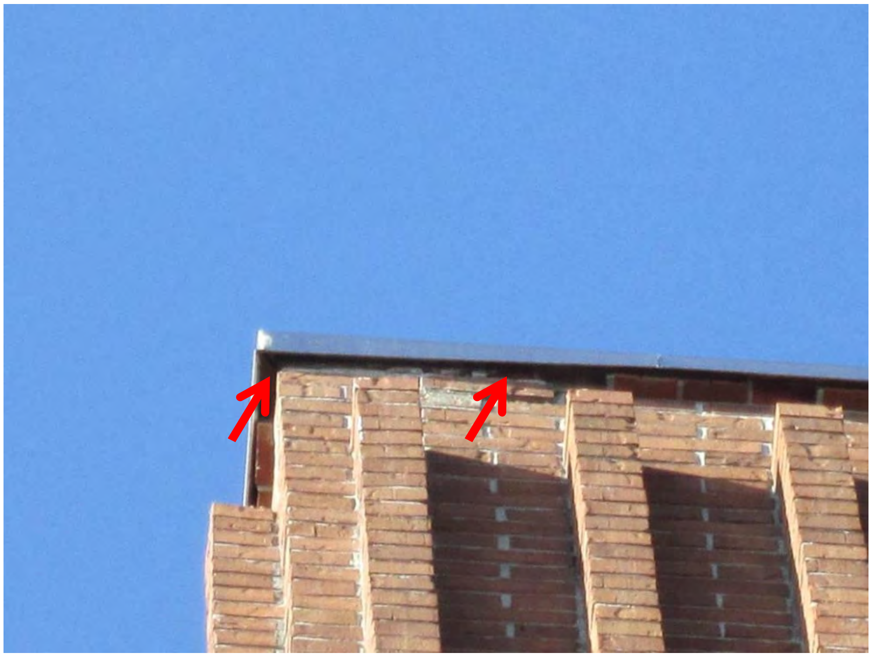
Appendix S – Structural Photographs



S1 – View of missing brick beneath Roof Level parapet wall coping cap

S2 - Close-up view of Photo S1 showing missing overhead brick below parapet wall coping

S3 - Cracked overhead brick noted beneath Roof Level parapet wall coping cap

S4 - Cracked overhead brick shown in Photo S3 readily dislodged by hand

S5 - Disengaged fastener for parapet coping nailer attachment at missing brick location

S6 – Separation along bed joint noted at top of Level 2 and Level 3 exterior corridor façade

S7 – Separation at bed joint noted at top of Level 2 and Level 3 exterior corridor façade areas

S8 - Potentially loose overhead brick at Level 2 exterior open corridor areas above Level 1 access walkways

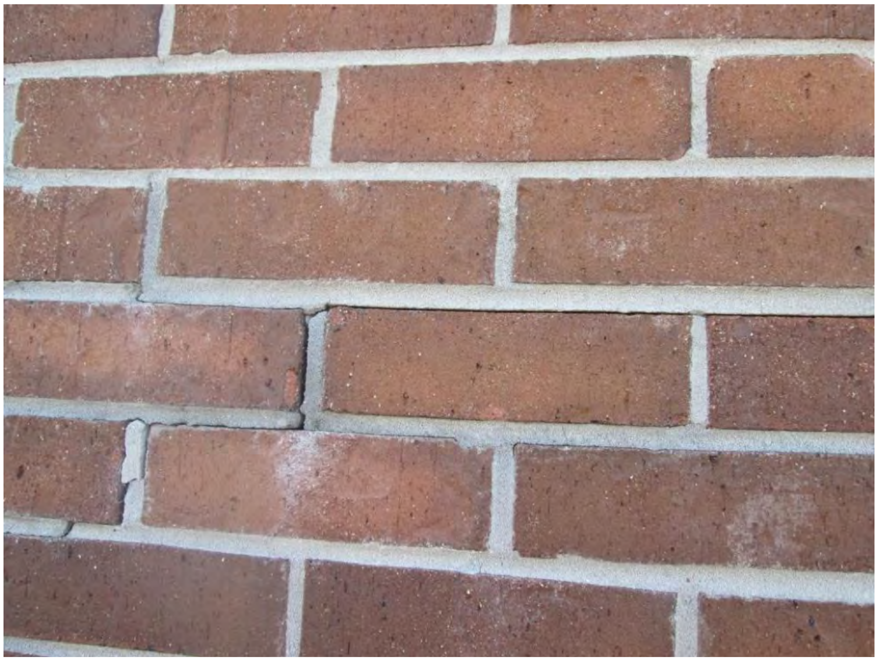
S9 - View of cracked brick

S10 - Close-up of Photo S9 showing 1/4-inch wide brick cracking

S11 - Cracked and spalled brick

S12 - Spalled brick below shelf angle

S13 - Mortar joints generally noted to be in fair condition



S14 - Brick mortar cracking

S15 - Mortar separation at exterior open corridor brick coping (note through-wall fabric flashing)

S16 - Mortar separation at brick courses below Roof Level parapet

S17 - Mortar separation at brick courses below Roof Level parapet (note through-wall flashing)

S18 - Corrosion at exposed shelf angle toe

S19 - Corrosion product buildup at shelf angle

S20 - Close-up view of Photo 19 showing corrosion product buildup at shelf angle

S21 - Caliper measurement of delaminated shelf angle leg (~0.68-inch)

S22 - Caliper measurement of cleaned bare shelf angle leg (~0.32-inch)

S23 - Shelf angles not noted in exploratory opening at attached tower structure

S24 - Spliced discontinuous shelf angle at Exploratory Opening 6