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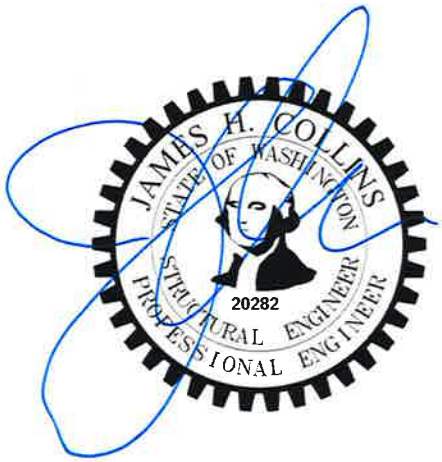
BROADWAY BUILDING

MARKET BUILDING

STRUCTURAL EVALUATION FOR

RHODES CENTER
BROADWAY BUILDING
MARKET BUILDING
TACOMA, WASHINGTON



PREPARED BY
PCS STRUCTURAL *SOLUTIONS*

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I. PREFACE

The structural evaluation of the Rhodes Center consists of an ASCE 41-13 “Seismic Evaluation and Retrofit of Existing Buildings” Tier 1 Evaluation with Life Safety Performance criteria. Building checklists and quick checks were completed where information was available.

The Rhodes Center consists of two primary buildings, the Broadway Building to the east and the Market Building uphill to the west. The Broadway Building is a five story Unreinforced Masonry (URM) Bearing Wall Building. The Market Building will be evaluated as two separate structures, with the five story URM Bearing Wall Building to the south and the seven story Concrete Frame Building to the north.

The five story Broadway and Market URM buildings exceed the limit of the ASCE 41-13 Tier 1 Evaluation by one story. We used the Tier 1 Methodology as a Tier 3 Systematic Evaluation is a considerably more rigorous analysis beyond the scope of our services. In our opinion, the Tier 1 will identify similar structural concerns as a Tier 3 Evaluation.

The construction drawings from the 1979 and 1997 remodels were available for our review. Assumptions were made where building information was limited or not available.

The summary identifies the structural deficiencies identified by the ASCE 41-13 Tier 1 Evaluation. Nonstructural elements were not evaluated.

II. EXECUTIVE SUMMARY

The Rhodes Center consists of two buildings, the Broadway Building to the east and the Market Building up the hill to the west. The Market Building has two different primary structural systems (URM Bearing Wall and Concrete Frame) that will be individually summarized.

All buildings were modernized in 1979 where buildings were repurposed for the University of Puget Sound Law School use. The Broadway Building was used for a combination of classrooms, lecture halls, and offices. The Market Building was used primarily as office space. In 1997, the Broadway building was again repurposed for office use. The original construction dates for the buildings are not known. It is estimated that the Broadway building and URM portion of the Market Building were constructed in the early 1900's and the Market Concrete Frame building in the 1950's.

A. Broadway Building

The Broadway Building is a five-story URM bearing wall building. It has gone through two significant seismic upgrades in 1979 and 1997 when the building was repurposed. Overall, the building appears to be in good structural repair and we did not observe signs of significant structural distress or differential settlement. One concern we noted was water infiltration along the west side of the building. There is the potential of deterioration of the existing steel support beam that should be further evaluated.

The 1979 and 1997 seismic upgrades addressed many common seismic concerns for URM bearing wall building and significantly improved the anticipated seismic performance of the building; however, not all structural concerns, as identified in the ASCE 41-13 Tier 1 Evaluation, which are common for URM Bearing Wall Buildings, were addressed or meet current standards. The most notable is the overall global lateral resisting system. Interior plywood and GWB shear walls were added to improve the seismic performance of the building but do not meet the structural intent of current existing building standards. Some of the detailing standards, specifically the wall anchorage, have changed design forces since the 1997 seismic upgrade work.

Overall, the structural concerns identified by the ASCE 41-13 Tier 1 Evaluation are common to URM Bearing Wall Buildings.

B. Market URM Building

The Market URM Building is a five-story URM bearing wall building. In 1979, the main seismic improvement was the addition of through wall anchors and parapet braces at the east and west exterior walls and the south wall where it extends above the adjacent building. Overall, the building appears to be in good structural repair and we did not observe signs of significant structural distress, deterioration, or differential settlement. One concern we noted was some cracks in the finishes of two masonry piers at the east entry at alley/grade level. It is not clear if the cracks are just in the finishes or in the structural piers themselves.

The 1979 seismic upgrade addressed the URM walls anchorage at the east and west exterior walls fronting on public ways and anchoring beams to columns. The global lateral resisting system was not addressed. There are significant cross walls in the east west direction and the building relies on adjacent buildings to resist seismic forces in the north south direction.

The structural concerns, as identified in the ASCE 41-13 Tier 1 Evaluation, are common for URM buildings.

C. Market Concrete Building

The Market Concrete Building is a seven-story concrete frame building with URM Masonry Infill Walls. Drawings of the original construction showing details or reinforcing for the concrete partition of the building were not available, and therefore our evaluation was somewhat limited. The building appears to be in good structural repair and has performed well structurally as we did not observe significant signs of structural distress, deterioration, or differential settlement.

Based on the estimated age of construction, the concrete frame of the building was not designed to meet current seismic detailing standards, and by observation based on the mass of the building and the thickness of the URM infill walls, they would not meet the minimum shear stress checks.

The structural concerns, as identified in the ASCE 41-13 Tier 1 Evaluation, are common for Concrete Frame Buildings constructed in the 1950's or 60''s.

SUMMARY

The ASCE 41-13 Tier 1 Evaluation has identified structural deficiencies for all the buildings of the Rhodes Center. An upgrade of the global lateral resisting system, which would likely include additional concrete shear walls, would address most of the deficiencies identified. The Broadway Building has had the most seismic improvements; however, the design criteria at the time of the upgrades has changed with respect to the ASCE 41-13 Tier 1 requirements. All the buildings do have a lateral load path, wall anchorage and parapet braces at the URM walls fronting on public ways (streets and alleys).

III. INTRODUCTION

A) SCOPE OF WORK

a) Field Investigation

- Walked through the complex, looking for signs of structural distress, differential settlement, or deterioration.
- Visually verified vertical and lateral systems.
- Reviewed structural concerns identified in the ASCE 41-13 Checklist along with field observations identified in the checklists.
- Viewed structure wherever visible.
- Testing or selective demolition was not completed at this time.

b) Initial Review of Construction Drawings

- Reviewed available construction drawings.
- Completed ASCE 41-13 Building Tier 1 Checklists to help identify common structural deficiencies for the building.
- Where no drawings were available, or the drawings did not adequately describe as-built conditions, recommendations were based on field investigation and observations.

c) Report Preparation and Further Construction Drawing Review

- Further evaluated drawings with respect to structural concerns identified in the initial review or field investigation.
- Summary:
  - Described vertical and lateral load resisting system for each building.
  - Summarized visual observations of building condition, signs of structural distress, and differential settlement.
  - Identified structural concerns from observations and ASCE 41-13 checklists.

B) PUGET SOUND SEISMICITY

The Puget Sound is considered a seismically active region. Within this region, there are three basic types of earthquake that can occur:

- Shallow crustal earthquakes
- Benioff Zone (intra-plate) earthquakes
- Subduction zone (inter-plate) earthquakes

Movement of tectonic plates creates the mechanism that drives all three types of earthquake, as the Juan de Fuca Plate, comprising the bottom of the Pacific Ocean floor several miles off of the Washington and Oregon coasts, is forced into and below the North American Plate. The level of seismic hazard assigned to any particular building is related to the type of earthquake that may occur in the region, and can vary significantly based on the magnitude of earthquake and proximity of a given site to the epicenter.

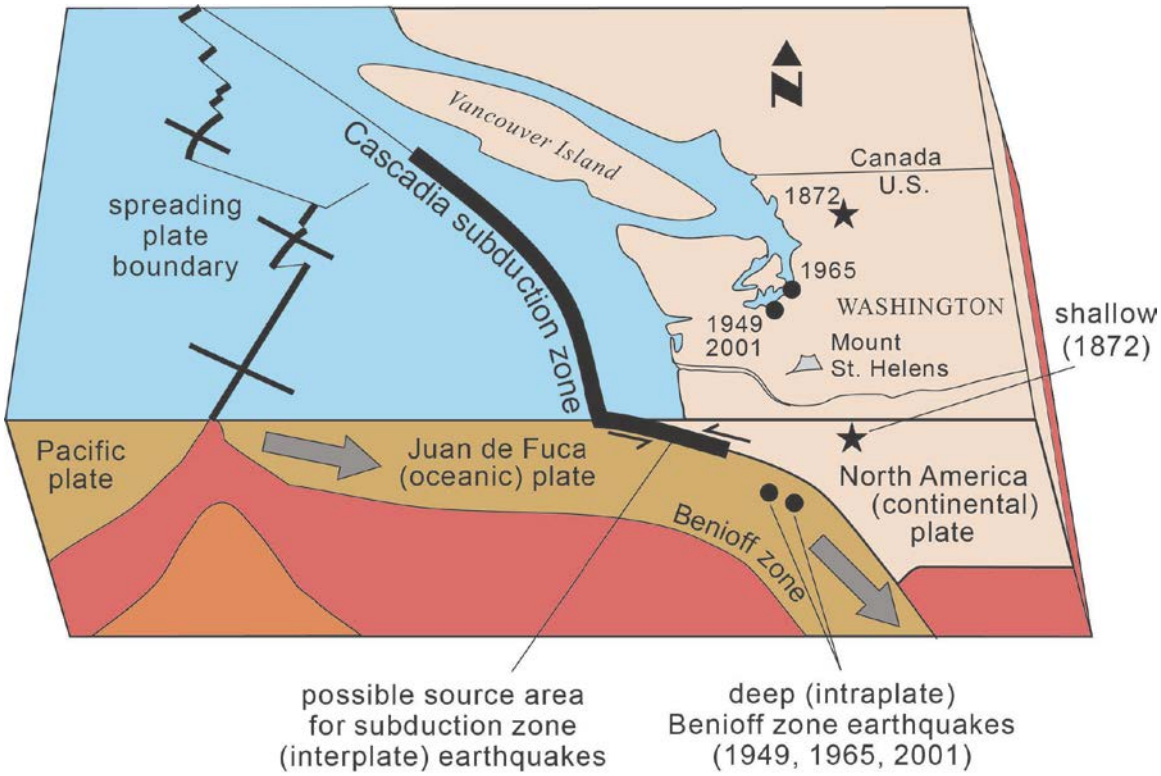

Figure A: Cross Section of the Cascadia Subduction Zone
(Source: Washington State Department of Natural Resources)

Shallow crustal earthquakes occur in the overriding North American plate and are generally at depths less than 25 miles. There are at least six significant faults that have been identified in the Puget Sound region with concentrations in three primary locations; Seattle, Tacoma and South Whidbey Island. These groupings of faults run generally in an east-west orientation and cut across the heavily populated zones of the region. These earthquakes have a relatively long average recurrence interval at approximately 330 years and are capable of generating moderate to large events registering M5.5-M7 on the Richter Scale. This type of earthquake is generally expected to be of shorter duration and more localized as it relates to strong ground motions.

Intra-plate earthquakes occur in the portion of the Juan de Fuca plate that moves beneath the overriding North American plate. This type of earthquake occurs deep below the ground surface (typically 25 to 40 miles) and has the ability to generate moderate to large events of M6-M7 on the Richter Scale. They have a much shorter recurrence interval of approximately 35 to 50 years on average. Earthquakes of this variety tend to have shorter durations, but can still generate significant ground shaking over large areas of land.

Inter-plate earthquakes, also known as subduction zone earthquakes, occur directly at the interface of two plates and are more likely to be large magnitude events. They have the potential of registering upwards of M9 on the Richter Scale, with a relatively long average time of approximately 500 years between occurrences. These earthquakes are generally expected to have long durations, and can generate significant ground shaking over very large areas.

C) METHODOLOGY

Evaluation

The Rhodes Center was evaluated using the methodology of the ASCE 41-13 “Seismic Evaluation and Retrofit of Existing Buildings” Tier 1 evaluation, addressing the Life/Safety Performance level. The ASCE 41-13 document provides building checklists that identifies common seismic concerns for typical building types (i.e. Concrete Frames with Infill Masonry Shear walls, Unreinforced Masonry Bearing Wall Buildings with Flexible Diaphragms, etc). Each question on the checklist may be answered by “compliant”, “non-compliant”, “not applicable” or “unknown”. For those items that are non-compliant or unknow, additional evaluation or mitigation of the structural concern is recommended. Detailed calculations were not performed for this study.

The ASCE 41-13 is a performance based design/evaluation manual with varying performance objectives. The performance objective is selecting based up the acceptable level of risk, as well as the tier level used in the evaluation. In general, there are three primary performance levels for existing buildings:

Immediate Occupancy: a higher level performance that focuses on maintaining building functionality after an earthquake. Light damage is anticipated in the event of a major earthquake; however, the building function is expected to be maintained with little to no disruption in service. Fire Stations, Hospitals, Police Stations and other critical facilities are buildings that are designed for this level.

Life Safety: focuses on protecting the occupants of the building. This is the most common level of performance for building design. In the event of a major earthquake, the building may suffer moderate damage with a small margin of total or partial collapse. The facility may be unusable after an earthquake, with low overall risk of injury from structural damage.

Collapse Prevention: a low level of performance, where the damage to the building after a moderate earthquake may be severe. The lateral resisting system would have little residual strength, and large permanent deformations would occur. The building would likely be near collapse.

Once the Performance Level is selected it can be determined which procedural tier review to use in the evaluation:

- Tier 1 is a screening process utilizing Building Checklists to help identify common structural deficiencies for typical buildings types. The owner/designer has the option of possibly mitigating the structural concern identified by Tier 1 or performing a more detailed analysis outlined in Tiers 2 and 3.
- Tier 2 is a deficiency-based evaluation and renovation procedure. This methodology includes analyzing specific elements or areas within a building to determine if potential deficiencies identified in a Tier 1 review actually require mitigation. Analysis of the entire building may not be necessary. This tier can be used for both evaluation and retrofit.
- Tier 3 is a systematic evaluation and retrofit procedure, and involves a computationally extensive approach towards a complete analysis of the facility. The performance of the building as structural elements begin to yield, also known as a non-linear analysis, is considered. This tier is applicable for both the evaluation and retrofit of a facility.

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JUNE 22, 2017

IV. STRUCTURAL EVALUATION

RHODES CENTER
TACOMA, WA

The Rhodes Center was evaluated using the methodology of the ASCE 41-13 "Seismic Evaluation and Retrofit of Existing Buildings" Tier 1 Evaluation, addressing the Life/Safety Performance level. Completion of nonstructural checklists or evaluation of non-structural components such as ceilings, partitions, lights, mechanical piping, and equipment were not performed as it was beyond the scope of this Report.

The Rhodes Center consists of two buildings, the Broadway Building to the east and the Market Building up the hill to the west. The Market Building has two different primary structural systems (URM Bearing Wall and Concrete Frame) that will be individually summarized.

The Broadway and Market URM building are five-story URM buildings, which exceed the limit of the ASCE 41-13 Tier 1 Evaluation by one-story. We used the Tier 1 Methodology as a Tier 3 Systematic Evaluation is a considerably more rigorous analysis beyond the scope of our services. In our opinion, the Tier 1 Evaluation will identify the similar structural concerns that would be identified in a Tier 3 Evaluation.

All buildings were modernized in 1979 where buildings were repurposed for the University of Puget Sound Law School use. The Broadway Building was used for a combination of classrooms, lecture halls, and offices. The Market Building was used primarily as office space. In 1997, the Broadway building was again repurposed for office use. The original construction dates for the buildings are not known. It is estimated that the Broadway building and URM portion of the Market Building were constructed in the early 1900's and the Market Concrete Frame building in the 1950's.

A. BROADWAY BUILDING

1. TYPE OF CONSTRUCTION/STRUCTURAL SYSTEM

The Broadway Building is a five-story URM bearing wall building with a mezzanine level above the first floor and a basement. The original construction date is unknown and assumed to be in the early 1900's. It has under gone two significant structural upgrades in 1979 and 1997. See Appendix A for representative photos, Appendix B for floor plans, and Appendix C for ASCE 41-13 Building Checklist.

SYSTEM DESCRIPTIONS

Vertical Load Resisting System:

Spread footing foundations, wood crawl space at the basement level, exterior URM bearing walls, heavy timber wood framed floors and roof. The mezzanine above the first floor was expanded in 1979 along with additional stairs full height of the building. An atrium was added from the first floor to the roof in 1997. A sky bridge was added to the Market Building to the west in the 1979 remodel.

Lateral Force Resisting System:

URM exterior shear walls, interior plywood and GWB shear walls added in 1979 and further modified or relocated in 1997. Wood floor and roof diaphragms of either original diagonally sheathed floor or plywood over existing wood decking. Seismic improvements from 1979 include the plywood sheathing at the roof noted above, through wall ties anchoring the exterior URM walls to the floor and roof structure, parapet braces and supplemental interior plywood and GWB shear walls. In 1997 continuous angles and additional drilled in wall anchors were added to the perimeter URM walls, additional parapet braces to the north URM wall, and plywood sheathing and straps added around the new atrium.

2. OBSERVATIONS AND COMMENTS

- Along the west wall at the alley level (level (3)), water has been infiltrating into the building. Some delamination was noted in the steel support beam supporting the masonry wall above. Moisture was also evident in the finishes of the adjacent nonstructural partitions. Water infiltration should be mitigated and further evaluation of the deterioration should be performed.
- Minor cracking in the west exterior wall stucco finish.
- Other than noted above, we observed no signs of structural distress, differential settlement, or deterioration.

3. ASCE 41-13 “SEISMIC EVALUATION AND RETROFIT OF EXISTING BUILDINGS” CHECKLIST – NON-COMPLIANT – STRUCTURAL CONCERNS

The structural items noted below outline the structural concerns related to the anticipated seismic and overall structural performance of the existing building. Conclusions are based on a walk-through evaluation, review of available construction drawings, and on experience in renovations of similar building types in the Puget Sound Area. The ASCE 41-13 structural checklists were used as guidelines to identify building deficiencies that have historically resulted in damage or collapse of structures under seismic loading. The following issues are a summary of deficiencies identified for the Broadway Building. ASCE 41-13 Checklist in Appendix C.

ASCE 41-13 Non-Compliant or Unknown Items

- Lack of building separation from the building to the north.
- Weak story and soft story at the second level with a number of openings in west wall.
- Vertical irregularities, with the interior plywood/GWB shear walls not lining up floor to floor.
- Torsion, shear walls at the east and south walls significantly less than north and west.
- URM and plywood/GWB shear walls do not pass quick check. Estimated Demand to Capacity (DCR) ratio in the range of 2-4.
- Wall anchorage does not pass quick check with a DCR in the range of 2-3.
- Height to thickness ratios exceed allowable limit at the fifth floor.
- Stair openings adjacent to URM shear walls exceed 8 feet.
- Girders do not have independent support where they bear on URM walls.

Other Structural Concerns

- Deterioration of steel support beam along west wall at the alley level.

4. SUMMARY

Overall, the Broadway Building appears to have performed well for the era in which it was constructed. The structural concerns noted are common for URM buildings. The building has gone through two rounds of seismic improvements where many of the structural deficiencies have been addressed but not to the extent to meet the ASCE 41-13 Tier 1 requirements. One example is the exterior wall anchors to the floor and roof structure. The current design criteria is higher than required during the time of the initial seismic improvements. Complete upgrade of the global lateral resisting system was not completed as part of the 1979 or 1997 seismic upgrades.

Mitigation of the water infiltration along the wall is recommended along with further evaluation to determine the extent of deterioration.

B. MARKET URM BUILDING

1. TYPE OF CONSTRUCTION/STRUCTURAL SYSTEM

The Market Building is a five-story URM bearing wall building. The center portion of the second floor was removed at some point. The original construction date is unknown and assumed to be in the early 1900's. It has under gone a significant structural upgrade and modernization in 1979. See Appendix A for representative photos, Appendix B for floor plans and Appendix C for ASCE 41-13 Building Checklists.

SYSTEM DESCRIPTIONS

Vertical Load Resisting System:

Spread footing foundations, concrete slab on grade at the first level, exterior URM bearing walls, interior URM walls running east-west with the bottom two levels being concrete in locations, heavy timber wood framed floors and roof with one row of heavy timber columns. An additional masonry stair tower was added at the northwest corner full height to the top floor of the concrete building to the north. An atrium was added at the fifth floor during the 1979 remodel in the center bay of the building. The seven-story concrete building is directly to the north and a three-story URM building to the south.

Lateral Force Resisting System:

URM exterior shear walls, interior URM and concrete cross/shear walls in the east west direction, and wood floor and roof diaphragms. In some locations, plywood roof or floor sheathing has been added, specifically in an eight-foot band at the roof along the east, south, and west walls. Seismic improvements from 1979 include anchoring the east and west exterior URM walls to the roof and floor structure, bracing the URM parapets at the west and south walls, and redundant wood columns in the south bay at the first floor supporting the second framing above.

2. OBSERVATIONS AND COMMENTS

- Cracks were observed in the finishes of the two masonry columns at the east entry at ground floor. It is not clear if these cracks are just in the finish and what caused the cracks. There is the potential for impact damage or freeze thaw action. They do not appear to be from earthquake movement or other easily identifiable structural concern.
- Minor cracking in the east exterior wall stucco finish.
- Minor deterioration in the brick at the upper level of the west exterior wall.
- Water infiltration at the south wall of the CMU masonry stair wall near the top of the wall.
- Other than noted above, we observed no signs of structural distress, differential settlement, or deterioration.

3. ASCE 41-13 “SEISMIC EVALUATION AND RETROFIT OF EXISTING BUILDINGS” CHECKLIST – NON-COMPLIANT – STRUCTURAL CONCERNS

The structural items noted below outline the structural concerns related to the anticipated seismic and overall structural performance of the existing building. Conclusions are based on a walk-through evaluation, review of available construction drawings, and on experience in renovations of similar building types in the Puget Sound Area. The ASCE 41-13 structural checklists were used as guidelines to identify building deficiencies that have historically resulted in damage or collapse of structures under seismic loading. The following issues are a summary of deficiencies identified for the Market URM Building. ASCE 41-13 Checklists in Appendix C.

ASCE 41-13 Non-Compliant or Unknown Items

- Lack of building separation from the buildings to the north and south.
- Weak story and soft story above and below the fourth floor.
- Vertical irregularities, with the interior masonry shear wall not present at the third floor, while present at the floor above.
- Torsion, shear wall at the south wall mostly solid while the interior and north shear wall are not causing the center of rigidity towards the south.
- URM shear walls do not pass quick check. Estimated Demand to Capacity (DCR) ratio in the range of 2-4.
- Wall anchorage does not pass quick check with a DCR in the range of 2-3.
- Stair openings adjacent to URM shear wall at south wall exceed 8 feet.
- No apparent cross ties in the north-south direction.
- Orientation of floor sheathing unknown, if diagonal meets criteria. At roof, with the addition of plywood at the perimeter, it is assumed sheathing is oriented perpendicular to joist and non-complaint.
- Girders do not have independent support where they bear on URM walls.

Other Structural Concerns

- Damage to the finish at the base of the masonry columns at the east entry. Further investigation many determine this is cosmetic only.

4. SUMMARY

Overall, the Market URM Building appears to have performed well for the era in which it was constructed. The structural concerns noted are common for URM buildings. The wall anchorage, parapet bracing and beam column connections were addressed in the 1979 upgrades; although, not to the extent to meet ASCE 41-13 Tier 1 requirement. The exterior wall anchors to the floor and roof structure, the current design criteria is higher than required during the time of the initial seismic improvements. Complete upgrade of the global lateral resisting system was not completed as part of the 1979 seismic upgrades and the building depends on the neighboring buildings to resist seismic forces in the north-south direction.

C. MARKET CONCRETE BUILDING

1. TYPE OF CONSTRUCTION/STRUCTURAL SYSTEM

The Market Concrete Building is a seven-story concrete frame building with infill masonry walls at the perimeter frame. It appears in the 1979 remodel the concrete portion of the structure remained unchanged. A sky bridge was added to the building to the west and one to the east, both at the fifth floor.

SYSTEM DESCRIPTIONS

Vertical Load Resisting System:

Concrete spread footing foundations (assumed), concrete slab on grade, concrete flat slab supported by interior concrete columns and perimeter concrete frame. Infill masonry walls at the exterior walls, stairs and elevator. A penthouse structure at the roof with concrete beams and columns and masonry infill walls. The building is directly north of the URM building.

Lateral Force Resisting System:

Concrete floor and roof rigid diaphragms. URM infill masonry shear walls at the perimeter walls and potentially moment frame action of the perimeter concrete frames and to a lesser extent the interior flat slab column interaction. Without existing drawings, we were not able to evaluate the moment capabilities of the concrete frames.

In 1979, metal stud backing walls were added to the URM infill walls at the east and west exterior walls, and the north and south walls where they extend above the adjacent buildings to the north and south.

2. OBSERVATIONS AND COMMENTS

- Minor cracks were observed in some of the infill walls.
- We observe not significant signs of structural distress, deterioration or differential settlement.

3. ASCE 41-13 "SEISMIC EVALUATION AND RETROFIT OF EXISTING BUILDINGS" CHECKLIST – NON-COMPLIANT – STRUCTURAL CONCERNS

The structural items noted below outline the structural concerns related to the anticipated seismic and overall structural performance of the existing building. Conclusions are based on a walk-through evaluation, review of available construction drawings, and on experience in renovations of similar building types in the Puget Sound Area. The ASCE 41-13 structural checklists were used as guidelines to identify building deficiencies that have historically resulted in damage or collapse of structures under seismic loading. The following issues are a summary of deficiencies identified for the Market Concrete Building. ASCE 41-13 Checklists in Appendix C. We filled out the ASCE 41-13 Checklist for Concrete Frame with Infill Masonry Shear Walls. Filling out an ASCE 41-13 Checklist for a Concrete Moment Frame Building would have "Unknown" response to most questions without the original construction drawings to review.

ASCE 41-13 Non-Compliant or Unknown Items

- Lack of building separation from the buildings to the north and south.
- Weak story and soft story with lack of shear walls at the south wall below the fifth floor.
- Vertical irregularities, with the interruption of the south infill shear walls below the fifth floor.
- A lateral analysis was not provided for the Market Concrete Building with the lack of as-built information on the building. By observation and mass of building, it is unlikely the infill shear walls would meet shear stress check and assumed non-complaint.
- The following items are unknown with lack of original construction drawings:
    - Transfer of diaphragm forces to shear walls (transfer through bearing as a minimum).
    - Concrete columns doweled to foundation (assumed they are based on age of construction).
    - Deflection capability of secondary or flat slab with primary lateral system (Masonry infill shear walls or concrete moment frame) (Detailed lateral analysis required to determine this. Potentially, flat slab will be stiff enough to attract lateral forces they are not designed or detailed for).
- Height to thickness ratio of URM infill shear walls exceed limit.
- Stair and elevator openings adjacent to URM infill walls at east end of building exceed 8 feet. With the concrete frame, this is not a significant issue.

4. SUMMARY

Overall, the Market Concrete Building appears to have performed well for the era in which it was constructed. Without original construction drawings and details to review, a thorough evaluation of the building is not practical. Based on the apparent age of construction, the building is not designed to meet current seismic standards for a concrete building. The primary structural concern is the ability of the global lateral resisting system to meet seismic demands.

The structural concerns identified by the ASCE 41-13 Tier 1 Evaluation are common for a concrete frame building with URM infill shear walls.

V. APPENDIX A – PHOTOGRAPHS

A. Broadway Building

East Exterior Wall

North Exterior Wall and Roof

Delaminating Steel Beam at Third Level at West Wall.

Water Damage in Finishes Second Level Below West Wall

Typical Beam/Column Connection Second Level

West Exterior Wall

B. Market URM Building

West Exterior Wall. Note Deterioration of Brick at Fifth Level.

URM Cross Wall Construction

Crack in East Column Base

Crack in Concrete Cross Wall adjacent to Market Concrete Building

Concrete Cross Wall where Second Level Removed

Redundant Support at South Cross Wall First Level.

C. Market Concrete Building

West Exterior Wall with Sky Bridge to Parking Garage

East Exterior Wall at Grade Level.

North Exterior Wall

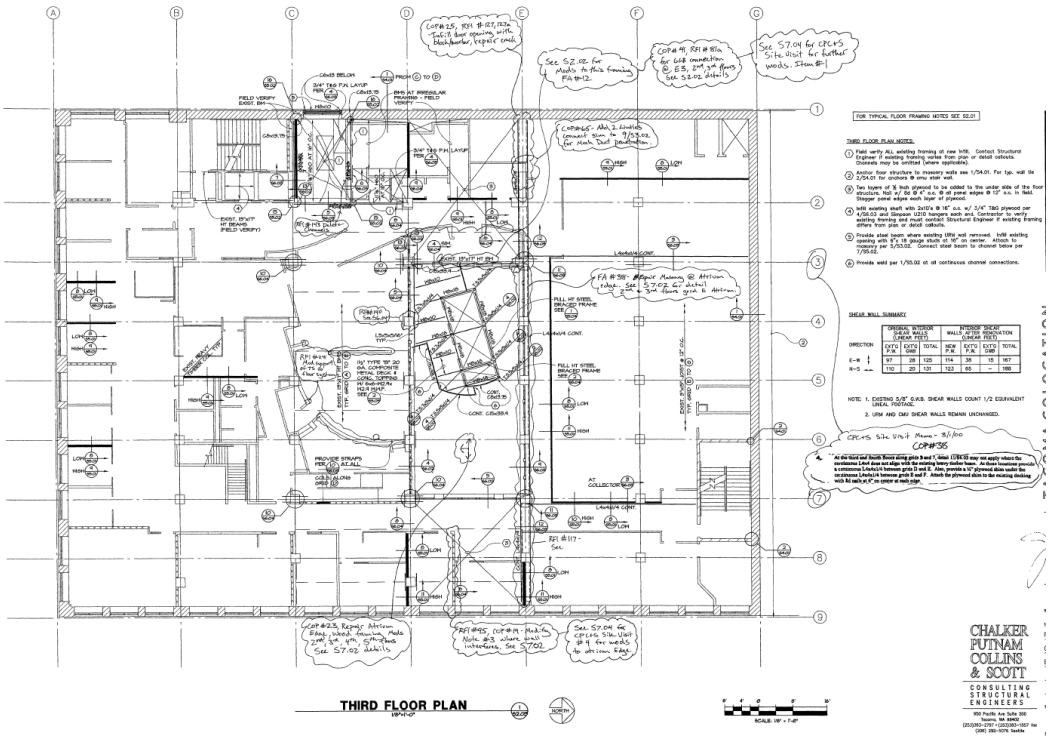
Typical Exterior Column/Capital

Typical Interior Column/Capital

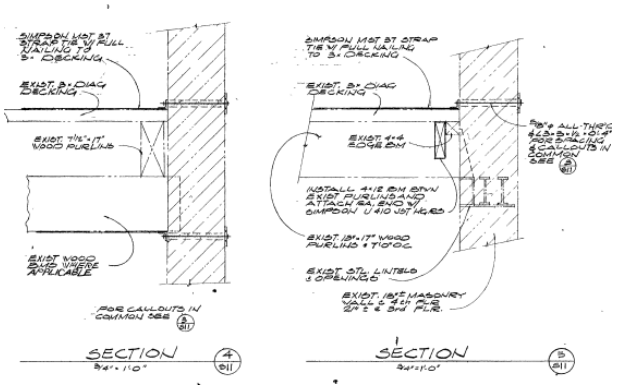
Roof Top Mechanical Unit Support to Concrete Column Locations

VI. APPENDIX B – PLANS AND ELEVATIONS

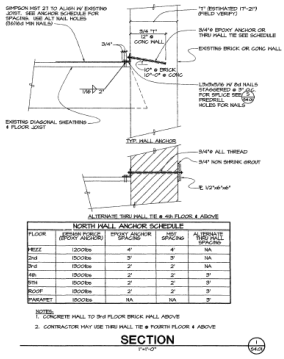
A. BROADWAY BUILDING



Third Level Plan

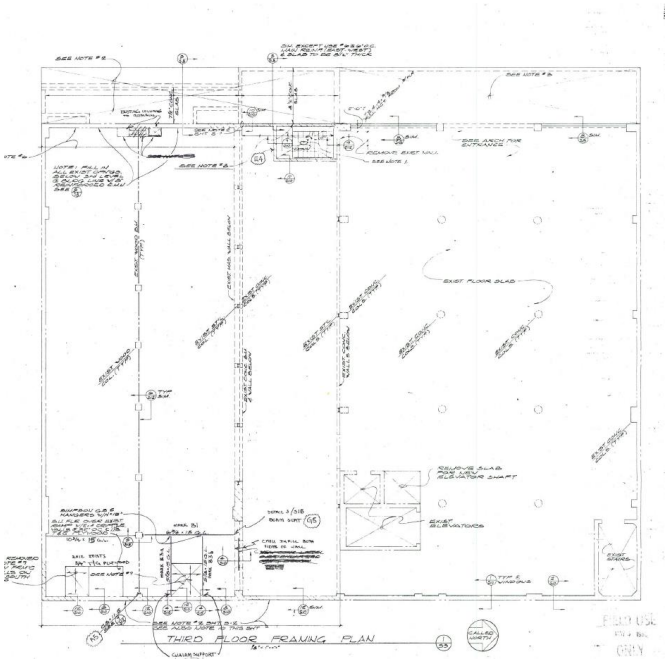


Typical URM Wall Anchor 1979 Remodel

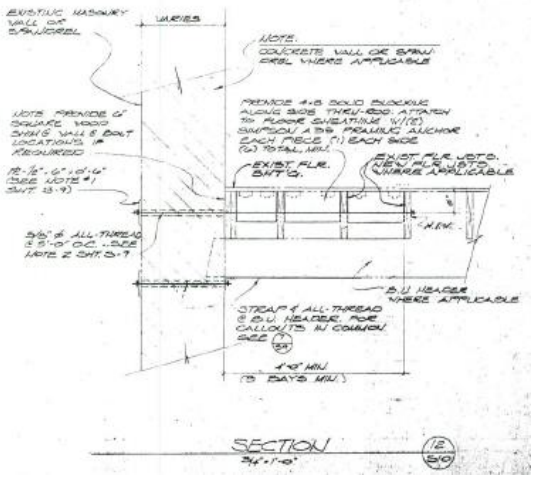


Typical URM Wall Anchor 1997 Remodel

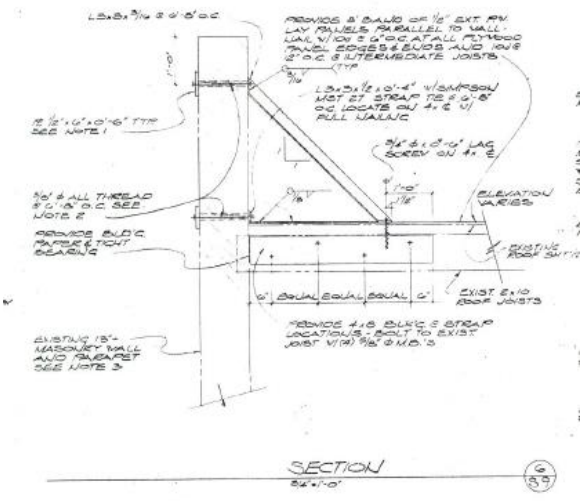
B. MARKET URM BUILDING



Third Level Plan

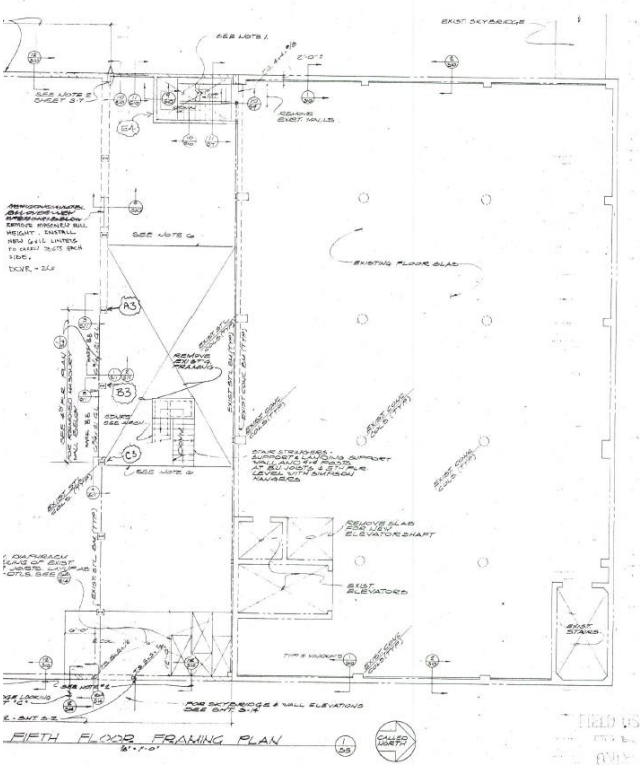


Typical URM Wall Anchor 1979 Remodel

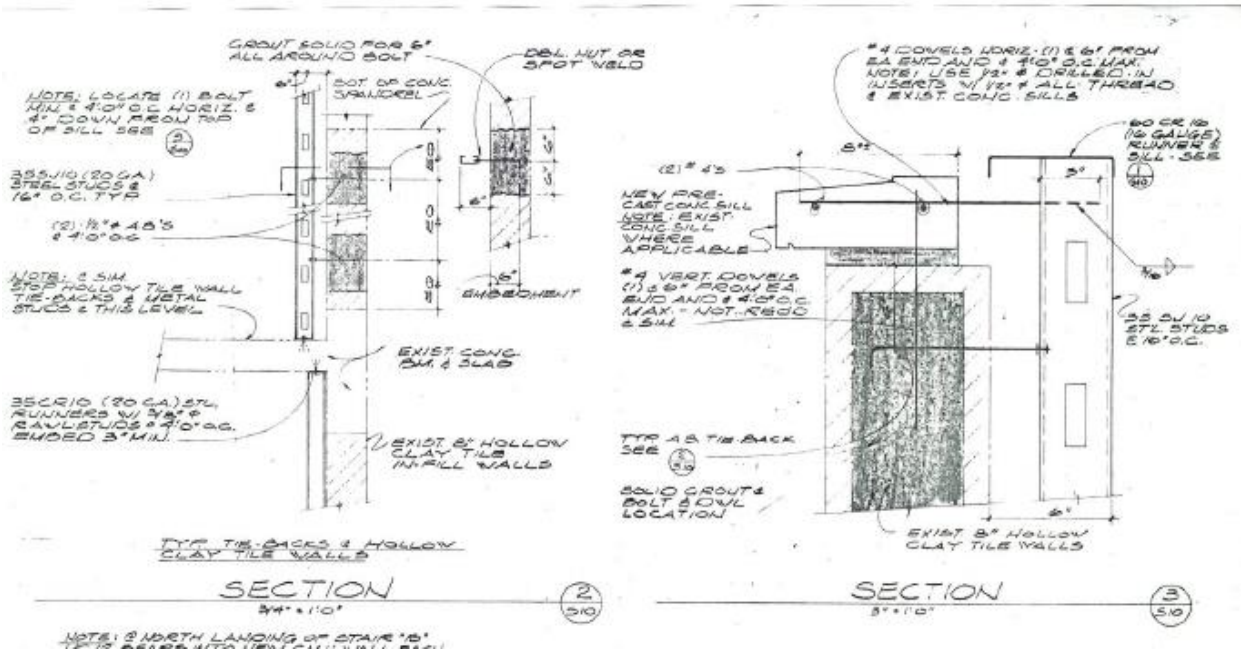


Typical URM Parapet Brace 1979 Remodel

C. MARKET CONCRETE BUILDING



Fifth Level Plan



Typical Metal Stud Backing Wall at Exterior HCT Walls 1979 Remodel

VII. APPENDIX C – ASCE 41-13 CHECKLISTS

A. BROADWAY BUILDING
Life Safety Basic Configuration Checklist
Life Safety Checklist for Unreinforced Masonry Bearing Wall Building

ASCE 41-13 Tier 1 Checklists

FIRM:	PCS STRUCTURAL SOLUTIONS
PROJECT NAME:	RHODES BUILDING - BROADWAY URM BUILDING
SEISMICITY LEVEL:	HIGH
PROJECT NUMBER:	17-513
COMPLETED BY:	JIMC
DATE COMPLETED:	06-14-17
REVIEWED BY:	
REVIEW DATE:	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

16.1 Basic Checklist

Very Low Seismicity

Structural Components

RATING				DESCRIPTION	COMMENTS
C ☐	NC ☐	N/A ☒	U ☐	LOAD PATH: The structure shall contain a complete, well-defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1)	
C ☐	NC ☐	N/A ☒	U ☐	WALL ANCHORAGE: Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support are anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 4.5.3.7. (Commentary: Sec. A.5.1.1. Tier 2: Sec. 5.7.1.1)	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

16.1.2LS Life Safety Basic Configuration Checklist

Low Seismicity

Building System

General

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☒	☐	☐	☐	LOAD PATH: The structure shall contain a complete, well-defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1)	URM perimeter shear walls, interior plywood and gwb shear walls, plywood roof and floor diaphragms.
C	NC	N/A	U		
☐	☒	☐	☐	ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building is greater than 4% of the height of the shorter building. This statement need not apply for the following building types: W1, W1A, and W2. (Commentary: Sec. A.2.1.2. Tier 2: Sec. 5.4.1.2)	No separation to building to the two story building to the north.
C	NC	N/A	U		
☒	☐	☐	☐	MEZZANINES: Interior mezzanine levels are braced independently from the main structure or are anchored to the seismic-force-resisting elements of the main structure. (Commentary: Sec. A.2.1.3. Tier 2: Sec. 5.4.1.3)	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

Building Configuration

RATING				DESCRIPTION	COMMENTS
C ☐	NC ☒	N/A ☐	U ☐	WEAK STORY: The sum of the shear strengths of the seismic-force-resisting system in any story in each direction is not less than 80% of the strength in the adjacent story above. (Commentary: Sec. A2.2.2. Tier 2: Sec. 5.4.2.1)	There are significant number of openings at the west second floor level that are not present above or below. Estimated a 67% less strength than the third floor above and 60% of the strength of the first floor.
C ☐	NC ☒	N/A ☐	U ☐	SOFT STORY: The stiffness of the seismic-force-resisting system in any story is not less than 70% of the seismic-force-resisting system stiffness in an adjacent story above or less than 80% of the average seismic-force-resisting system stiffness of the three stories above. (Commentary: Sec. A.2.2.3. Tier 2: Sec. 5.4.2.2)	There are significant number of openings at the west second floor level that are not present above or below. Estimated a 67% less stiffness than the third floor above and 60% of the stiffness of the first floor below.
C ☐	NC ☒	N/A ☐	U ☐	VERTICAL IRREGULARITIES: All vertical elements in the seismic-force-resisting system are continuous to the foundation. (Commentary: Sec. A.2.2.4. Tier 2: Sec. 5.4.2.3)	The interior plywood and gwb shear walls added during the 1979 and 1997 remodels are not continuous to the foundation and do not align floor to floor.
C ☒	NC ☐	N/A ☐	U ☐	GEOMETRY: There are no changes in the net horizontal dimension of the seismic-force-resisting system of more than 30% in a story relative to adjacent stories, excluding one-story penthouses and mezzanines. (Commentary: Sec. A.2.2.5. Tier 2: Sec. 5.4.2.4)	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

C	NC	N/A	U		
☒	☐	☐	☐	MASS: There is no change in effective mass more than 50% from one story to the next. Light roofs, penthouses, and mezzanines need not be considered. (Commentary: Sec. A.2.2.6. Tier 2: Sec. 5.4.2.5)	In general all floors are wood framed and do not very significantly in dead load mass.
☐	☒	☐	☐	TORSION: The estimated distance between the story center of mass and the story center of rigidity is less than 20% of the building width in either plan dimension. (Commentary: Sec. A.2.2.7. Tier 2: Sec. 5.4.2.6)	When considering masonry shear walls along the west and north wall are solid or mostly solid while the south and east walls have typical punched openings. When considering interior plywood and gwb shear walls torsion is significantly reduced. A more comprehensive lateral analysis is required to determine effect of torsion when considering plywood shear walls.

Moderate Seismicity

Geologic Site Hazards

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☒	☐	☐	☐	LIQUEFACTION: Liquefaction-susceptible, saturated, loose granular soils that could jeopardize the building's seismic performance shall not exist in the foundation soils at depths within 50 ft under the building. (Commentary: Sec. A.6.1.1. Tier 2: 5.4.3.1)	Building is in a low risk liquefaction area.
☒	☐	☐	☐	SLOPE FAILURE: The building site is sufficiently remote from potential earthquake-induced slope failures or rockfalls to be unaffected by such failures or is capable of accommodating any predicted movements without failure. (Commentary: Sec. A.6.1.2. Tier 2: 5.4.3.1)	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

C	NC	N/A	U		
☒	☐	☐	☐	SURFACE FAULT RUPTURE: Surface fault rupture and surface displacement at the building site are not anticipated. (Commentary: Sec. A.6.1.3. Tier 2: 5.4.3.1)	

High Seismicity

Foundation Configuration

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☒	☐	☐	☐	OVERTURNING: The ratio of the least horizontal dimension of the seismic-force-resisting system at the foundation level to the building height (base/height) is greater than $0.6S_a$. (Commentary: Sec. A.6.2.1. Tier 2: Sec. 5.4.3.3)	Complaint for URM shear walls, non-complaint for interior plywood shear walls. plywood shear walls have maximum height of approximately 20 feet which would require a base of 8 feet.
C	NC	N/A	U		
☒	☐	☐	☐	TIES BETWEEN FOUNDATION ELEMENTS: The foundation has ties adequate to resist seismic forces where footings, piles, and piers are not restrained by beams, slabs, or soils classified as Site Class A, B, or C. (Commentary: Sec. A.6.2.2. Tier 2: Sec. 5.4.3.4)	footings are confined by concrete slab on grade.

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

ASCE 41-13 Tier 1 Checklists

FIRM:	PCS STRUCTURAL SOLUTIONS
PROJECT NAME:	RHODES CENTER - BROADWAY BUILDING
SEISMICITY LEVEL:	HIGH
PROJECT NUMBER:	17-513
COMPLETED BY:	JIMC
DATE COMPLETED:	06-14-17
REVIEWED BY:	
REVIEW DATE:	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

16.16LS Life Safety Structural Checklist for Building Types URM: Unreinforced Masonry Bearing Walls with Flexible Diaphragms and URMA: Unreinforced Masonry Bearing Walls with Stiff Diaphragms

Low and Moderate Seismicity

Seismic-Force-Resisting System

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☒	☐	☐	☐	REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.2.1.1. Tier 2: Sec. 5.5.1.1)	URM Shear walls at perimeter, plywood/gwb shear walls at interior.
C	NC	N/A	U		
☐	☒	☐	☐	SHEAR STRESS CHECK: The shear stress in the unreinforced masonry shear walls, calculated using the Quick Check procedure of Section 4.5.3.3, is less than 30 lb/in.^{2} for clay units and 70 lb/in.^{2} for concrete units. (Commentary: Sec. A.3.2.5.1. Tier 2: Sec. 5.5.3.1.1)	Total Pseudo Seismic Force = 5925 kips Ms= 1.5 for URM Max NS at second floor 160 psi Max EW at second floor 91 psi If you consider interior plywood shear walls at 1/4 stiffness of URM walls Ms = 4 for Plywood Max NS second floor URM 105 psi PW 2480 plf Max EX second floor URM 73 psi PW 1740 plf

Connections

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☐	☒	☐	☐	WALL ANCHORAGE: Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support are anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 4.5.3.7. (Commentary: Sec. A.5.1.1. Tier 2: Sec. 5.7.1.1)	Through wall ties were added each pier in 1979 supplemental drilled in wall ties added between 2-3 feet. Quick check indicated wall anchors at non full height wall complaint, full Height walls have DCR approximately 1.8

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

C	NC	N/A	U		
☒	☐	☐	☐	WOOD LEDGERS: The connection between the wall panels and the diaphragm does not induce cross-grain bending or tension in the wood ledgers. (Commentary: Sec. A.5.1.2. Tier 2: Sec. 5.7.1.3)	Typically 48 inch straps are anchored to the floor diaphragm at 2 to 3 feet on center.
☒	☐	☐	☐	TRANSFER TO SHEAR WALLS: Diaphragms are connected for transfer of seismic forces to the shear walls. (Commentary: Sec. A.5.2.1. Tier 2: Sec. 5.7.2)	Continuous angle added in 1997 partial seismic upgrade anchored to the exterior walls and nailed to the floor diaphragm. Positive anchorage to interior plywood/gwb shear walls for both 1979 and 1997 seismic upgrade work.
☒	☐	☐	☐	GIRDER–COLUMN CONNECTION: There is a positive connection using plates, connection hardware, or straps between the girder and the column support. (Commentary: Sec. A.5.4.1. Tier 2: Sec. 5.7.4.1)	Straps added as part of 1979 partial seismic upgrade.

High Seismicity

Seismic-Force-Resisting System

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☐	☒	☐	☐	PROPORTIONS: The height-to-thickness ratio of the shear walls at each story is less than the following (Commentary: Sec. A.3.2.5.2. Tier 2: Sec. 5.5.3.1.2): Top story of multi-story building 9 First story of multi-story building 15 All other conditions 13	h/t 10.5 5th to roof h/t 10.5 4th floor h/t 9 3rd floor h/t 9.7 2nd floor h/t 11.4 1st floor

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

C	NC	N/A	U		
☒	☐	☐	☐	MASONRY LAYUP: Filled collar joints of multi-wythe masonry walls have negligible voids. (Commentary: Sec. A.3.2.5.3. Tier 2: Sec. 5.5.3.4.1)	

Diaphragms (Flexible or Stiff)

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☒	☐	☐	☐	OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls are less than 25% of the wall length. (Commentary: Sec. A.4.1.4. Tier 2: Sec. 5.6.1.3)	
C	NC	N/A	U		
☐	☒	☐	☐	OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls are not greater than 8 ft long. (Commentary: Sec. A.4.1.6. Tier 2: Sec. 5.6.1.3)	There are two locations where the opening is greater than 8 feet. One at the west wall stairwell and one at the north stair well. At the north stair well there are masonry cross walls added that brace the exterior wall.

Flexible Diaphragms

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☒	☐	☐	☐	CROSS TIES: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2)	Cross ties are present with straps added to wood beams and splices of wood joist or decking. Connections likely do not meet current standards.

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

C	NC	N/A	U		
☒	☐	☐	☐	STRAIGHT SHEATHING: All straight sheathed diaphragms have aspect ratios less than 2-to-1 in the direction being considered. (Commentary: Sec. A.4.2.1. Tier 2: Sec. 5.6.2)	
☒	☐	☐	☐	SPANS: All wood diaphragms with spans greater than 24 ft consist of wood structural panels or diagonal sheathing. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2)	plywood sheathing added to roof during 1979 partial seismic upgrade. Existing diagonal sheathing noted on drawings.
☒	☐	☐	☐	DIAGONALLY SHEATHED AND UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 40 ft and aspect ratios less than or equal to 4-to-1. (Commentary: Sec. A.4.2.3. Tier 2: Sec. 5.6.2)	Complaint if you consider interior plywood/ gwb shear walls. Non-complaint if you don't.
☒	☐	☐	☐	OTHER DIAPHRAGMS: The diaphragm does not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Commentary: Sec. A.4.7.1. Tier 2: Sec. 5.6.5)	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

Connections

RATING				DESCRIPTION	COMMENTS
C ☒	NC ☐	N/A ☐	U ☐	STIFFNESS OF WALL ANCHORS: Anchors of concrete or masonry walls to wood structural elements are installed taut and are stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 in. before engagement of the anchors. (Commentary: Sec. A.5.1.4. Tier 2: Sec. 5.7.1.2)	
C ☐	NC ☒	N/A ☐	U ☐	BEAM, GIRDER, AND TRUSS SUPPORTS: Beams, girders, and trusses supported by unreinforced masonry walls or pilasters have independent secondary columns for support of vertical loads. (Commentary: Sec. A.5.4.5. Tier 2: Sec. 5.7.4.4)	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

B. MARKET URM BUILDING
Life Safety Basic Configuration Checklist
Life Safety Checklist for Unreinforced Masonry Bearing Wall Building

ASCE 41-13 Tier 1 Checklists

FIRM:	PCS STRUCTURAL SOLUTIONS
PROJECT NAME:	RHODES CENTER - MARKET URM BUILDING
SEISMICITY LEVEL:	HIGH
PROJECT NUMBER:	17-513
COMPLETED BY:	JIMC
DATE COMPLETED:	06-16-17
REVIEWED BY:	
REVIEW DATE:	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

16.1 Basic Checklist

Very Low Seismicity

Structural Components

RATING				DESCRIPTION	COMMENTS
C ☐	NC ☐	N/A ☒	U ☐	LOAD PATH: The structure shall contain a complete, well-defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1)	
C ☐	NC ☐	N/A ☒	U ☐	WALL ANCHORAGE: Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support are anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 4.5.3.7. (Commentary: Sec. A.5.1.1. Tier 2: Sec. 5.7.1.1)	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

16.1.2LS Life Safety Basic Configuration Checklist

Low Seismicity

Building System

General

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☒	☐	☐	☐	LOAD PATH: The structure shall contain a complete, well-defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1)	Wood floor and roof diaphragms, URM shear walls, party or transverse wall in east-west direction, east and west exterior walls in north south direction. Minimal shear walls at east wall top floor.
C	NC	N/A	U		
☐	☒	☐	☐	ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building is greater than 4% of the height of the shorter building. This statement need not apply for the following building types: W1, W1A, and W2. (Commentary: Sec. A.2.1.2. Tier 2: Sec. 5.4.1.2)	Buildings to north and south in direct contact with the building. Building to the north has similar floor elevations but is two stories taller. Building to the south is one story shorter.
C	NC	N/A	U		
☐	☐	☒	☐	MEZZANINES: Interior mezzanine levels are braced independently from the main structure or are anchored to the seismic-force-resisting elements of the main structure. (Commentary: Sec. A.2.1.3. Tier 2: Sec. 5.4.1.3)	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

Building Configuration

RATING				DESCRIPTION	COMMENTS
C ☐	NC ☒	N/A ☐	U ☐	WEAK STORY: The sum of the shear strengths of the seismic-force-resisting system in any story in each direction is not less than 80% of the strength in the adjacent story above. (Commentary: Sec. A2.2.2. Tier 2: Sec. 5.4.2.1)	Estimated 30% difference in length of shear walls at the four floor level in the east west direction versus the levels above and below.
C ☐	NC ☒	N/A ☐	U ☐	SOFT STORY: The stiffness of the seismic-force-resisting system in any story is not less than 70% of the seismic-force-resisting system stiffness in an adjacent story above or less than 80% of the average seismic-force-resisting system stiffness of the three stories above. (Commentary: Sec. A.2.2.3. Tier 2: Sec. 5.4.2.2)	Estimated 30% difference in length of shear walls at the four floor level in the east west direction versus the levels above and below.
C ☐	NC ☒	N/A ☐	U ☐	VERTICAL IRREGULARITIES: All vertical elements in the seismic-force-resisting system are continuous to the foundation. (Commentary: Sec. A.2.2.4. Tier 2: Sec. 5.4.2.3)	The infill shear walls at the north wall and the interior wall noted above are interrupted with the exception of the stair walls.
C ☒	NC ☐	N/A ☐	U ☐	GEOMETRY: There are no changes in the net horizontal dimension of the seismic-force-resisting system of more than 30% in a story relative to adjacent stories, excluding one-story penthouses and mezzanines. (Commentary: Sec. A.2.2.5. Tier 2: Sec. 5.4.2.4)	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

C	NC	N/A	U		
☒	☐	☐	☐	MASS: There is no change in effective mass more than 50% from one story to the next. Light roofs, penthouses, and mezzanines need not be considered. (Commentary: Sec. A.2.2.6. Tier 2: Sec. 5.4.2.5)	At the second and fifth floor the center section of floor is not present.
☐	☒	☐	☐	TORSION: The estimated distance between the story center of mass and the story center of rigidity is less than 20% of the building width in either plan dimension. (Commentary: Sec. A.2.2.7. Tier 2: Sec. 5.4.2.6)	The south wall is mostly solid full height. The north exterior wall and interior cross wall

Moderate Seismicity

Geologic Site Hazards

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☒	☐	☐	☐	LIQUEFACTION: Liquefaction-susceptible, saturated, loose granular soils that could jeopardize the building's seismic performance shall not exist in the foundation soils at depths within 50 ft under the building. (Commentary: Sec. A.6.1.1. Tier 2: 5.4.3.1)	Low risk liquefaction site.
☒	☐	☐	☐	SLOPE FAILURE: The building site is sufficiently remote from potential earthquake-induced slope failures or rockfalls to be unaffected by such failures or is capable of accommodating any predicted movements without failure. (Commentary: Sec. A.6.1.2. Tier 2: 5.4.3.1)	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

C	NC	N/A	U		
☒	☐	☐	☐	SURFACE FAULT RUPTURE: Surface fault rupture and surface displacement at the building site are not anticipated. (Commentary: Sec. A.6.1.3. Tier 2: 5.4.3.1)	

High Seismicity

Foundation Configuration

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☒	☐	☐	☐	OVERTURNING: The ratio of the least horizontal dimension of the seismic-force-resisting system at the foundation level to the building height (base/height) is greater than $0.6S_a$. (Commentary: Sec. A.6.2.1. Tier 2: Sec. 5.4.3.3)	h=64 b = 75 75/64 = 1.17 Sa = 0.693 .06(0.693) = 0.42
C	NC	N/A	U		
☒	☐	☐	☐	TIES BETWEEN FOUNDATION ELEMENTS: The foundation has ties adequate to resist seismic forces where footings, piles, and piers are not restrained by beams, slabs, or soils classified as Site Class A, B, or C. (Commentary: Sec. A.6.2.2. Tier 2: Sec. 5.4.3.4)	Confined by concrete slab on grade

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

ASCE 41-13 Tier 1 Checklists

FIRM:	PCS STRUCTURAL SOLUTIONS
PROJECT NAME:	RHODES CENTER - MARKET URM BUILDING
SEISMICITY LEVEL:	HIGH
PROJECT NUMBER:	17-513
COMPLETED BY:	JIMC
DATE COMPLETED:	06-16-17
REVIEWED BY:	
REVIEW DATE:	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

16.16LS Life Safety Structural Checklist for Building Types URM: Unreinforced Masonry Bearing Walls with Flexible Diaphragms and URMA: Unreinforced Masonry Bearing Walls with Stiff Diaphragms

Low and Moderate Seismicity

Seismic-Force-Resisting System

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☒	☐	☐	☐	REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.2.1.1. Tier 2: Sec. 5.5.1.1)	Three cross walls in the east west direction east and west exterior walls in the north south direction.
C	NC	N/A	U		
☐	☒	☐	☐	SHEAR STRESS CHECK: The shear stress in the unreinforced masonry shear walls, calculated using the Quick Check procedure of Section 4.5.3.3, is less than 30 lb/in.^{2} for clay units and 70 lb/in.^{2} for concrete units. (Commentary: Sec. A.3.2.5.1. Tier 2: Sec. 5.5.3.1.1)	Average shear in north south direction fail at all levels with a minimum average at the fifth level with 43 psi and a maximum 107 psi at the first level . In the east west direction the average only fails at the third level with 33 psi. However if the walls took their tributary load the north walls would fail at the 5th and 3rd level with a maximum of 81 psi at the 3rd level. At the first and second level the party of cross walls appear to be concrete.

Connections

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☐	☒	☐	☐	WALL ANCHORAGE: Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support are anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 4.5.3.7. (Commentary: Sec. A.5.1.1. Tier 2: Sec. 5.7.1.1)	Design at time of upgrade was .2g ASD design. Quick check .83g ult or .58 ASD. Anchors that were checked appear to have a DCR of 2 to 3 times what is required. There are additional anchors at the girder beam locations at the east and west exterior walls. North and south URM walls do not appear to be anchored where there are adjacent buildings.

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

C	NC	N/A	U		
☒	☐	☐	☐	WOOD LEDGERS: The connection between the wall panels and the diaphragm does not induce cross-grain bending or tension in the wood ledgers. (Commentary: Sec. A.5.1.2. Tier 2: Sec. 5.7.1.3)	Anchors added at the east and west exterior walls where the joist span parallel to the walls.
C	NC	N/A	U		
☐	☒	☐	☐	TRANSFER TO SHEAR WALLS: Diaphragms are connected for transfer of seismic forces to the shear walls. (Commentary: Sec. A.5.2.1. Tier 2: Sec. 5.7.2)	Transfer depends on tension wall anchors and bearing of wood joist. There is a shear transfer mechanism, but not a direct positive one.
C	NC	N/A	U		
☒	☐	☐	☐	GIRDER–COLUMN CONNECTION: There is a positive connection using plates, connection hardware, or straps between the girder and the column support. (Commentary: Sec. A.5.4.1. Tier 2: Sec. 5.7.4.1)	Straps were added in 1979 seismic upgrade.

High Seismicity

Seismic-Force-Resisting System

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☒	☐	☐	☐	PROPORTIONS: The height-to-thickness ratio of the shear walls at each story is less than the following (Commentary: Sec. A.3.2.5.2. Tier 2: Sec. 5.5.3.1.2): Top story of multi-story building 9 First story of multi-story building 15 All other conditions 13	Height and thickness approximate 5th h = 12', t = 17", h/t =8.5 4th h = 12', t = 17", h/t = 8.5 3rd h = 15', t = 17", h/t = 10.6 2nd h = 10', t = 21", h/t = 5.7 1st h = 15', t = 21", h/t = 8.6

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

C	NC	N/A	U		
☒	☐	☐	☐	MASONRY LAYUP: Filled collar joints of multi-wythe masonry walls have negligible voids. (Commentary: Sec. A.3.2.5.3. Tier 2: Sec. 5.5.3.4.1)	Section of wall available to view at the second level.

Diaphragms (Flexible or Stiff)

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☒	☐	☐	☐	OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls are less than 25% of the wall length. (Commentary: Sec. A.4.1.4. Tier 2: Sec. 5.6.1.3)	
C	NC	N/A	U		
☐	☒	☐	☐	OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls are not greater than 8 ft long. (Commentary: Sec. A.4.1.6. Tier 2: Sec. 5.6.1.3)	South wall stairwell opening greater than 8'

Flexible Diaphragms

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☐	☒	☐	☐	CROSS TIES: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2)	No strapping added in north south direction.

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

C	NC	N/A	U		
☒	☐	☐	☐	STRAIGHT SHEATHING: All straight sheathed diaphragms have aspect ratios less than 2-to-1 in the direction being considered. (Commentary: Sec. A.4.2.1. Tier 2: Sec. 5.6.2)	
☐	☒	☐	☐	SPANS: All wood diaphragms with spans greater than 24 ft consist of wood structural panels or diagonal sheathing. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2)	orientation of sheathing is unknown. Roof sheathing is assumed to be straight with the addition of plywood at the perimeter.
☐	☒	☐	☐	DIAGONALLY SHEATHED AND UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 40 ft and aspect ratios less than or equal to 4-to-1. (Commentary: Sec. A.4.2.3. Tier 2: Sec. 5.6.2)	Oreintation of sheathing not know. If diagonal meets criteria. Most likely does not meet criteria at roof structure.
☒	☐	☐	☐	OTHER DIAPHRAGMS: The diaphragm does not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Commentary: Sec. A.4.7.1. Tier 2: Sec. 5.6.5)	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

Connections

RATING				DESCRIPTION	COMMENTS
C ☒	NC ☐	N/A ☐	U ☐	STIFFNESS OF WALL ANCHORS: Anchors of concrete or masonry walls to wood structural elements are installed taut and are stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 in. before engagement of the anchors. (Commentary: Sec. A.5.1.4. Tier 2: Sec. 5.7.1.2)	
C ☐	NC ☒	N/A ☐	U ☐	BEAM, GIRDER, AND TRUSS SUPPORTS: Beams, girders, and trusses supported by unreinforced masonry walls or pilasters have independent secondary columns for support of vertical loads. (Commentary: Sec. A.5.4.5. Tier 2: Sec. 5.7.4.4)	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

C. MARKET CONCRETE BUILDING
Life Safety Basic Configuration Checklist
Life Safety Checklist for Concrete Frames with Masonry Infill Shear Walls Building

ASCE 41-13 Tier 1 Checklists

FIRM:	PCS STRUCTURAL SOLUTIONS
PROJECT NAME:	RHODES CENTER - MARKET CONCRETE FRAME BUILDING
SEISMICITY LEVEL:	HIGH
PROJECT NUMBER:	17-513
COMPLETED BY:	JIMC
DATE COMPLETED:	06-14-17
REVIEWED BY:	
REVIEW DATE:	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

16.1 Basic Checklist

Very Low Seismicity

Structural Components

RATING				DESCRIPTION	COMMENTS
C ☐	NC ☐	N/A ☒	U ☐	LOAD PATH: The structure shall contain a complete, well-defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1)	
C ☐	NC ☐	N/A ☒	U ☐	WALL ANCHORAGE: Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support are anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 4.5.3.7. (Commentary: Sec. A.5.1.1. Tier 2: Sec. 5.7.1.1)	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

16.1.2LS Life Safety Basic Configuration Checklist

Low Seismicity

Building System

General

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☒	☐	☐	☐	LOAD PATH: The structure shall contain a complete, well-defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1)	Concrete frame with infill hollow clay tile or brick masonry shear walls.
C	NC	N/A	U		
☐	☒	☐	☐	ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building is greater than 4% of the height of the shorter building. This statement need not apply for the following building types: W1, W1A, and W2. (Commentary: Sec. A.2.1.2. Tier 2: Sec. 5.4.1.2)	Building to north and south there is no separation and appear to be constructed prior to this building.
C	NC	N/A	U		
☐	☐	☒	☐	MEZZANINES: Interior mezzanine levels are braced independently from the main structure or are anchored to the seismic-force-resisting elements of the main structure. (Commentary: Sec. A.2.1.3. Tier 2: Sec. 5.4.1.3)	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

Building Configuration

RATING				DESCRIPTION	COMMENTS
C ☐	NC ☒	N/A ☐	U ☐	WEAK STORY: The sum of the shear strengths of the seismic-force-resisting system in any story in each direction is not less than 80% of the strength in the adjacent story above. (Commentary: Sec. A2.2.2. Tier 2: Sec. 5.4.2.1)	The third through fifth floor have significantly reduced infill walls where is abuts the URM Market Building to the south. The infill walls at the west wall were removed at the third level. The concrete frame itself does not appear to significantly change in stiffness from floor to floor. Further evaluation beyond the scope of this report is required to determine actual stiffness.
C ☐	NC ☒	N/A ☐	U ☐	SOFT STORY: The stiffness of the seismic-force-resisting system in any story is not less than 70% of the seismic-force-resisting system stiffness in an adjacent story above or less than 80% of the average seismic-force-resisting system stiffness of the three stories above. (Commentary: Sec. A.2.2.3. Tier 2: Sec. 5.4.2.2)	Infill walls missing at south wall floors 3-5 see above. Concrete frame more consistent full height of the building with the columns increasing in size at the lower floors.
C ☐	NC ☒	N/A ☐	U ☐	VERTICAL IRREGULARITIES: All vertical elements in the seismic-force-resisting system are continuous to the foundation. (Commentary: Sec. A.2.2.4. Tier 2: Sec. 5.4.2.3)	infill walls missing at south wall floors 3-5, see above. No vertical irregularities in concrete frame.
C ☒	NC ☐	N/A ☐	U ☐	GEOMETRY: There are no changes in the net horizontal dimension of the seismic-force-resisting system of more than 30% in a story relative to adjacent stories, excluding one-story penthouses and mezzanines. (Commentary: Sec. A.2.2.5. Tier 2: Sec. 5.4.2.4)	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

C	NC	N/A	U		
☒	☐	☐	☐	MASS: There is no change in effective mass more than 50% from one story to the next. Light roofs, penthouses, and mezzanines need not be considered. (Commentary: Sec. A.2.2.6. Tier 2: Sec. 5.4.2.5)	
☒	☐	☐	☐	TORSION: The estimated distance between the story center of mass and the story center of rigidity is less than 20% of the building width in either plan dimension. (Commentary: Sec. A.2.2.7. Tier 2: Sec. 5.4.2.6)	

Moderate Seismicity

Geologic Site Hazards

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☒	☐	☐	☐	LIQUEFACTION: Liquefaction-susceptible, saturated, loose granular soils that could jeopardize the building's seismic performance shall not exist in the foundation soils at depths within 50 ft under the building. (Commentary: Sec. A.6.1.1. Tier 2: 5.4.3.1)	Low risk liquefaction site.
☒	☐	☐	☐	SLOPE FAILURE: The building site is sufficiently remote from potential earthquake-induced slope failures or rockfalls to be unaffected by such failures or is capable of accommodating any predicted movements without failure. (Commentary: Sec. A.6.1.2. Tier 2: 5.4.3.1)	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

C	NC	N/A	U		
☒	☐	☐	☐	SURFACE FAULT RUPTURE: Surface fault rupture and surface displacement at the building site are not anticipated. (Commentary: Sec. A.6.1.3. Tier 2: 5.4.3.1)	

High Seismicity

Foundation Configuration

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☒	☐	☐	☐	OVERTURNING: The ratio of the least horizontal dimension of the seismic-force-resisting system at the foundation level to the building height (base/height) is greater than $0.6S_a$. (Commentary: Sec. A.6.2.1. Tier 2: Sec. 5.4.3.3)	base is considered full width of building. base = 75' height = 80 feet .6Sa = 0.42 base/height = 0.94 OK
C	NC	N/A	U		
☒	☐	☐	☐	TIES BETWEEN FOUNDATION ELEMENTS: The foundation has ties adequate to resist seismic forces where footings, piles, and piers are not restrained by beams, slabs, or soils classified as Site Class A, B, or C. (Commentary: Sec. A.6.2.2. Tier 2: Sec. 5.4.3.4)	confined by concrete slab on grade.

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

ASCE 41-13 Tier 1 Checklists

FIRM:	PCS STRUCTURAL SOLUTIONS
PROJECT NAME:	RHODES CENTER - MARKET CONCRETE BUILDING
SEISMICITY LEVEL:	HIGH
PROJECT NUMBER:	17-513
COMPLETED BY:	JIMC
DATE COMPLETED:	06-14-17
REVIEWED BY:	
REVIEW DATE:	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

16.11LS Life Safety Structural Checklist for Building Types C3: Concrete Frames with Infill Masonry Shear Walls and C3A: Concrete Frames with Infill Masonry Shear Walls and Flexible Diaphragms

Low and Moderate Seismicity

Seismic-Force-Resisting System

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☒	☐	☐	☐	REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.2.1.1. Tier 2: Sec. 5.5.1.1)	Infill shear walls all four sides of building.
☐	☐	☒	☐	SHEAR STRESS CHECK: The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 4.5.3.3, is less than 70 lb/in.^{2}. (Commentary: Sec. A.3.2.4.1. Tier 2: Sec. 5.5.3.1.1)	Infill walls not reinforced
☐	☒	☐	☐	SHEAR STRESS CHECK: The shear stress in the unreinforced masonry shear walls, calculated using the Quick Check procedure of Section 4.5.3.3, is less than 30 lb/in.^{2} for clay units and 70 lb/in.^{2} for concrete units. Bays with openings greater than 25% of the wall area shall not be included in A_w of Eq. 4-9. (Commentary: Sec. A.3.2.5.1. Tier 2: Sec. 5.5.3.1.1)	By observation infill walls are not adequate. They were backed or strong backed out of plane in the 1979 seismic upgrade.
☒	☐	☐	☐	INFILL WALL CONNECTIONS: Masonry is in full contact with frame. (Commentary: A.3.2.6.1. Tier 2: Sec. 5.5.3.5.1 and 5.5.3.5.3)	No separation noted between infill walls and concrete frame.

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

Connections

RATING				DESCRIPTION	COMMENTS
C ☐	NC ☐	N/A ☐	U ☒	TRANSFER TO SHEAR WALLS: Diaphragms are connected for transfer of loads to the shear walls. (Commentary: Sec. A.5.2.1. Tier 2: Sec. 5.7.2)	Concrete slabs are assumed to be doweled into perimeter beams. Transfer to infill masonry walls assumed to be through bearing.
C ☐	NC ☐	N/A ☐	U ☒	CONCRETE COLUMNS: All concrete columns are doweled into the foundation with a minimum of 4 bars. (Commentary: Sec. A.5.3.2. Tier 2: Sec. 5.7.3.1)	1950 or 60 construction would have dowels into foundation.

High Seismicity

Seismic-Force-Resisting System

RATING				DESCRIPTION	COMMENTS
C ☐	NC ☐	N/A ☐	U ☒	DEFLECTION COMPATIBILITY: Secondary components have the shear capacity to develop the flexural strength of the components. (Commentary: Sec. A.3.1.6.2. Tier 2: Sec. 5.5.2.5.2)	reinforcing of columns unknown. Most likely they are not compatible based on act of construction.
C ☐	NC ☐	N/A ☐	U ☒	FLAT SLABS: Flat slabs or plates not part of the seismic-force-resisting system have continuous bottom steel through the column joints. (Commentary: Sec. A.3.1.6.3. Tier 2: Sec. 5.5.2.5.3)	floor plates are flat slabs with reinforcing unknown. To the degree they contribute to the lateral system based on stiffness is unknown and would require analysis beyond the scope of this evaluation.

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

C	NC	N/A	U		
☐	☒	☐	☐	PROPORTIONS: The height-to-thickness ratio of the unreinforced infill walls at each story is less than 9. (Commentary: A.3.2.6.2. Tier 2: Sec. 5.5.3.1.2)	masonry walls appear to be 8 inches with a height of 15 feet less two feet of the perimeter concrete beam or h/t = 13x12/8" = 19.5
☒	☐	☐	☐	CAVITY WALLS: The infill walls are not of cavity construction. (Commentary: Sec. A.3.2.6.3. Tier 2: Sec. 5.5.3.5.2)	
☒	☐	☐	☐	INFILL WALLS: The infill walls are continuous to the soffits of the frame beams and to the columns to either side. (Commentary: Sec. A.3.2.6.4. Tier 2: Sec. 5.5.3.5.3)	infill walls are full height adjacent to columns but not at the center where the exterior opening extends to the concrete spandrel beam.

Connections

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☐	☐	☒	☐	UPLIFT AT PILE CAPS: Pile caps have top reinforcement, and piles are anchored to the pile caps. (Commentary: Sec. A.5.3.8. Tier 2: Sec. 5.7.3.5)	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

C	NC	N/A	U		
☐	☐	☒	☐	STIFFNESS OF WALL ANCHORS: Anchors of concrete or masonry walls to wood structural elements are installed taut and are stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 in. before engagement of the anchors. (Commentary: Sec. A.5.1.4. Tier 2: Sec. 5.7.1.2)	Concrete floors

Diaphragms (Flexible or Stiff)

RATING				DESCRIPTION	COMMENTS
C	NC	N/A	U		
☒	☐	☐	☐	DIAPHRAGM CONTINUITY: The diaphragms are not composed of split-level floors and do not have expansion joints. (Commentary: Sec. A.4.1.1. Tier 2: Sec. 5.6.1.1)	
C	NC	N/A	U		
☒	☐	☐	☐	OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls are less than 25% of the wall length. (Commentary: Sec. A.4.1.4. Tier 2: Sec. 5.6.1.3)	
C	NC	N/A	U		
☐	☒	☐	☐	OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls are not greater than 8 ft long. (Commentary: Sec. A.4.1.6. Tier 2: Sec. 5.6.1.3)	Walls are confined within concrete frame.

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

Flexible Diaphragms

RATING				DESCRIPTION	COMMENTS
C ☐	NC ☐	N/A ☒	U ☐	CROSS TIES: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2)	Rigid concrete floor diaphragm. Flexible wood diaphragm comments not applicable.
C ☐	NC ☐	N/A ☒	U ☐	STRAIGHT SHEATHING: All straight sheathed diaphragms have aspect ratios less than 2-to-1 in the direction being considered. (Commentary: Sec. A.4.2.1. Tier 2: Sec. 5.6.2)	
C ☐	NC ☐	N/A ☒	U ☐	SPANS: All wood diaphragms with spans greater than 24 ft consist of wood structural panels or diagonal sheathing. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2)	
C ☐	NC ☐	N/A ☒	U ☐	DIAGONALLY SHEATHED AND UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 40 ft and aspect ratios less than or equal to 4-to-1. (Commentary: Sec. A.4.2.3. Tier 2: Sec. 5.6.2)	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

C	NC	N/A	U		
☐	☐	☒	☐	OTHER DIAPHRAGMS: The diaphragm does not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Commentary: Sec. A.4.7.1. Tier 2: Sec. 5.6.5)	

Legend: C = Compliant, NC = Noncompliant, N/A = Not Applicable, U = Unknown

VIII. APPENDIX D – COMMON SEISMIC TERMINOLOGY

COMMON SEISMIC TERMINOLOGY – SEISMIC PERFORMANCE GOALS

Major Earthquake: Also known as the "Design" earthquake since its criteria is used for most codes. It is an earthquake that produces ground motions (shaking) at the site under consideration that have a 10% probability of being exceeded in 50 years. A 30% of gravity (0.3g) ground acceleration would be anticipated in the Puget Sound area.

Moderate Earthquake: An earthquake that produces ground motions (shaking) at the site under consideration that have a 50% probability of being exceeded in 50 years. The 1949, 1965 and 2001 earthquakes in the Puget Sound area are classified as moderate earthquakes.

Minor Earthquake: An earthquake that produces ground motions (shaking) at the site under consideration less than a moderate earthquake and would be short in duration. The recent Richter scale 5.5 earthquakes in the Puget Sound area would be considered minor earthquakes.

Probability of Exceedance: The probability that the ground shaking level or damage level will be exceeded.

International Building Code (IBC): The IBC is a comprehensive set of national regulations for building systems consistent with and inclusive of the scope of originally regional legacy codes. The IBC is the current nationally recognized building code and has been adopted by a majority of states and building jurisdictions.

Anticipated Seismic Performance of New Construction Built to Comply with the International Building Code:

1. Resist a minor level earthquake ground motion without structural or nonstructural damage.
2. Resist moderate level of earthquake ground motion without structural damage, but possibly experience some nonstructural damage.
3. Resist a major level of earthquake ground motion having an intensity equal to the strongest either experienced or forecast for the building site, without collapse, but possibly with some structural, as well as nonstructural damage.
4. Essential facilities are designed for force levels 25% to 50% greater than standard buildings. The building is intended to have minimal structural and nonstructural damage after a major earthquake. The repair of the damage that has occurred would generally not be required prior to re-occupancy, or in other words, be in an operable condition after a major earthquake. Hospitals, Police and Fire Stations are common essential facilities.

International Existing Building Code (IEBC): Building Code Standard that addresses older buildings not constructed under current codes and specifically older unreinforced masonry buildings, concrete tilt-up building, wood buildings and concrete buildings. Its provisions for rehabilitation of unreinforced masonry buildings are less stringent requirements than are demanded for new construction, and were developed considering and balancing the expense of retrofit, the value of the existing building stock and the desired reduction in seismic risk.

ASCE 41-13 – Seismic Evaluation and Retrofit of Existing Buildings: A comprehensive standard based on performance based design, it identifies areas of seismic vulnerability with each common building type based on past seismic performance. The performance level design criteria include Collapse Prevention, Life Safety, Immediate Occupancy and Operational (the last for new construction only). ASCE 41-13 has become the accepted standard in the building industry.

Anticipated Seismic Performance of Building Renovated to International Existing Building Code or ASCE 41-13 Life/Safety Performance Level: The seismic performance would be less than that of new construction. The goal is to reduce life/safety hazards as best as possible with available resources. This code is directed at insuring a coherent load path for lateral loads, reduction of out-of-plane wall failures, reduction of loss of support for floors and roofs and reduction of falling parapets or ornamentation. Anticipated post-earthquake condition would be similar to life/safety design performance for moderate earthquakes and near collapse for major earthquakes as described below.

Immediate Occupancy Seismic Performance Level: Post-earthquake condition of the building would be such that only limited structural damage has occurred. The basic vertical and lateral load resisting systems of the building retain nearly all of their pre-earthquake strength and stiffness. The risk of life- threatening injury as a result of structural damage is very low, although some minor structural repairs may be appropriate; these would generally not be required prior to re-occupancy.

Life/Safety Performance Level: The post-earthquake condition of the building would be that the building may suffer significant structural damage with some anticipated margin against either partial, or total structural collapse. Injuries may occur during the earthquake; however, it is expected that the overall risk of life-threatening injury as a result of structural damage is low. It should be possible to repair the structure; however, for economic reasons this may not be practical. While the damaged structure is not an imminent collapse risk, it would be prudent to implement structural repairs or install temporary bracing prior to re-occupancy.

Collapse Prevention Seismic Performance Level: The post-earthquake condition of the building would be such that the building would be on the verge of experiencing partial or total collapse. Substantial damage to the structure has occurred, potentially including significant degradation in stiffness and strength of the lateral force resisting system, large permanent lateral deformation of the structure and to a more limited extent, degradation in the vertical load carrying capacity. The primary vertical gravity load resisting system should still be able to support its load demand. Significant risk of injury due to falling hazards from structural debris may exist. The structure may not be technically practical to repair and is not safe for re-occupancy, as aftershock activity could induce collapse.

Hazard Reduction/Mitigation of Seismic Hazard: Objective is met with the removal or strengthening of elements of the building which have commonly performed poorly in past earthquakes or presents a life/safety threat to the building occupants.

Structural Damage: Damage to the structural elements of the building. A building with structural damage may require evacuation after an earthquake until structural components are repaired.

Nonstructural Damage: Damage to architectural, mechanical, electrical or building components that do not affect the overall structural integrity of the building. Examples are window breakage, shelves overturning, and ceilings falling down. This is the most common and may be the most expensive damage caused by an earthquake.

Lateral Force Resisting System: Those elements of the structure that provide its basic lateral strength and stiffness (to resist lateral forces due to wind or earthquake motion), and without which the structure would be laterally unstable.

Vertical Load Resisting System: Those elements of the structure that provide a load path for the gravity loads to the foundation.

Ductility: A measure of the ability of a material, elements or system to deform beyond yield. (Yielding after material, element, system has exceeded its initial design strength without a significant loss in load-carrying capacity).

Redundancy: The presence of multiple structural support systems, such that if one or several elements have substantial strength or stiffness loss, continuing lateral displacement and vertical loads may be resisted by the other structural or nonstructural elements in the system.

Brittle Systems: Systems that do not have a defined yield phase (ductility) and that have a significant strength degradation immediately after the displacement associated with peak strength. (Unreinforced clay tile and brick masonry bearing wall systems would be considered brittle systems.)

Diaphragm: A horizontal, or nearly horizontal system designed to transmit lateral forces to vertical elements (shear walls, braced frames, etc.) of the lateral-force-resisting system. Common diaphragm types are plywood sheathing, reinforced concrete, metal decking or concrete topping over metal decking.

Shear Wall: A wall designed to resist lateral forces acting in the plane of the wall (parallel to the wall). Common shear wall types are plywood, reinforced masonry or concrete walls.

Braced Frame: An essentially vertical truss, or its equivalent. Two common braced frame types are concentric (members meet at a common point) or eccentric (to resist lateral loads, some members do not meet at common point). Braced frames are most commonly constructed of steel members.

Redundant Load Path: Secondary load path, normally independent of primary load path, to provide vertical support of floors and roof, if bearing walls or vertical frame fail.

Unreinforced Masonry Wall: Masonry walls, such as solid brick masonry, hollow clay tile or concrete masonry unit (CMU), that rely on the tensile strength of masonry units, mortar and grout to provide structural support. (Current code (IBC) requires reinforced masonry walls to resist tensile forces in our seismic risk zone.)

Unreinforced Concrete Wall: Concrete walls lacking reinforcing that rely on the tensile strength of the concrete to provide structural support. Nominally or minimally reinforced concrete walls act in a similar manner. (Current code (IBC) requires reinforcing steel to resist tensile forces in our seismic risk zone.)

Shotcrete: Concrete that is pneumatically sprayed on vertical, or near vertical, surfaces typically with a minimum use of concrete form work.

Re-Entrant Corner: Plan irregularity in a building, such as an extending wing, plan inset or E, T, X, and L shaped configuration, where large tensile and compression forces can develop at “inside corner configurations”.

Strong Back System: A secondary system, such as a wood or steel frame wall or columns, used to provide out-of-plane support to an unreinforced or under-reinforced masonry wall.

Sub-Diaphragm: A portion of a larger diaphragm used to distribute loads between members. Sub-diaphragms are commonly used to distribute tension loads from anchorage of masonry or concrete walls to tension ties (crossties) across the building.

Crosstie: A beam, girder, or other structural member that accumulates tension loads from wall anchorage and distributes them over the entire width of the building (diaphragm).

Richter Scale: A measurement of the amount of energy released in an earthquake. It utilizes a base-10 logarithmic scale, so every magnitude level increase (i.e M6 to M7) corresponds to 10 times the energy released.

Interplate/Subduction Zone Earthquake: An earthquake that occurs directly at the interface of two tectonic plates. They typically have long reoccurrence levels (500 years or more), and have the ability to produce the largest magnitude earthquakes, upwards of M9 on the Richter Scale.

Intraplate Subduction Zone Earthquake: A deep earthquake, with an epicenter typically 25 to 40 miles below the surface, that has the ability to produce large magnitude earthquakes, upward of M6 to M7 on the Richter Scale. They have a short reoccurrence level, often in the 35 to 50 year range.

Shallow Earthquake: An earthquake that occurs at depths less than 25 miles. While they may release less energy than other earthquake (M5.5 to perhaps M7 on the Richter Scale), they shallow nature of the earthquake can often lead to more ground disruption, and therefore more geographically isolated damage.