Coos Bay Public Library

Structural Assessment

525 Anderson Avenue, Coos Bay, OR

February 21, 2014

Prepared for:
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REGISTERED PROFESSIONAL ENGINEER
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OREGON
Sept. 19, 2006
KYLAS EMMETT ALLEN
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February 21, 2014

Randy Dixon, Operations Manager
City of Coos Bay
500 Central Avenue
Coos Bay, OR 97420

Reference: Coos Bay Public Library

Subject: Structural Improvement Evaluation

Mr. Dixon,

Please accept this report outlining our findings and recommendations for the structural improvement plan for the Coos Bay Public Library located at 525 Anderson Avenue in Coos Bay, Oregon. The purpose of our investigation was to verify the existing structural systems and perform an assessment based on current building code requirements to determine deficiencies, and to provide repair recommendations. We have outlined the findings of our evaluation in the enclosed report.

If you have any questions or concerns, please do not hesitate to contact our office at (541) 479-3865, or email me at SyA@ZCSengineering.com.

Sincerely,

Sylas E. Allen, PE
Branch Manager

Enc: Structural evaluation report with repair recommendations and Tier 1 seismic evaluation.

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Report Organization

Introduction: This section provides a brief overview and summary of the Structural Assessment and is intended to provide the reader with the important facts and findings contained in the overall report.

Project Overview: This section provides information on the background of the situation so the reader understands why this report was necessary.

Observations & Findings: This section includes a detailed summary of the building inspections along with the deficiencies that were observed.

Conclusions & Recommendations: This section outlines the conclusions that can be drawn from the information gathered and the actions deemed necessary to correct the noted deficiencies.

Opinion of Probable Construction Cost: This section provides a rough cost estimate to assist with the determination of the feasibility of moving forward with the structural repair work.

Recommendations Moving Forward: This section gives the reader an idea of the next steps to be taken if the City decides to move forward with the repair of this building.

Limitations & Exclusions: This section outlines the limits of the work performed, and the extent to which ZCS can be held responsible for the information provided in this report.

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1.0 Introduction

This report outlines our findings regarding the structural assessment of the Coos Bay Public Library located at 525 Anderson Ave. in Coos Bay, Oregon. The purpose of this assessment was to determine the cause of building settlement, investigate existing structural systems for deficiencies, and prescribe repairs for the items found with associated costs to guide the City in their decision making regarding this building. Our scope did not include evaluation of space planning; fire and life safety and ADA code related items; energy efficiency, security measures, finish upgrades, facility modernization, or mechanical, electrical and plumbing systems. The list below briefly outlines the findings of our evaluation, and recommended repairs.

Summary of Findings and Recommended Repairs

- Global settlement throughout the building, with localized areas of substantial settlement over short distances. In addition, condition of the existing pile and attachment to the pile caps is unknown. Refer to geotechnical report prepared by SHN Consulting Engineers & Geologists, Inc. dated January 22, 2014.
  - Complete foundation rehabilitation in the form of cased micropiles extending approximately 120' (into the underlying bearing stratum).
  - Localized floor slab repair incidental to structural work and levelling of drastic changes in elevation.
  - Repair and replacement of finishes, fixtures, casework, etc.
- Deficient gravity framing elements at the second floor storage portion of the original building (beams 'L' and 'F', and truss 'T-1' in Figure 5).
  - Repair measures should be further investigated, but could consist of additional columns or direct repairs to deficient members.
  - If deficiency is deemed a major concern, abandonment of second floor storage may be necessary.
- Concrete columns acting as lateral force resisting system in original structure are not compliant, refer to Appendix B: Tier 1 Evaluation.
  - Provide CMU shear walls to resist lateral loads, concrete columns remain for gravity element support.
- The roof diaphragm of the original building consists of 2x horizontal sheathing, rendering it inadequate for seismic loading, refer to Appendix B: Tier 1 Evaluation.
  - Provide plywood sheathing over existing 2x horizontal sheathing in conjunction with the re-roof of the building.
- The roof diaphragm of the wood-framed addition consists of unblocked plywood sheathing, refer to Appendix B: Tier 1 Evaluation.
  - Provide blocking at all panel edges and edge nail sheathing.
  - Improve connections at beam lines and walls to roof, provide strapping for connectivity across the building.

We have prepared an "Opinion of Probable Construction Cost" for the repair and rehabilitation of this building in Table 1. Based on expected costs to perform the work described above, we arrived at approximately **$6.3 million**. The use of this budget should be limited to planning level decision making only, to determine the feasibility of undertaking the structural repairs outlined herein. The findings in this report, that the budget is based on, will need to be further evaluated to determine the exact nature of the necessary repairs should the City decide this route to be in their best interest. In addition, the following is recommended: hazardous material investigation, space planning if so desired, utility coordination, detailed code review, and preparation of construction documents for structural, architectural, and MEP disciplines.

2.0 Project Overview

The original Coos Bay Public Library was constructed around 1965 on the corner of Anderson and 5th Streets in Coos Bay, Oregon. Based on the original construction drawings made available for our review, this single-story, 16,640 sf building was founded on timber pile capped with concrete, a structural floor slab and building superstructure. The perimeter concrete columns appear to function as the building's lateral- and gravity-force resisting system, with non-structural masonry infill walls and window packages between. The roof construction is comprised of heavy timber trusses and beam systems, with 2x roof decking and asphalt shingle roofing. The library underwent an approximately 9000 sf addition around 1998, expanding to the west of the original building and modifying the main entrance. Based on construction documents made available for our review, the addition was founded on steel pipe pile, and also supports a structural slab system, but the lateral- and gravity-force resisting system is comprised of wood shearwalls, and the roof is light timber-framed trusses with plywood sheathing and asphalt shingle roofing. At some point between the original construction and the addition, the north wall of the original building underwent undocumented modifications, bumping the exterior wall out under the existing overhang. This minor addition involved new concrete grade beams between the columns, and a wood-framed floor system and exterior walls between the existing concrete columns.

Figure 1 Building Exterior

It is our understanding the City of Coos Bay (City) retained the services of SHN Consulting Engineers & Geologists, Inc. (SHN) to investigate the apparent settlement of the north wall of the library where the undocumented modifications occurred (refer to Geotechnical Evaluation dated May 8, 2012). Based on the findings in that report, the City retained the services of ZCS Engineering, Inc. (ZCS) to design a foundation solution to address the localized settlement. During the course of this design, ZCS began to question the effectiveness of a localized solution, when the problem appeared to be of a global nature. The City again enlisted the services of SHN to provide further geotechnical investigation on a global scale (refer to "Supplemental Geotechnical Investigation" dated January 22, 2014), in conjunction with the structural investigation performed by ZCS. The following report summarizes the findings, recommendations and conclusions of the geotechnical and structural evaluations.

3.0 Observations & Findings

3.1 Geotechnical

Refer to SHN report "Supplemental Geotechnical Investigation Relative to Structural Distress" dated January 22, 2014 for additional information. The following summarizes the report:

- SHN performed geotechnical investigations to determine soil characteristics essential to determining the adequacy of the existing foundation and appropriate foundation repair methods.
- SHN performed a floor level survey to ascertain the nature of the building settlement in an attempt to relate the findings to the actual building grid loads as provided by ZCS.
- The soils were deemed highly compressible, even under light loading, with a long time-rate of settlement and possibility of induced downdrag forces on pile.
- The allowable pile capacity is approximately 16.67 kips for single pile, 11.77 kips per pile for pile groups (FS = 3.0, group efficiency factor = 0.7)

3.2 Structural

Agents of ZCS visited the site on a number of occasions at the request of the City to observe what appeared to be recent cracking of the finishes, to verify the information provided in the original construction drawings, and to observe the general layout of the furniture and shelving units to approximate the floor loading accurately. We prepared a summary of the loading on a grid basis for use by SHN in correlating their findings with the actual loading conditions (this loading summary can be found in the supplemental geotechnical report referenced above).

Figure 2 Storage Space Construction

In conjunction with the loading summary, we also performed calculations to analyze the existing beams and trusses for deficient members. It was determined that some of the members supporting the second floor storage space are deficient under the prescribed code loading (see Figure 2). We also performed a Tier 1 Evaluation, per the ASCE 31-03 – Seismic Evaluation of Existing Buildings, to get a general sense of the adequacy of the lateral-force resisting system as it pertains to seismic loading (see Appendix B: Tier 1 Evaluation). Overall, the building did not raise many red flags; most notable were the inadequacy of the diaphragms (2x roof decking on the original structure, unblocked plywood sheathing on the addition), lack of cross-ties between diaphragm chords, improper spacing of the column ties at the connection to the pile cap where the forces would concentrate, and insufficient anchorage of the existing pile to the pile caps.

4.0 Conclusions & Recommendations

4.1 Geotechnical

Refer to SHN report "Supplemental Geotechnical Investigation Relative to Structural Distress" dated January 22, 2014 for additional information. To summarize:

- The existing pile are inadequate for support of the structure, although a majority of the total expected settlement has occurred.
- Groundwater fluctuation could be deteriorating the top of the timber pile, contributing to the settlement observed.
- The best option for remediation of the settlement and adequate support of the building is cased micropile installed to a depth of approximately 120' (into the underlying dense siltstone bedrock).

4.2 Structural

Based on the calculated loads and condition of the underlying soils, all of the existing pile have insufficient capacity to support the calculated loads, contributing to the settlements observed. SHN has determined that the best repair option is to install an array of micropile that take the existing foundation out of service completely, even if the loads can be reduced below the provided allowable capacity of the existing pile. These micropile are very expensive, due to the depth they have to be installed to achieve capacity. The number of pile could fluctuate depending on the repair methods chosen, but our preliminary estimate puts the total just over 200 pile. This would involve installing a single pile through the middle of the existing pile caps where there are no columns to interfering, and installing two pile where columns are interfering; one either side of the existing pile cap to negate any eccentricity (see Figure 4).

The installation of the pile will require intensive demolition with regards to the existing slab system. Portions of the slab would have to be removed to allow access to the existing pile caps, and replaced after the pile installation is complete. Structure would have to be appended to the existing pile caps to anchor the new micropile system to the building. Among other options, removal of the entire slab and replacement with a lighter wood-framed floor system was entertained, but the gain does not outweigh the cost since the existing pile were deemed useless regardless of the loading applied. In essence, it would require the same number of new micropile, and even more work to the substructure in order to frame the new floor into the building. The only major gain with this approach is a more level floor and unlimited access to the existing substructure during construction.

In order to install the micropile, the entire building would need to be cleared of all contents, and gutted of all interior walls and items conflicting with the pile locations, perhaps leaving the ceiling finishes and the existing HVAC system intact. This includes, but is not limited to, walls, casework, plumbing, fixtures, electrical, and floor finishes, which would all have to be replaced after the work is complete. This would also involve storing all the contents and closing down the library for the duration of construction, which could be a year to a year-and-a-half. This would provide the City with an opportune time to perform the desired roof replacement, and recommended structural roof upgrades.

The structural work described above is considered “repairs”, and is completely voluntary on the part of the City as the structure has not been deemed “dangerous”. Repairs are work that is deemed necessary to fix a structural deficiency, with the exception of the voluntary seismic strengthening that would fall into the “upgrades” category. Upgrades are items that may or may not improve the usability of the space, but improve the overall performance of the structure. While the seismic strengthening is voluntary per sections 3408.4 and 3404.5 of the OSSC, we would recommend performing this work to protect the investment that is made in the building. This would entail providing new CMU shearwalls to take the place of the existing concrete columns as part of the lateral force resisting system, as well as providing plywood sheathing and cross-ties at the roof level to create diaphragms and load path components.

It is our opinion that the repair of the library as described above would not be money well spent on the part of the City. The expected gain is minimal: reduction in maintenance associated with settlement, and assurance of public perception of safety. What is not gained is what determined our recommendation: the floor is still uneven; you gain no efficiencies that a modern building would grant you in MEP systems, maintenance costs, energy consumption, up-to-date electronics, security measures, and usability. An evaluation could be performed to determine if the library still fits the needs of the community, or if it is outdated. The contents of the library would have to be moved out, and the library closed for at least a year during construction, whereas if a new building was constructed, the City could move the contents directly into the new building with little down-time.

The City maintains the option to take no action, and continue to use the library as they are currently. The building is safe for occupancy, as the settlements observed do not constitute a collapse potential or immediate danger. The City will have to keep up with maintenance items such as repairs to finishes and thresholds as they become an issue due to continued settlement. We would recommend a monthly monitoring program be established to track the continued settlement of the building, as we can provide no warranty as to the condition of the building as it continues to settle, or its performance during a code wind or seismic event. The City will also have to tolerate the public perception of the settlement, with the knowledge that at some point the perception of the safety of the library may be compromised due to the undulations of the floor and the finish damage.

5.0 Opinion of Probable Construction Cost

The intent of this section is to help establish a reasonable estimate of the construction cost to help the City determine the feasibility of undertaking the foundation repair. To develop the probable construction cost for the repairs, we consulted a specialty contractor regarding the micropile foundation system, and a local contractor regarding the incidental demo and replacement work. The construction cost excludes the voluntary seismic strengthening work outlined previously, roof replacement, optional HVAC replacement, any hazardous material investigation/mitigation, any moving and storage of building contents, any costs associated with down-time during the construction process (approx. 1 to 1.5 year), and any alterations to the building outside the scope of the repairs. Based on basic finishes such as carpet and vinyl flooring, standard fixtures and casework, painted wood doors and trim, and wood framed walls with gypsum finishes, the following opinion utilizes a cost of $85.00 per square foot for direct replacement of the existing interior elements.

Separate line items, including an industry standard 5% for permitting fees, 15% for soft costs associated with architectural/engineering plan development, and a 15% contingency associated with potential unknowns that could develop with a repair of this magnitude, have been included. The total construction cost is based on 26,000 sf of building area. The following table outlines our Opinion of Probable Construction Cost:

Table 1 Opinion of Probable Construction Cost

Micropile Foundation Repairs	207 pile @ $12,000 per pile	$2,484,000
Demo and Replacement	$85/sf	$2,210,000
	Subtotal	**$4,694,000**
Permitting Fees	5%	$235,000
Plan Development Fees	15%	$704,000
Contingency	15%	$704,000
	Total Building Improvements	**$6,337,000**

By comparison, if a new library of the same square footage were built today, the City could expect to pay around $250/sf. At 26,000 sf, a new library would cost around **$6.5 million**. With the current technology trends, and departure from paper media to more electronic media, a new library may not need to be as large as the existing library. An evaluation could be performed within the local community to determine if the currently library is sufficient, or if a new library could better serve the needs of the community.

It should be noted that the above probable construction costs do not include potential increases related to inflation over time and material price escalations. The above construction cost is based on current pricing data available. This budget should be used for planning level decision making only.

6.0 Recommendations Moving Forward

As stated above, it is not our recommendation to repair the existing library. We believe the community of Coos Bay could benefit from a more modern public library facility, and the City may come out money-ahead by pursuing a newer, more efficient building. We believe a viable option may be to construct a new facility on a corner of the current library parking lot, while continuing to utilize the existing library. When this structure is complete, the moving process would be relatively easy by comparison to moving to a completely different site, decreasing the down-time, and maintaining the public association with this site as the public library.

Should the City decide to proceed with the repairs to the library foundation, based on the information provided in this report, further investigation/evaluation will need to be performed during a schematic design phase. Further consultation with the micropile specialty contractor will be necessary to confirm the assumptions that were made to provide the above cost estimate. A schematic foundation repair plan shall be developed, which will be utilized during discussions and subsequent testing or selective demolition to maximize the efficiency of the proposed repairs. Schematic mechanical, electrical and plumbing plans shall be developed, which will be utilized to evaluate the existing utilities and compare to the new requirements. This phase will also include hazardous materials testing to determine the occurrence of the materials and how they will have to be dealt with during demolition and construction. The construction cost should be reevaluated at the end of the schematic design phase, prior to progressing into the construction document phase, and during each phase thereafter.

7.0 Limitations & Exclusions

This report is limited to the footprint of the building, and does not include public ways or parking requirements. This inspection took place within the readily accessible areas of the building and is limited to visual observations of evident conditions existing at the time of the inspection only. Limited structural analysis was performed at this stage to substantiate the structure's performance during prescribed code loading events. Concealed and latent defects and deficiencies are excluded from this report. Systems were not dismantled to provide inspection access. Destructive investigation and testing was not performed.

It is understood that ZCS Engineering, Inc. is not an insurer and that this inspection and report are not intended or to be construed as an express or implied guarantee or warranty of adequacy, performance, or condition of the structure at the inspected property address. No guarantee or warranty of the structure's performance outside the loading observed at the time of inspection can be made. The Client hereby releases and exempts ZCS Engineering, Inc. and its agents and employees of and from all claims of responsibility and liability for the cost of repairing or replacing any unreported deficiency or defect and for any consequential harm, property damage, personal injury of any nature, and/or legal fees. This report is for the sole, confidential and exclusive use of the Client.

Appendix A: Figures

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Figure 3 Coos Bay Public Library

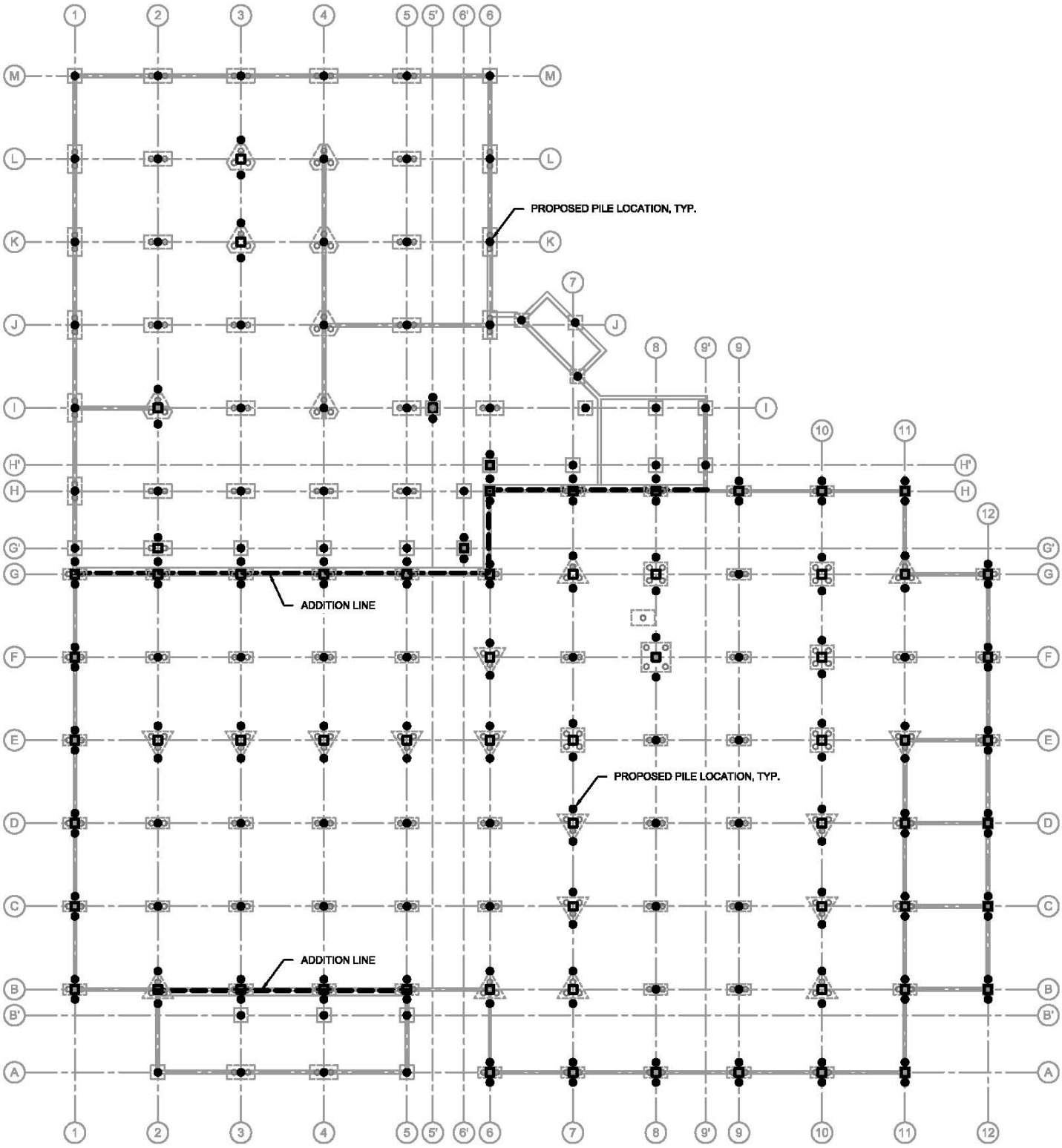

Figure 4 Foundation Plan with Column and Proposed Micropile Locations

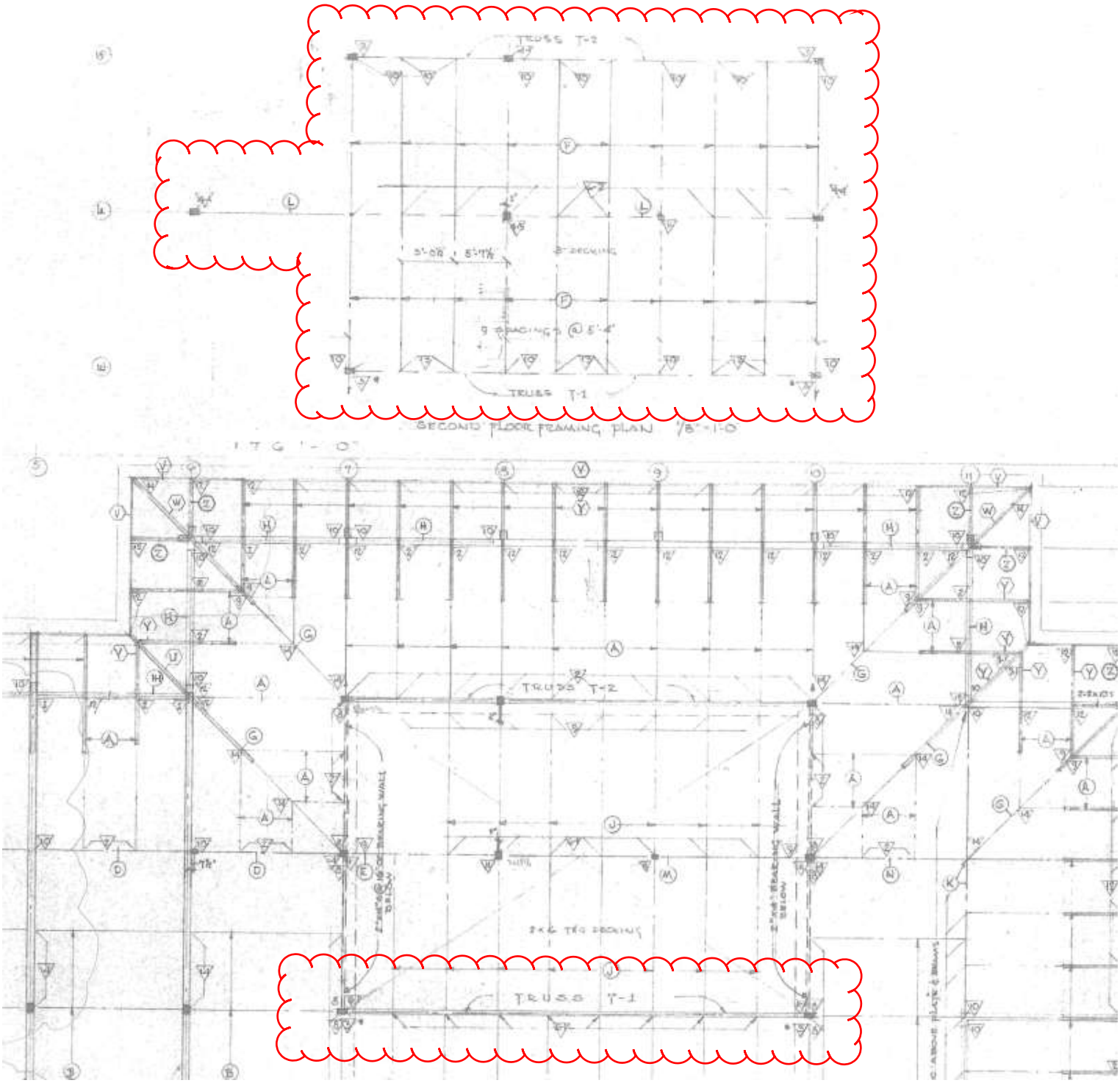

Figure 5 Original Roof and Second Floor Framing at Deficient Members

Figure 6 Building Exterior

Figure 7 Building Lobby

Figure 8 Building Interior

Figure 9 Building Interior

Figure 10 Second Floor Storage

Figure 11 Existing HVAC Unit

Appendix B: Tier 1 Evaluation

ASCE/SEI 31-03 – Seismic Evaluation of Existing Buildings

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C3.3 Selection and Use of Checklists

The evaluation statements provided in the checklists form the core of the Tier 1 Evaluation methodology. These evaluation statements are based on observed earthquake structural damage during actual earthquakes. The checklists do not necessarily identify the response of the structure to ground motion; rather, the design professional obtains a general sense of the structure's deficiencies and potential behavior during an earthquake. By quickly identifying the potential deficiencies in the structure, the design professional has a better idea of what to examine and analyze in a Tier 2 or Tier 3 Evaluation.

The General Structural Checklists are a complete listing of all evaluation statements used in the Common Building Type checklists. They should be used for buildings with structural systems that do not match the Common Building Types. While the general purpose of the Tier 1 Checklists is to identify potential weak links associated with structures of a specific type that have been observed in past significant earthquakes, the General Checklists, by virtue of their design, do not accomplish this. They only represent a listing of possible deficiencies. The design professional must consider first the applicability of the potential deficiency to the building system being considered. Generally, only the deficiencies applicable to the primary lateral-force-resisting elements of the building need be considered.

While the section numbers in parentheses following each evaluation statement correspond to Tier 2 Evaluation procedures, they also correspond to commentary in Chapter 4 regarding the statement's purpose. If additional information on the evaluation statement is required, please refer to the commentary in the Tier 2 procedure for that evaluation statement.

Table 3-2. Checklists Required for a Tier 1 Evaluation

Level of Seismicity[3]	Level of Performance[2]	Required Checklists[1]						
		Level of Low Seismicity (Sec. 3.6)	Basic Structural (Sec. 3.7)	Supplemental Structural (Sec. 3.7)	Geologic Site Hazard and Foundation (Sec. 3.8)	Basic Nonstructural (Sec. 3.9.1)	Intermediate Nonstructural (Sec. 3.9.2)	Supplemental Nonstructural (Sec. 3.9.3)
Low	LS	▶						
	IO		▶		▶	▶		
Moderate	LS		▶		▶	▶		
	IO		▶	▶	▶	▶	▶	
High	LS		▶	▶	▶	▶	▶	
	IO		▶	▶	▶	▶	▶	▶

[1]A checkmark (▶) designates the checklist that must be completed for a Tier 1 Evaluation as a function of the level of seismicity and level of performance.

[2]LS = Life Safety; IO = Immediate Occupancy (defined in Section 2.4).

[3]Defined in Section 2.5.

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3.7.2 Basic Structural Checklist for Building Type W2: Wood Frames, Commercial and Industrial

This Basic Structural Checklist shall be completed where required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked Compliant (C), Non-compliant (NC), or Not Applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this standard, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 Evaluation procedure; corresponding section numbers are in parentheses following each evaluation statement.

C3.7.2 Basic Structural Checklist for Building Type W2

These buildings are commercial or industrial buildings with a floor area of 5,000 square feet or more. There are few, if any, interior walls. The floor and roof framing consists of wood or steel trusses, glulam or steel beams, and wood posts or steel columns. Lateral forces are resisted by wood diaphragms and exterior stud walls sheathed with plywood, oriented strand board, stucco, plaster, straight or diagonal wood sheathing, or braced with rod bracing. Wall openings for storefronts and garages, where present, are framed by post-and-beam framing.

Building System

(C) NC N/A — LOAD PATH: The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

C NC (N/A) — MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

C NC (N/A) — WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C NC (N/A) — SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

C NC (N/A) — GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)

(C) NC N/A — VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C NC (N/A) — MASS: There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)

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C NC N/A DETERIORATION OF WOOD: There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members, and none of the metal connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)

C NC N/A WOOD STRUCTURAL PANEL SHEAR WALL FASTENERS: There shall be no more than 15 percent of inadequate fastening such as overdriven fasteners, omitted blocking, excessive fastening spacing, or inadequate edge distance. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.3.3.2)

Lateral-Force-Resisting System

C NC N/A REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

SEE ATT.

C NC N/A SHEAR STRESS CHECK: The shear stress in the shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than the following values for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.4.2.7.1):

Structural panel sheathing	1,000 plf
Diagonal sheathing	700 plf
Straight sheathing	100 plf
All other conditions	100 plf

C NC N/A STUCCO (EXTERIOR PLASTER) SHEAR WALLS: Multi-story buildings shall not rely on exterior stucco walls as the primary lateral-force-resisting system. (Tier 2: Sec. 4.4.2.7.2)

C NC N/A GYPSUM WALLBOARD OR PLASTER SHEAR WALLS: Interior plaster or gypsum wallboard shall not be used as shear walls on buildings over one story in height with the exception of the uppermost level of a multi-story building. (Tier 2: Sec. 4.4.2.7.3)

C NC N/A NARROW WOOD SHEAR WALLS: Narrow wood shear walls with an aspect ratio greater than 2-to-1 for Life Safety and 1.5-to-1 for Immediate Occupancy shall not be used to resist lateral forces developed in the building in levels of moderate and high seismicity. ~~Narrow wood shear walls with an aspect ratio greater than 2-to-1 for Immediate Occupancy shall not be used to resist lateral forces developed in the building in levels of low seismicity.~~ (Tier 2: Sec. 4.4.2.7.4)

C NC N/A WALLS CONNECTED THROUGH FLOORS: Shear walls shall have interconnection between stories to transfer overturning and shear forces through the floor. (Tier 2: Sec. 4.4.2.7.5)

C NC N/A HILLSIDE SITE: For structures that are taller on at least one side by more than one-half story due to a sloping site, all shear walls on the downhill slope shall have an aspect ratio less than 1-to-1 for Life Safety and 1-to-2 for Immediate Occupancy. (Tier 2: Sec. 4.4.2.7.6)

C NC N/A CRIPPLE WALLS: Cripple walls below first-floor-level shear walls shall be braced to the foundation with wood structural panels. (Tier 2: Sec. 4.4.2.7.7)

C NC N/A OPENINGS: Walls with openings greater than 80 percent of the length shall be braced with wood structural panel shear walls with aspect ratios of not more than 1.5-to-1 or shall be supported by adjacent construction through positive ties capable of transferring the lateral forces. (Tier 2: Sec. 4.4.2.7.8)

Connections

C NC N/A WOOD POSTS: There shall be a positive connection of wood posts to the foundation. (Tier 2: Sec. 4.6.3.3)

C NC N/A WOOD SILLS: All wood sills shall be bolted to the foundation. (Tier 2: Sec. 4.6.3.4)

C NC N/A GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)

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CLIENT CITY OF COOS BAY
PROJECT COOS BAY LIBRARY

BY JCL DATE 1-21-14
JOB NO. G-0517-12 SHEET B5 OF 33

TIER 1 EVAL

3.5.3.3 - SHEAR STRESS IN SHEAR WALLS (WOOD)

$$v_{j\,AVE} = \left(\frac{1}{m}\right)\left(\frac{V_j}{A_W}\right)$$

$V_j = \sum_{x=j}^{n} F_x \rightarrow V_j = F_x$

$F_x = V = C S_a W = 242^K$

$C = 1.3$

$S_a = S_{D1}/T = 2.97 > 0.90 = S_{DS} = S_a$

$S_{D1} = 1.15$

$T = C_t h_n^{\beta} = 0.387$ sec

$C_t = 0.06$

$h_n = 12'$

$\beta = 0.75$

$W = 207.^K$ (10,351 sf)

~~$V = 0.15\ W = 510^K = V_j \rightarrow$ m - FACTOR = 1.0 §3.5.3~~

(E-W) $A_W = 17' + 22' + 17' + 9' + 6' + 8' + 19' = 98'$

(N-S) $A_W = 29' + 29' + 23' + 12' + 16' + 22' + 9' = 140'$

$m = 4.0$

(E-W) $v_{j\,AVE} = 617$ plf < 1000 plf ✓OK

(N-S) $v_{j\,AVE} = 432$ plf < 1000 plf ✓OK

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3.7.2S Supplemental Structural Checklist for Building Type W2: Wood Frames, Commercial and Industrial

This Supplemental Structural Checklist shall be completed where required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral-Force-Resisting System

C NC (N/A) HOLD-DOWN ANCHORS: All shear walls shall have hold-down anchors constructed per acceptable construction practices, attached to the end studs. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.7.9)

Diaphragms

(C) NC N/A DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints. (Tier 2: Sec. 4.5.1.1)

(C) NC N/A ROOF CHORD CONTINUITY: All chord elements shall be continuous, regardless of changes in roof elevation. (Tier 2: Sec. 4.5.1.3)

C NC (N/A) PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC (N/A) DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

(C) NC N/A STRAIGHT SHEATHING: All straight sheathed diaphragms shall have aspect ratios less than 2-to-1 for Life Safety and 1-to-1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)

(C) NC N/A SPANS: All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. Wood commercial and industrial buildings may have rod-braced systems. (Tier 2: Sec. 4.5.2.2)

C (NC) N/A UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet for Immediate Occupancy and shall have aspect ratios less than or equal to 4-to-1 for Life Safety and 3-to-1 for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)

(C) NC N/A OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)

Connections

(C) NC N/A WOOD SILL BOLTS: Sill bolts shall be spaced at 6 feet or less for Life Safety and 4 feet or less for Immediate Occupancy, with proper edge and end distance provided for wood and concrete. (Tier 2: Sec. 4.6.3.9)

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3.7.8 Basic Structural Checklist for Building Type C1: Concrete Moment Frames

This Basic Structural Checklist shall be completed where required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked Compliant (C), Non-compliant (NC), or Not Applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this standard, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 Evaluation procedure; corresponding section numbers are in parentheses following each evaluation statement.

C3.7.8 Basic Structural Checklist for Building Type C1

These buildings consist of a frame assembly of cast-in-place concrete beams and columns. Floor and roof framing consists of cast-in-place concrete slabs, concrete beams, one-way joists, two-way waffle joists, or flat slabs. Lateral forces are resisted by concrete moment frames that develop their stiffness through monolithic beam-column connections. In older construction, or in levels of low seismicity, the moment frames may consist of the column strips of two-way flat slab systems. Modern frames in levels of high seismicity have joint reinforcing, closely spaced ties, and special detailing to provide ductile performance. This detailing is not present in older construction. Foundations consist of concrete spread footings, mat foundations, or deep foundations.

Building System

(C) NC N/A	LOAD PATH: The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)
(C) NC N/A	ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building shall be greater than 4 percent of the height of the shorter building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)
C NC (N/A)	MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)
C NC (N/A)	WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)
C NC (N/A)	SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)
C NC (N/A)	GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)
(C) NC N/A	VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C NC N/A — MASS: There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)

C NC N/A — TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20 percent of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)

C NC N/A — DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)

C NC N/A — POST-TENSIONING ANCHORS: There shall be no evidence of corrosion or spalling in the vicinity of post-tensioning or end fittings. Coil anchors shall not have been used. (Tier 2: Sec. 4.3.3.5)

Lateral-Force-Resisting System

C NC N/A — REDUNDANCY: The number of lines of moment frames in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. The number of bays of moment frames in each line shall be greater than or equal to 2 for Life Safety and 3 for Immediate Occupancy. (Tier 2: Sec. 4.4.1.1.1)

C NC N/A — INTERFERING WALLS: All concrete and masonry infill walls placed in moment frames shall be isolated from structural elements. (Tier 2: Sec. 4.4.1.2.1)

C NC N/A — SHEAR STRESS CHECK: The shear stress in the concrete columns, calculated using the Quick Check procedure of Section 3.5.3.2, shall be less than the greater of 100 psi or $2\sqrt{f'c}$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.1)

C NC N/A — AXIAL STRESS CHECK: The axial stress due to gravity loads in columns subjected to overturning forces shall be less than $0.10f'_c$ for Life Safety and Immediate Occupancy. Alternatively, the axial stresses due to overturning forces alone, calculated using the Quick Check procedure of Section 3.5.3.6, shall be less than $0.30f'_c$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.2)

Connections

C NC N/A — CONCRETE COLUMNS: All concrete columns shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the tensile capacity of reinforcement in columns of lateral-force-resisting system for Immediate Occupancy. (Tier 2: Sec. 4.6.3.2)

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TIER 1 EVAL

3.5.3.2 - SHEAR STRESS IN CONC. FRAME COLUMNS

$$V_{j\,AVE} = \frac{1}{m}\left(\frac{n_c}{n_c - n_f}\right)\left(\frac{V_j}{A_c}\right)$$

$V_j = C\,S_a\,W = 476^K$
$C = 1.3$
$S_a = S_{D1}/T < S_{DS} = 4.1 > S_{DS} = 0.90 = S_a$
$S_{D1} = 1.15$
$T = C_t\,h_n^{\beta} = 0.281$
$C_t = 0.03$
$h_n = 12'$
$\beta = 0.90$
$W = 407^K$ (20,360 sf)

$A_c = 79$ sf (SEE REVERSE) → 11,376 in²
$n_c = 39$ COLUMNS
$n_f = 17$ (E-W), 25 (N-S)
$m = 2.0$ LIFE SAFETY

$V_{j\,AVE}$ (E-W) = 37 psi < 100 psi → √OK

$V_{j\,AVE}$ (N-S) = 58 psi < 100 psi → √OK

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TIER 1

3.5.3.6 - AXIAL STRESS DUE TO OVERTURNING

$$p_{ot} = \frac{1}{M}\left(\frac{2}{3}\right)\left(\frac{V h_n}{L n_f}\right)\left(\frac{1}{A_{col}}\right)$$

$M = 2.0$ LIFE SAFETY
$V = 476^K$ (SEE 3.5.3.2)
$h_n = 12'$
$L = 112'$ (E-W), $176'$ (N-S)
$n_f = 17$ (E-W), 25 (N-S)
$A_{col} = 2.4 sf$ @ CORNERS → $346 in^2$

p_{ot} (E-W) = 2.9 psi < 900 psi = 0.3 (3000 psi)
p_{ot} (N-S) = 1.3 psi < 900 psi = 0.3 (3000 psi)

AXIAL STRESS FROM GRAVITY LOADS ONLY

WORST CASE = $26K / 346 in^2$ = 75 psi < 300 psi = 0.1 (3000psi)

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3.7.8S Supplemental Structural Checklist for Building Type C1: Concrete Moment Frames

This Supplemental Structural Checklist shall be completed where required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

Lateral-Force-Resisting System

C NC N/A — FLAT SLAB FRAMES: The lateral-force-resisting system shall not be a frame consisting of columns and a flat slab/plate without beams. (Tier 2: Sec. 4.4.1.4.3)

C NC N/A — PRESTRESSED FRAME ELEMENTS: The lateral-force-resisting frames shall not include any prestressed or post-tensioned elements where the average prestress exceeds the lesser of 700 psi or $f'_c/6$ at potential hinge locations. The average prestress shall be calculated in accordance with the Quick Check procedure of Section 3.5.3.8. (Tier 2: Sec. 4.4.1.4.4)

C NC N/A — CAPTIVE COLUMNS: There shall be no columns at a level with height/depth ratios less than 50 percent of the nominal height/depth ratio of the typical columns at that level for Life Safety and 75 percent for Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.5)

C NC N/A — NO SHEAR FAILURES: The shear capacity of frame members shall be able to develop the moment capacity at the ends of the members. (Tier 2: Sec. 4.4.1.4.6)

C NC N/A — STRONG COLUMN/WEAK BEAM: The sum of the moment capacity of the columns shall be 20 percent greater than that of the beams at frame joints. (Tier 2: Sec. 4.4.1.4.7)

C NC N/A — BEAM BARS: At least two longitudinal top and two longitudinal bottom bars shall extend continuously throughout the length of each frame beam. At least 25 percent of the longitudinal bars provided at the joints for either positive or negative moment shall be continuous throughout the length of the members for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.8)

C NC N/A — COLUMN-BAR SPLICES: All column bar lap splice lengths shall be greater than $35d_b$ for Life Safety and $50d_b$ for Immediate Occupancy, and shall be enclosed by ties spaced at or less than $8d_b$ for Life Safety and Immediate Occupancy. Alternatively, column bars shall be spliced with mechanical couplers with a capacity of at least 1.25 times the nominal yield strength of the spliced bar. (Tier 2: Sec. 4.4.1.4.9)

C NC N/A — BEAM-BAR SPLICES: The lap splices or mechanical couplers for longitudinal beam reinforcing shall not be located within $l_b/4$ of the joints and shall not be located in the vicinity of potential plastic hinge locations. (Tier 2: Sec. 4.4.1.4.10)

C NC N/A — COLUMN-TIE SPACING: Frame columns shall have ties spaced at or less than $d/4$ for Life Safety and Immediate Occupancy throughout their length and at or less than $8d_b$ for Life Safety and Immediate Occupancy at all potential plastic hinge locations. (Tier 2: Sec. 4.4.1.4.11)

C NC N/A — STIRRUP SPACING: All beams shall have stirrups spaced at or less than $d/2$ for Life Safety and Immediate Occupancy throughout their length. At potential plastic hinge locations, stirrups shall be spaced at or less than the minimum of $8d_b$ or $d/4$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.12)

C NC N/A — JOINT REINFORCING: Beam-column joints shall have ties spaced at or less than $8d_b$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.13)

C NC N/A — JOINT ECCENTRICITY: There shall be no eccentricities larger than 20 percent of the smallest column plan dimension between girder and column centerlines. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.4.14)

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C NC N/A STIRRUP AND TIE HOOKS: The beam stirrups and column ties shall be anchored into the member cores with hooks of 135° or more. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.4.15)

C NC N/A DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of Sections 4.4.1.4.9, 4.4.1.4.10, 4.4.1.4.11, 4.4.1.4.12 and 4.4.1.4.15 for Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.2)

C NC N/A FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.3)

Diaphragms

C NC N/A DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints. (Tier 2: Sec. 4.5.1.1)

C NC N/A PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC N/A DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

Connections

C NC N/A UPLIFT AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

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3.7.16 General Basic Structural Checklist

This General Basic Structural Checklist shall be completed where required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked Compliant (C), Non-compliant (NC), or Not Applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this standard, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 Evaluation procedure; corresponding section numbers are in parentheses following each evaluation statement.

BUILDING SYSTEM

General

(C) NC N/A — LOAD PATH: The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)

(C) NC N/A — ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building shall be greater than 4 percent of the height of the shorter building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)

C NC (N/A) — MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)

Configuration

C NC (N/A) — WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)

C NC (N/A) — SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)

C NC (N/A) — GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)

(C) NC N/A — VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)

C NC (N/A) — MASS: There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)

(C) NC N/A — TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20 percent of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)

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Condition of Materials

C NC N/A — DETERIORATION OF WOOD: There shall be no signs of decay, shrinkage, splitting, fire damage, or sagging in any of the wood members, and none of the metal connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)

C NC N/A — WOOD STRUCTURAL PANEL SHEAR WALL FASTENERS: There shall be no more than 15 percent of inadequate fastening such as overdriven fasteners, omitted blocking, excessive fastening spacing, or inadequate edge distance. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.3.3.2)

C NC N/A — DETERIORATION OF STEEL: There shall be no visible rusting, corrosion, cracking, or other deterioration in any of the steel elements or connections in the vertical- or lateral-force-resisting systems. (Tier 2: Sec. 4.3.3.3)

C NC N/A — DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)

C NC N/A — POST-TENSIONING ANCHORS: There shall be no evidence of corrosion or spalling in the vicinity of post-tensioning or end fittings. Coil anchors shall not have been used. (Tier 2: Sec. 4.3.3.5)

C NC N/A — PRECAST CONCRETE WALLS: There shall be no visible deterioration of concrete or reinforcing steel or evidence of distress, especially at the connections. (Tier 2: Sec. 4.3.3.6)

C NC N/A — MASONRY UNITS: There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)

C NC N/A — MASONRY JOINTS: The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)

C NC N/A — CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.9)

C NC N/A — REINFORCED MASONRY WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.10)

C NC N/A — UNREINFORCED MASONRY WALL CRACKS: There shall be no existing diagonal cracks in wall elements greater than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy or out-of-plane offsets in the bed joint greater than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.11)

C NC N/A — CRACKS IN INFILL WALLS: There shall be no existing diagonal cracks in the infilled walls that extend throughout a panel greater than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, or out-of-plane offsets in the bed joint greater than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy. (Tier 2: Sec. 4.3.3.12)

C NC N/A — CRACKS IN BOUNDARY COLUMNS: There shall be no existing diagonal cracks wider than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy in concrete columns that encase masonry infills. (Tier 2: Sec. 4.3.3.13)

LATERAL-FORCE-RESISTING SYSTEM

Moment Frames

General

C NC N/A — REDUNDANCY: The number of lines of moment frames in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. The number of bays of moment frames in each line shall be greater than or equal to 2 for Life Safety and 3 for Immediate Occupancy. (Tier 2: Sec. 4.4.1.1.1)

Moment Frames with Infill Walls

C NC N/A — INTERFERING WALLS: All concrete and masonry infill walls placed in moment frames shall be isolated from structural elements. (Tier 2: Sec. 4.4.1.2.1)

Steel Moment Frames

C NC N/A — DRIFT CHECK: The drift ratio of the steel moment frames, calculated using the Quick Check procedure of Section 3.5.3.1, shall be less than 0.025 for Life Safety and 0.015 for Immediate Occupancy. (Tier 2: Sec. 4.4.1.3.1)

C NC N/A — AXIAL STRESS CHECK: The axial stress due to gravity loads in columns subjected to overturning forces shall be less than $0.10F_y$ for Life Safety and Immediate Occupancy. Alternatively, the axial stress due to overturning forces alone, calculated using the Quick Check procedure of Section 3.5.3.6, shall be less than $0.30F_y$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.3.2)

Concrete Moment Frames

C NC N/A — SHEAR STRESS CHECK: The shear stress in the concrete columns, calculated using the Quick Check procedure of Section 3.5.3.2, shall be less than the greater of 100 psi or $2\sqrt{f'c}$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.1)

C NC N/A — AXIAL STRESS CHECK: The axial stress due to gravity loads in columns subjected to overturning forces shall be less than $0.10f'_c$ for Life Safety and Immediate Occupancy. Alternatively, the axial stresses due to overturning forces alone, calculated using the Quick Check procedure of Section 3.5.3.6, shall be less than $0.30f'_c$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.2)

Precast Concrete Moment Frames

C NC N/A — PRECAST CONNECTION CHECK: The precast connections at frame joints shall have the capacity to resist the shear and moment demands calculated using the Quick Check procedure of Section 3.5.3.5. (Tier 2: Sec. 4.4.1.5.1)

Frames Not Part of the Lateral-Force-Resisting System

C NC N/A — COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical-load-carrying system. (Tier 2: Sec. 4.4.1.6.1)

Shear Walls

General

C NC N/A — REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)

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Concrete Shear Walls

C NC (N/A) SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than the greater of 100 psi or $2\sqrt{f'c}$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.1)

C NC (N/A) REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area shall be not less than 0.0015 in the vertical direction and 0.0025 in the horizontal direction for Life Safety and Immediate Occupancy. The spacing of reinforcing steel shall be equal to or less than 18 inches for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.2)

C NC (N/A) COLUMN SPLICES: Steel columns encased in shear-wall-boundary elements shall have splices that develop the tensile strength of the column. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.9)

Precast Concrete Shear Walls

C NC (N/A) SHEAR STRESS CHECK: The shear stress in the precast panels, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than the greater of 100 psi or $2\sqrt{f'c}$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.3.1)

C NC (N/A) REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area shall be not less than 0.0015 in the vertical direction and 0.0025 in the horizontal direction for Life Safety and Immediate Occupancy. The spacing of reinforcing steel shall be equal to or less than 18 inches for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.3.2)

Reinforced Masonry Shear Walls

C NC (N/A) SHEAR STRESS CHECK: The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 70 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)

C NC (N/A) REINFORCING STEEL: The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls shall be greater than 0.002 for Life Safety and Immediate Occupancy of the wall with the minimum of 0.0007 for Life Safety and Immediate Occupancy in either of the two directions; the spacing of reinforcing steel shall be less than 48 inches for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls. (Tier 2: Sec. 4.4.2.4.2)

Unreinforced Masonry Shear Walls

C NC (N/A) SHEAR STRESS CHECK: The shear stress in the unreinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 30 psi for clay units and 70 psi for concrete units for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.5.1)

Infill Walls in Frames

C NC (N/A) WALL CONNECTIONS: Masonry shall be in full contact with frame for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.6.1)

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Walls in Wood-Frame Buildings

C NC N/A — SHEAR STRESS CHECK: The shear stress in the shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than the following values for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.4.2.7.1):

Structural panel sheathing:	1,000 plf
Diagonal sheathing:	700 plf
Straight sheathing:	100 plf
All other conditions:	100 plf

C NC N/A — STUCCO (EXTERIOR PLASTER) SHEAR WALLS: Multi-story buildings shall not rely on exterior stucco walls as the primary lateral-force-resisting system. (Tier 2: Sec. 4.4.2.7.2)

C NC N/A — GYPSUM WALLBOARD OR PLASTER SHEAR WALLS: Interior plaster or gypsum wallboard shall not be used as shear walls on buildings over one story in height with the exception of the uppermost level of a multi-story building. (Tier 2: Sec. 4.4.2.7.3)

C NC N/A — NARROW WOOD SHEAR WALLS: Narrow wood shear walls with an aspect ratio greater than 2-to-1 for Life Safety and 1.5-to-1 for Immediate Occupancy shall not be used to resist lateral forces developed in the building in levels of moderate and high seismicity. Narrow wood shear walls with an aspect ratio greater than 2-to-1 for Immediate Occupancy shall not be used to resist lateral forces developed in the building in levels of low seismicity. (Tier 2: Sec. 4.4.2.7.4)

C NC N/A — WALLS CONNECTED THROUGH FLOORS: Shear walls shall have interconnection between stories to transfer overturning and shear forces through the floor. (Tier 2: Sec. 4.4.2.7.5)

C NC N/A — HILLSIDE SITE: For structures that are taller on at least one side by more than one-half story due to a sloping site, all shear walls on the downhill slope shall have an aspect ratio less than 1-to-1 for Life Safety and 1-to-2 for Immediate Occupancy. (Tier 2: Sec. 4.4.2.7.6)

C NC N/A — CRIPPLE WALLS: Cripple walls below first-floor-level shear walls shall be braced to the foundation with wood structural panels. (Tier 2: Sec. 4.4.2.7.7)

C NC N/A — OPENINGS: Walls with openings greater than 80 percent of the length shall be braced with wood structural panel shear walls with aspect ratios of not more than 1.5-to-1 or shall be supported by adjacent construction through positive ties capable of transferring the lateral forces. (Tier 2: Sec. 4.4.2.7.8)

Braced Frames

General

C NC N/A — REDUNDANCY: The number of lines of braced frames in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. The number of braced bays in each line shall be greater than 2 for Life Safety and 3 for Immediate Occupancy. (Tier 2: Sec. 4.4.3.1.1)

C NC N/A — AXIAL STRESS CHECK: The axial stress in the diagonals, calculated using the Quick Check procedure of Section 3.5.3.4, shall be less than $0.50F_y$ for Life Safety and for Immediate Occupancy. (Tier 2: Sec. 4.4.3.1.2)

C NC N/A — COLUMN SPLICES: All column splice details located in braced frames shall develop the tensile strength of the column. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.1.3)

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DIAPHRAGMS

Precast Concrete Diaphragms

C NC N/A — TOPPING SLAB: Precast concrete diaphragm elements shall be interconnected by a continuous reinforced concrete topping slab. (Tier 2: Sec. 4.5.5.1)

CONNECTIONS

Anchorage for Normal Forces

C NC N/A — WALL ANCHORAGE: Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support shall be 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 3.5.3.7. (Tier 2: Sec. 4.6.1.1)

C NC N/A — WOOD LEDGERS: The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers. (Tier 2: Sec. 4.6.1.2)

Shear Transfer

C NC N/A — TRANSFER TO SHEAR WALLS: Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2 Sec. 4.6.2.1)

C NC N/A — TRANSFER TO STEEL FRAMES: Diaphragms shall be connected for transfer of loads to the steel frames for Life Safety, and the connections shall be able to develop the lesser of the strength of the frames or the diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.2)

C NC N/A — TOPPING SLAB TO WALLS OR FRAMES: Reinforced concrete topping slabs that interconnect the precast concrete diaphragm elements shall be doweled for transfer of forces into the shear wall or frame elements for Life Safety, and the dowels shall be able to develop the lesser of the shear strength of the walls, frames, or slabs for Immediate Occupancy. (Tier 2: Sec. 4.6.2.3)

Vertical Components

C NC N/A — STEEL COLUMNS: The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety, and the anchorage shall be able to develop the lesser of the tensile capacity of the column, the tensile capacity of the lowest level column splice (if any), or the uplift capacity of the foundation, for Immediate Occupancy. (Tier 2: Sec. 4.6.3.1)

C NC N/A — CONCRETE COLUMNS: All concrete columns shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the tensile capacity of reinforcement in columns of lateral-force-resisting system for Immediate Occupancy. (Tier 2: Sec. 4.6.3.2)

C NC N/A — WOOD POSTS: There shall be a positive connection of wood posts to the foundation. (Tier 2: Sec. 4.6.3.3)

C NC N/A — WOOD SILLS: All wood sills shall be bolted to the foundation. (Tier 2: Sec. 4.6.3.4)

C NC N/A — FOUNDATION DOWELS: Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)

C NC N/A — SHEAR-WALL-BOUNDARY COLUMNS: The shear-wall-boundary columns shall be anchored to the building foundation for Life Safety, and the anchorage shall be able to develop the tensile capacity of the column for Immediate Occupancy. (Tier 2: Sec. 4.6.3.6)

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C NC (N/A) PRECAST WALL PANELS: Precast wall panels shall be connected to the foundation for Life Safety and the connections shall be able to develop the strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.6.3.7)

C NC (N/A) WALL PANELS: Metal, fiberglass, or cementitious wall panels shall be positively attached to the foundation for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.6.3.8)

Interconnection of Elements

(C) NC N/A GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)

Panel Connections

C NC (N/A) ROOF PANELS: Metal, plastic, or cementitious roof panels shall be positively attached to the roof framing to resist seismic forces for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.6.5.1)

C NC (N/A) WALL PANELS: Metal, fiberglass, or cementitious wall panels shall be positively attached to the framing to resist seismic forces for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.6.5.2)

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3.7.16S General Supplemental Structural Checklist

This General Supplemental Structural Checklist shall be completed where required by Table 3-2. The General Basic Structural Checklist shall be completed prior to completing this General Supplemental Structural Checklist.

LATERAL-FORCE-RESISTING SYSTEM

Moment Frames

Steel Moment Frames

C NC N/A MOMENT-RESISTING CONNECTIONS: All moment connections shall be able to develop the strength of the adjoining members or panel zones. (Tier 2: Sec. 4.4.1.3.3)

C NC N/A PANEL ZONES: All panel zones shall have the shear capacity to resist the shear demand required to develop 0.8 times the sum of the flexural strengths of the girders framing in at the face of the column. (Tier 2: Sec. 4.4.1.3.4)

C NC N/A COLUMN SPLICES: All column splice details located in moment-resisting frames shall include connection of both flanges and the web for Life Safety, and the splice shall develop the strength of the column for Immediate Occupancy. (Tier 2: Sec. 4.4.1.3.5)

C NC N/A STRONG COLUMN/WEAK BEAM: The percentage of strong column/weak beam joints in each story of each line of moment-resisting frames shall be greater than 50 percent for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.3.6)

C NC N/A COMPACT MEMBERS: All frame elements shall meet section requirements set forth by *Seismic Provisions for Structural Steel Buildings* Table I-9-1 (AISC, 1997). (Tier 2: Sec. 4.4.1.3.7)

C NC N/A BEAM PENETRATIONS: All openings in frame-beam webs shall be less than ¼ of the beam depth and shall be located in the center half of the beams. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.8)

C NC N/A GIRDER FLANGE CONTINUITY PLATES: There shall be girder flange continuity plates at all moment-resisting frame joints. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.9)

C NC N/A OUT-OF-PLANE BRACING: Beam-column joints shall be braced out-of-plane. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.10

C NC N/A BOTTOM FLANGE BRACING: The bottom flanges of beams shall be braced out-of-plane. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.3.11)

Concrete Moment Frames

C NC N/A FLAT SLAB FRAMES: The lateral-force-resisting system shall not be a frame consisting of columns and a flat slab/plate without beams. (Tier 2: Sec. 4.4.1.4.3)

C NC N/A PRESTRESSED FRAME ELEMENTS: The lateral-force-resisting frames shall not include any prestressed or post-tensioned elements where the average prestress exceeds the lesser of 700 psi or $f'_c/6$ at potential hinge locations. The average prestress shall be calculated in accordance with the Quick Check procedure of Section 3.5.3.8. (Tier 2: Sec. 4.4.1.4.4)

C NC N/A CAPTIVE COLUMNS: There shall be no columns at a level with height/depth ratios less than 50 percent of the nominal height/depth ratio of the typical columns at that level for Life Safety and 75 percent for Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.5)

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C NC N/A — NO SHEAR FAILURES: The shear capacity of frame members shall be able to develop the moment capacity at the ends of the members. (Tier 2: Sec. 4.4.1.4.6)

C NC N/A — STRONG COLUMN/WEAK BEAM: The sum of the moment capacity of the columns shall be 20 percent greater than that of the beams at frame joints. (Tier 2: Sec. 4.4.1.4.7)

C NC N/A — BEAM BARS: At least two longitudinal top and two longitudinal bottom bars shall extend continuously throughout the length of each frame beam. At least 25 percent of the longitudinal bars provided at the joints for either positive or negative moment shall be continuous throughout the length of the members for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.8)

C NC N/A — COLUMN-BAR SPLICES: All column bar lap splice lengths shall be greater than $35d_b$ for Life Safety and $50d_b$ for Immediate Occupancy, and shall be enclosed by ties spaced at or less than $8d_b$ for Life Safety and Immediate Occupancy. Alternatively, column bars shall be spliced with mechanical couplers with a capacity of at least 1.25 times the nominal yield strength of the spliced bar. (Tier 2: Sec. 4.4.1.4.9)

C NC N/A — BEAM-BAR SPLICES: The lap splices or mechanical couplers for longitudinal beam reinforcing shall not be located within $l_b/4$ of the joints and shall not be located in the vicinity of potential plastic hinge locations. (Tier 2: Sec. 4.4.1.4.10)

C NC N/A — COLUMN-TIE SPACING: Frame columns shall have ties spaced at or less than $d/4$ for Life Safety and Immediate Occupancy throughout their length and at or less than $8d_b$ for Life Safety and Immediate Occupancy at all potential plastic hinge locations. (Tier 2: Sec. 4.4.1.4.11)

C NC N/A — STIRRUP SPACING: All beams shall have stirrups spaced at or less than $d/2$ for Life Safety and Immediate Occupancy throughout their length. At potential plastic hinge locations, stirrups shall be spaced at or less than the minimum of $8d_b$ or $d/4$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.12)

C NC N/A — JOINT REINFORCING: Beam-column joints shall have ties spaced at or less than $8d_b$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.4.13)

C NC N/A — JOINT ECCENTRICITY: There shall be no eccentricities larger than 20 percent of the smallest column plan dimension between girder and column centerlines. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.4.14)

C NC N/A — STIRRUP AND TIE HOOKS: The beam stirrups and column ties shall be anchored into the member cores with hooks of 135° or more. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.1.4.15)

Precast Concrete Moment Frames

C NC N/A — PRECAST FRAMES: For buildings with concrete shear walls, precast concrete frame elements shall not be considered as primary components for resisting lateral forces. (Tier 2: Sec. 4.4.1.5.2)

C NC N/A — PRECAST CONNECTIONS: For buildings with concrete shear walls, the connection between precast frame elements such as chords, ties, and collectors in the lateral-force-resisting system shall develop the capacity of the connected members. (Tier 2: Sec. 4.4.1.5.3)

Frames Not Part of the Lateral-Force-Resisting System

C NC N/A — DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of Sections 4.4.1.4.9, 4.4.1.4.10, 4.4.1.4.11, 4.4.1.4.12 and 4.4.1.4.15 for Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.2)

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C NC N/A FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.3)

Shear Walls

Concrete Shear Walls

C NC N/A COUPLING BEAMS: The stirrups in coupling beams over means of egress shall be spaced at or less than $d/2$ and shall be anchored into the confined core of the beam with hooks of 135° or more for Life Safety. All coupling beams shall comply with the requirements above and shall have the capacity in shear to develop the uplift capacity of the adjacent wall for Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.3)

C NC N/A OVERTURNING: All shear walls shall have aspect ratios less than 4-to-1. Wall piers need not be considered. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.4)

C NC N/A CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2-to-1, the boundary elements shall be confined with spirals or ties with spacing less than $8d_b$. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.5)

C NC N/A REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings with a dimension greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.6)

C NC N/A WALL THICKNESS: Thickness of bearing walls shall not be less than 1/25 the unsupported height or length, whichever is shorter, nor less than 4 inches. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.7)

C NC N/A WALL CONNECTIONS: There shall be a positive connection between the shear walls and the steel beams and columns for Life Safety and the connection shall be able to develop the strength of the walls for Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.8)

Precast Concrete Shear Walls

C NC N/A WALL OPENINGS: The total width of openings along any perimeter wall line shall constitute less than 75 percent of the length of any perimeter wall for Life Safety and 50 percent for Immediate Occupancy with the wall piers having aspect ratios of less than 2-to-1 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.3.3)

C NC N/A CORNER OPENINGS: Walls with openings at a building corner larger than the width of a typical panel shall be connected to the remainder of the wall with collector reinforcing. (Tier 2: Sec. 4.4.2.3.4)

C NC N/A PANEL-TO-PANEL CONNECTIONS: Adjacent wall panels shall be interconnected to transfer overturning forces between panels by methods other than welded steel inserts. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.3.5)

C NC N/A WALL THICKNESS: Thickness of bearing walls shall not be less than 1/25 the unsupported height or length, whichever is shorter, nor less than 4 inches. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.3.6)

Reinforced Masonry Shear Walls

C NC N/A REINFORCING AT OPENINGS: All wall openings that interrupt rebar shall have trim reinforcing on all sides. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.3)

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C NC N/A PROPORTIONS: The height-to-thickness ratio of the shear walls at each story shall be less than 30. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.4)

Unreinforced Masonry Shear Walls

C NC N/A PROPORTIONS: The height-to-thickness ratio of the shear walls at each story shall be less than the following for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.4.2.5.2):

Top story of multi-story building:	9
First story of multi-story building:	15
All other conditions:	13

C NC N/A MASONRY LAY-UP: Filled collar joints of multi-wythe masonry walls shall have negligible voids. (Tier 2: Sec. 4.4.2.5.3)

Infill Walls in Frames

C NC N/A PROPORTIONS: The height-to-thickness ratio of the infill walls at each story shall be less than 9 for Life Safety in levels of high seismicity, 13 for Immediate Occupancy in levels of moderate seismicity, and 8 for Immediate Occupancy in levels of high seismicity. (Tier 2: Sec. 4.4.2.6.2)

C NC N/A SOLID WALLS: The infill walls shall not be of cavity construction. (Tier 2: Sec. 4.4.2.6.3)

C NC N/A INFILL WALLS: The infill walls shall be continuous to the soffits of the frame beams and to the columns to either side. (Tier 2: Sec. 4.4.2.6.4)

Walls in Wood-Frame Buildings

C NC N/A HOLD-DOWN ANCHORS: All shear walls shall have hold-down anchors constructed per acceptable construction practices, attached to the end studs. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.7.9)

Braced Frames

General

C NC N/A SLENDERNESS OF DIAGONALS: All diagonal elements required to carry compression shall have Kl/r ratios less than 120. (Tier 2: Sec. 4.4.3.1.4)

C NC N/A CONNECTION STRENGTH: All the brace connections shall develop the yield capacity of the diagonals. (Tier 2: Sec. 4.4.3.1.5)

C NC N/A OUT-OF-PLANE BRACING: Braced frame connections attached to beam bottom flanges located away from beam-column joints shall be braced out-of-plane at the bottom flange of the beams. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.1.6)

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Concentrically Braced Frames

C NC (N/A) K-BRACING: The bracing system shall not include K-braced bays. (Tier 2: Sec. 4.4.3.2.1)

C NC (N/A) TENSION-ONLY BRACES: Tension-only braces shall not comprise more than 70 percent of the total lateral-force-resisting capacity in structures over two stories in height. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.2.2)

C NC (N/A) CHEVRON BRACING: The bracing system shall not include chevron, or V-braced, bays. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.2.3)

C NC (N/A) CONCENTRICALLY BRACED FRAME JOINTS: All the diagonal braces shall frame into the beam-column joints concentrically. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.2.4)

DIAPHRAGMS

General

(C) NC N/A DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints. (Tier 2: Sec. 4.5.1.1)

C (NC) N/A CROSS TIES: There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)

(C) NC N/A ROOF CHORD CONTINUITY: All chord elements shall be continuous, regardless of changes in roof elevation. (Tier 2: Sec. 4.5.1.3)

(C) NC N/A OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)

C NC (N/A) OPENINGS AT BRACED FRAMES: Diaphragm openings immediately adjacent to the braced frames shall extend less than 25 percent of the frame length for Life Safety and 15 percent of the frame length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.5)

C NC (N/A) OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4 feet long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)

C NC (N/A) PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)

C NC (N/A) DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

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Wood Diaphragms

C (NC) N/A STRAIGHT SHEATHING: All straight sheathed diaphragms shall have aspect ratios less than 2-to-1 for Life Safety and 1-to-1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)

C (NC) N/A SPANS: All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. Wood commercial and industrial buildings may have rod-braced systems. (Tier 2: Sec. 4.5.2.2)

C NC (N/A) UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet for Immediate Occupancy and shall have aspect ratios less than or equal to 4-to-1 for Life Safety and 3-to-1 for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)

Metal Deck Diaphragms

C NC (N/A) NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 feet and shall have span/depth ratios less than 4-to-1. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)

Other Diaphragms

C NC (N/A) OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)

CONNECTIONS

Anchorage For Normal Forces

C NC (N/A) PRECAST PANEL CONNECTIONS: There shall be at least two anchors from each precast wall panel into the diaphragm elements for Life Safety and the anchors shall be able to develop the strength of the panels for Immediate Occupancy. (Tier 2: Sec. 4.6.1.3)

C NC (N/A) STIFFNESS OF WALL ANCHORS: Anchors of concrete or masonry walls to wood structural elements shall be installed taut and shall be stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 inch prior to engagement of the anchors. (Tier 2: Sec. 4.6.1.4)

Vertical Components

(C) NC N/A WOOD SILL BOLTS: Sill bolts shall be spaced at 6 feet or less for Life Safety and 4 feet or less for Immediate Occupancy, with proper edge and end distance provided for wood and concrete. (Tier 2: Sec. 4.6.3.9)

C (NC) N/A UPLIFT AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

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Interconnection Of Elements

C (NC) N/A GIRDERS: Girders supported by walls or pilasters shall have at least two ties securing the anchor bolts for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.6.4.2)

C NC (N/A) CORBEL BEARING: If the frame girders bear on column corbels, the length of bearing shall be greater than 3 inches for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.6.4.3)

C NC (N/A) CORBEL CONNECTIONS: The frame girders shall not be connected to corbels with welded elements. (Tier 2: Sec. 4.6.4.4)

C NC (N/A) BEAM, GIRDER, AND TRUSS SUPPORTS: Beams, girders, and trusses supported by unreinforced masonry walls or pilasters shall have independent secondary columns for support of vertical loads. (Tier 2: Sec. 4.6.4.5)

Panel Connections

C (NC) N/A ROOF PANEL CONNECTIONS: Roof panel connections shall be spaced at or less than 12 inches for Life Safety and 8 inches for Immediate Occupancy. (Tier 2: Sec. 4.6.5.3)

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3.8 Geologic Site Hazards and Foundations Checklist

This Geologic Site Hazards and Foundations Checklist shall be completed where required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked Compliant (C), Non-compliant (NC), or Not Applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this standard, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 Evaluation procedure; corresponding section numbers are in parentheses following each evaluation statement.

Geologic Site Hazards

The following statements shall be completed for buildings in levels of high or moderate seismicity.

C (NC) N/A — 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 feet under the building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.7.1.1)

(C) NC N/A — SLOPE FAILURE: The building site shall be sufficiently remote from potential earthquake-induced slope failures or rockfalls to be unaffected by such failures or shall be capable of accommodating any predicted movements without failure. (Tier 2: Sec. 4.7.1.2)

(C) NC N/A — SURFACE FAULT RUPTURE: Surface fault rupture and surface displacement at the building site is not anticipated. (Tier 2: Sec. 4.7.1.3)

Condition of Foundations

The following statement shall be completed for all Tier 1 building evaluations.

C (NC) N/A — FOUNDATION PERFORMANCE: There shall be no evidence of excessive foundation movement such as settlement or heave that would affect the integrity or strength of the structure. (Tier 2: Sec. 4.7.2.1)

The following statement shall be completed for buildings in levels of high or moderate seismicity being evaluated to the Immediate Occupancy Performance Level.

C NC (N/A) — DETERIORATION: There shall not be evidence that foundation elements have deteriorated due to corrosion, sulfate attack, material breakdown, or other reasons in a manner that would affect the integrity or strength of the structure. (Tier 2: Sec. 4.7.2.2)

Capacity of Foundations

The following statement shall be completed for all Tier 1 building evaluations.

C NC (N/A) — POLE FOUNDATIONS: Pole foundations shall have a minimum embedment depth of 4 feet for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.7.3.1)

The following statements shall be completed for buildings in levels of moderate seismicity being evaluated to the Immediate Occupancy Performance Level and for buildings in levels of high seismicity.

(C) NC N/A — OVERTURNING: The ratio of the horizontal dimension of the lateral-force-resisting system at the foundation level to the building height (base/height) shall be greater than $0.6S_a$. (Tier 2: Sec. 4.7.3.2)

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C NC N/A TIES BETWEEN FOUNDATION ELEMENTS: The foundation shall have ties adequate to resist seismic forces where footings, piles, and piers are not restrained by beams, slabs, or soils classified as Class A, B, or C. (Section 3.5.2.3.1, Tier 2: Sec. 4.7.3.3)

C NC N/A DEEP FOUNDATIONS: Piles and piers shall be capable of transferring the lateral forces between the structure and the soil. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.7.3.4)

C NC N/A SLOPING SITES: The difference in foundation embedment depth from one side of the building to another shall not exceed one story in height. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.7.3.5)

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3.9.1 Basic Nonstructural Component Checklist

This Basic Nonstructural Component Checklist shall be completed where required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked Compliant (C), Non-compliant (NC), or Not Applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this standard, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 Evaluation procedure; corresponding section numbers are in parentheses following each evaluation statement.

Partitions

C NC N/A UNREINFORCED MASONRY: Unreinforced masonry or hollow clay tile partitions shall be braced at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)

Ceiling Systems

C NC N/A SUPPORT: The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)

Light Fixtures

C NC N/A EMERGENCY LIGHTING: Emergency lighting shall be anchored or braced to prevent falling during an earthquake. (Tier 2: Sec. 4.8.3.1)

Cladding and Glazing

C NC N/A CLADDING ANCHORS: Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.1)

C NC N/A DETERIORATION: There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)

C NC N/A CLADDING ISOLATION: For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)

C NC N/A MULTI-STORY PANELS: For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.4)

C NC N/A BEARING CONNECTIONS: Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)

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C NC N/A INSERTS: Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)

C NC N/A PANEL CONNECTIONS: Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)

Masonry Veneer

C NC N/A SHELF ANGLES: Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)

C NC N/A TIES: Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)

C NC N/A WEAKENED PLANES: Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)

C NC N/A DETERIORATION: There shall be no evidence of deterioration, damage, or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)

Parapets, Cornices, Ornamentation, and Appendages

C NC N/A URM PARAPETS: There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)

C NC N/A CANOPIES: Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)

Masonry Chimneys

C NC N/A URM CHIMNEYS: No unreinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)

Stairs

C NC N/A URM WALLS: Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)

C NC N/A STAIR DETAILS: In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)

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Building Contents and Furnishing

C NC N/A — TALL NARROW CONTENTS: Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)

Mechanical and Electrical Equipment

C NC N/A — EMERGENCY POWER: Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)

C NC N/A — HAZARDOUS MATERIAL EQUIPMENT: HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)

C NC N/A — DETERIORATION: There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)

C NC N/A — ATTACHED EQUIPMENT: Equipment weighing over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be braced. (Tier 2: Sec. 4.8.12.4)

Piping

C NC N/A — FIRE SUPPRESSION PIPING: Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)

C NC N/A — FLEXIBLE COUPLINGS: Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)

Hazardous Materials Storage and Distribution

C NC N/A — TOXIC SUBSTANCES: Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec. 4.8.15.1)

3.9.2 Intermediate Nonstructural Component Checklist

This Intermediate Nonstructural Component Checklist shall be completed where required by Table 3-2. The Basic Nonstructural Component Checklist shall be completed prior to completing this Intermediate Nonstructural Component Checklist.

Ceiling Systems

C (NC) N/A — LAY-IN TILES: Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)

C (NC) N/A — INTEGRATED CEILINGS: Integrated suspended ceilings at exits and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)

C NC (N/A) — SUSPENDED LATH AND PLASTER: Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forces for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)

Light Fixtures

C (NC) N/A — INDEPENDENT SUPPORT: Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures. (Tier 2: Sec. 4.8.3.2)

Cladding and Glazing

C (NC) N/A — GLAZING: Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)

Parapets, Cornices, Ornamentation, and Appendages

C NC (N/A) — CONCRETE PARAPETS: Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)

C NC (N/A) — APPENDAGES: Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)

Masonry Chimneys

C NC (N/A) — ANCHORAGE: Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)

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Mechanical and Electrical Equipment

C (NC) N/A VIBRATION ISOLATORS: Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.5)

Ducts

C NC (N/A) STAIR AND SMOKE DUCTS: Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)