ASCE 41-17 Tier 1 Seismic Evaluation

Building Name: Foothill Housing (Building #2)
CAAN ID: 1082
Auxiliary Building ID: N/A
Address: 2700 Hearst Avenue, Berkeley, CA
Site location coordinates: Latitude 37.8764, Longitude -122.2565

Plan Image or Aerial Photo

Exterior Elevation Photo

UCOP SEISMIC PERFORMANCE LEVEL (OR “RATING”) BASED ON TIER 1 EVALUATION FINDINGS: V

BUILDING DATA
ASCE 41-17 Model Building Type (Governing Building Type bolded for Seismic Risk Model when multiple types exist):
  a. Longitudinal Direction: W1a: Wood Light Frames, Multi-Story, Multi-unit, Residential
     Transverse Direction: W1a: Wood Light Frames, Multi-Story, Multi-unit, Residential

Square Footage: 29,314 sf
Building Length: 170 ft
Building Width: 41 ft
Building Height: 46 ft
Story Height: 9 ft (Typical)
Number of stories above grade: 4
Number of basement stories below grade: Lowest level is partially embedded

Year of Original Construction and Code Year: 1990, 1985 UBC
Year of Later Constuction and Code Year: N/A

COST RANGE TO RETROFIT (if applicable): Pending the results of the Tier II evaluation. It is estimated that the retrofit cost (if required) will be Medium: over $50 per sf and less than $200 per sf.
BUILDING DESCRIPTION
General
This building is estimated to have been built in 1988 and is situated on a sloping site. The building has
four stories and is approximately 46 feet tall. The building has a rectangular shape with a footprint of
about 41 feet in the N-S direction and 170 feet in the E-W direction. The building area is approximately
29,314 square feet and houses residential units for students.

Structural System
The gravity load structural system consists of wood TJIs with plywood sheathing, wood posts and wood
stud walls. The roof consists of prefabricated wood trusses. The lateral load system consists of wood
stud walls with plywood sheathing on the interior and exterior of the building. The wood floor slabs
serve as horizontal diaphragms to transfer the load to the exterior and interior shear walls. The posts
and walls are founded on spread and strip footings.

Building Condition
Good.

Date of Site Visit: 03/26/2019, Russell Berkowitz, Forell/Elsesser Engineers
Limitations of walk-through: None

SITE INFORMATION
Site Class (A-F): C
Basis: Geologic Hazards and Site Classification, Geomatrix Plate 2
Site Specific Ground Motion Study? Yes, 2015 Update to the Site-Specific Seismic Hazard Analyses and
Development of Seismic Design Ground Motions
BSE-1N Spectral Accelerations: Basis: 2015 Site Specific Report Table 5 for <10 ft Soil
$S_d$: 1.71  $S_{d1}$: 0.61
BSE-2E Spectral Accelerations: Basis: 2015 Site Specific Report Table 6 for <10 ft Soil
$S_{x2}$: 2.31  $S_x$: 0.85 (Note: $S_x$ taken as 90% of the maximum spectral acceleration, obtained from the site-
specific spectrum, at any period within 0.2s to 5s, inclusive, in conformance with ASCE41-17 Section
2.4.2.1 and ASCE 7-16, Section 21.4 guidelines)
Level of Seismicity: High
Performance Level: Collapse Prevention Structural Performance

Geologic Hazards:
Fault Rupture Yes  Basis: California Geological Survey Website
https://maps.conervation.ca.gov/cgs/informationwarehouse/regulatedmaps/
Liquefaction No  Basis: California Geological Survey Website
https://maps.conervation.ca.gov/cgs/informationwarehouse/regulatedmaps/
Landslide No  Basis: California Geological Survey Website
https://maps.conervation.ca.gov/cgs/informationwarehouse/regulatedmaps/

PREVIOUS RATINGS SUMMARY
1. Good – 1997 Preliminary Seismic Evaluation (SAFER), Degenkolb Engineers
DOCUMENTATION

Architectural Drawings: Original Construction; The Ratcliff Architects, October 1988, Sheets A0.0 – A9.2
Structural Drawings: Original Construction; SOH & Associates, October 1988, Sheets 1S1.1–1S7.2

CONSTRUCTION DATA

Gravity Load Structural System: Wood TJIs with plywood sheathing, wood, posts and wood stud walls with plywood sheathing.

Exterior Transverse Walls: Wood Stud Walls with Plywood Sheathing
Opening(s)? Yes

Exterior Longitudinal Walls: Wood Stud Walls with Plywood Sheathing
Opening(s)? Yes

Roof Materials/Framing: Prefabricated roof truss @ 24” O.C. with ½” plywood sheathing

Intermediate Floors/Framing: Wood joists @ 16” O.C. with 5/8” plywood sheathing

Ground Floor: 6” concrete slab on grade

Columns: 6 x 6, 8 x 8 Posts
18” Φ Redwood Columns

Foundation: Spread footings
at columns, strip footing at walls.

General Condition of Structure: Good
Evidence of Settling?: No
Special Features & Comments:

LATERAL-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>ASCE 41-17 Building Type:</th>
<th>Longitudinal</th>
<th>Transverse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diaphragms</td>
<td>W1a: Wood Light Frames</td>
<td>W1a: Wood Light Frames</td>
</tr>
<tr>
<td></td>
<td>Wood joists with 5/8” plywood sheathing</td>
<td>Wood joists with 5/8” plywood sheathing</td>
</tr>
<tr>
<td>Vertical Elements</td>
<td>Wood stud walls with plywood sheathing</td>
<td>Wood stud walls with plywood sheathing</td>
</tr>
<tr>
<td>Connections</td>
<td>Anchored Posts Sills &amp; Walls attached to foundation with anchor bolts and clips.</td>
<td>Anchored Posts Sills &amp; Walls attached to foundation with anchor bolts and clips.</td>
</tr>
<tr>
<td>Details</td>
<td>Structural Details: 1S1.4, 1S1.5-1S1.7, S2.1-S2.8, 1S3.1-1S3.9, S4.1-S4.11, S5.1-1S5.2</td>
<td>Structural Details: 1S1.4, 1S1.5-1S1.7, S2.1-S2.8, 1S3.1-1S3.9, S4.1-S4.11, S5.1-1S5.2</td>
</tr>
</tbody>
</table>
### Significant Structural Deficiencies, Potentially Affecting Seismic Performance Level Designation:

- [x] Lateral System Stress Check (wall shear, column shear or flexure, or brace axial as applicable)
- [ ] Load Path
- [x] Adjacent Buildings
- [ ] Weak Story
- [ ] Soft Story
- [ ] Geometry (vertical irregularities)
- [ ] Torsion
- [ ] Mass – Vertical Irregularity
- [ ] Cripple Walls
- [ ] Wood Sills (bolting)
- [ ] Diaphragm Continuity
- [ ] Openings at Shear Walls (concrete or masonry)
- [ ] Liquefaction
- [ ] Slope Failure
- [x] Surface Fault Rupture
- [ ] Masonry or Concrete Wall Anchorage at Flexible Diaphragm
- [ ] URM wall height to thickness ratio
- [ ] URM Parapets or Cornices
- [ ] URM Chimney
- [ ] Heavy Partitions Braced by Ceilings
- [ ] Appendages

## OVERALL SEISMIC DEFICIENCIES & EXPECTED SEISMIC PERFORMANCE

The main deficiency for the structure is general overstress of the shear walls. The DCRs are approximately 2.0. The building may be expected to have large deformations due to overstress in the walls, with several walls damaged at the lower levels.

The building is also located in an area noted as “Earthquake Fault Zone” per the Alquist-Priolo hazard maps. The potential for surface fault rupture has not been factored into the seismic performance rating.

It is recommended that the deficiencies noted above be further evaluated using a Tier 2 or Tier 3 evaluation to determine if the rating could be improved to a “IV”. The building site slopes, which...
creates multiple levels where shear is taken out into the foundations. It is recommended that a more rigorous evaluation be completed to better account for the overall shear distribution in each level.

There are not any non-structural life-safety concerns for this building.

**Collapse Prevention Basic Configuration Checklist Non-Complaint Items**

- ADJACENT BUILDINGS
- OVERTURNING
- SURFACE FAULT RUPTURE

**Collapse Prevention Structural Checklist for building Type W1-W1A Non-Complaint Items**

- SHEAR STRESS CHECK

**Seismic Retrofit Concept Sketches/Description (only if above-listed rating is V or greater):**

- Replace gypboard sheathing with plywood sheathing at selected walls.
Appendices

A. Additional Photos

B. ASCE 41-17 Tier 1 Checklists (Structural)

C. UCOP Seismic Safety Policy Falling Hazards Assessment Summary

D. Quick Check Calculations
Appendix A – Additional Photos
Appendix B – ASCE 41-17 Tier I Checklists (Structural)
## LOW SEISMICITY

### BUILDING SYSTEMS - GENERAL

<table>
<thead>
<tr>
<th>Description</th>
<th>C</th>
<th>NC</th>
<th>N/A</th>
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<tbody>
<tr>
<td>LOAD PATH: The structure contains a complete, well-defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1)</td>
<td>C</td>
<td>NC</td>
<td>N/A</td>
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<tr>
<td>Comments:</td>
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<tr>
<td>ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building is greater than 0.25% of the height of the shorter building in low seismicity, 0.5% in moderate seismicity, and 1.5% in high seismicity. (Commentary: Sec. A.2.1.2. Tier 2: Sec. 5.4.1.2)</td>
<td>C</td>
<td>NC</td>
<td>N/A</td>
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<tr>
<td>Comments: There is no clear distance between building 2 and building 3.</td>
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<tr>
<td>MEZZANINES: Interior mezzanine levels are braced independently from the main structure or are anchored to the seismic-force-resisting elements of the main structure. (Commentary: Sec. A.2.1.3. Tier 2: Sec. 5.4.1.3)</td>
<td>C</td>
<td>NC</td>
<td>N/A</td>
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<td>Comments:</td>
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### BUILDING SYSTEMS - BUILDING CONFIGURATION

<table>
<thead>
<tr>
<th>Description</th>
<th>C</th>
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<th>N/A</th>
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<tbody>
<tr>
<td>WEAK STORY: The sum of the shear strengths of the seismic-force-resisting system in any story in each direction is not less than 80% of the strength in the adjacent story above. (Commentary: Sec. A2.2.2. Tier 2: Sec. 5.4.2.1)</td>
<td>C</td>
<td>NC</td>
<td>N/A</td>
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<tr>
<td>Comments:</td>
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<tr>
<td>SOFT STORY: The stiffness of the seismic-force-resisting system in any story is not less than 70% of the seismic-force-resisting system stiffness in an adjacent story above or less than 80% of the average seismic-force-resisting system stiffness of the three stories above. (Commentary: Sec. A.2.2.3. Tier 2: Sec. 5.4.2.2)</td>
<td>C</td>
<td>NC</td>
<td>N/A</td>
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<td>Comments:</td>
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<tr>
<td>VERTICAL IRREGULARITIES: All vertical elements in the seismic-force-resisting system are continuous to the foundation. (Commentary: Sec. A.2.2.4. Tier 2: Sec. 5.4.2.3)</td>
<td>C</td>
<td>NC</td>
<td>N/A</td>
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<td>Comments:</td>
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</table>

**Note:**  
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### ASCE 41-17
#### Collapse Prevention Basic Configuration Checklist

**GEOMETRY:** There are no changes in the net horizontal dimension of the seismic-force-resisting system of more than 30% in a story relative to adjacent stories, excluding one-story penthouses and mezzanines. (Commentary: Sec. A.2.2.5. Tier 2: Sec. 5.4.2.4)

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<th>C</th>
<th>NC</th>
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Comments:

**MASS:** There is no change in effective mass of more than 50% from one story to the next. Light roofs, penthouses, and mezzanines need not be considered. (Commentary: Sec. A.2.2.6. Tier 2: Sec. 5.4.2.5)

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Comments:

**TORSION:** The estimated distance between the story center of mass and the story center of rigidity is less than 20% of the building width in either plan dimension. (Commentary: Sec. A.2.2.7. Tier 2: Sec. 5.4.2.6)

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Comments:

### MODERATE SEISMICITY (COMPLETE THE FOLLOWING ITEMS IN ADDITION TO THE ITEMS FOR LOW SEISMICITY)

#### GEOLOGIC SITE HAZARD

<table>
<thead>
<tr>
<th>Description</th>
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<tbody>
<tr>
<td><strong>LIQUEFACTION:</strong> Liquefaction-susceptible, saturated, loose granular soils that could jeopardize the building’s seismic performance do not exist in the foundation soils at depths within 50 ft (15.2m) under the building. (Commentary: Sec. A.6.1.1. Tier 2: 5.4.3.1)</td>
</tr>
<tr>
<td>Comments:</td>
</tr>
<tr>
<td><strong>SLOPE FAILURE:</strong> The building site is located away from potential earthquake-induced slope failures or rockfalls so that it is unaffected by such failures or is capable of accommodating any predicted movements without failure. (Commentary: Sec. A.6.1.2. Tier 2: 5.4.3.1)</td>
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<tr>
<td>Comments:</td>
</tr>
<tr>
<td><strong>SURFACE FAULT RUPTURE:</strong> Surface fault rupture and surface displacement at the building site are not anticipated. (Commentary: Sec. A.6.1.3. Tier 2: 5.4.3.1)</td>
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<tr>
<td>Comments: The building is located in an area of “Earthquake Fault Zone” as indicated on the Alquist - Priolo hazard maps.</td>
</tr>
</tbody>
</table>

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ASCE 41-17
Collapse Prevention Basic Configuration Checklist

HIGH SEISMICITY (COMPLETE THE FOLLOWING ITEMS IN ADDITION TO THE ITEMS FOR MODERATE SEISMICITY)

FOUNDATION CONFIGURATION

<table>
<thead>
<tr>
<th>C</th>
<th>NC</th>
<th>N/A</th>
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<tbody>
<tr>
<td>OVERTURNING: The ratio of the least horizontal dimension of the seismic-force-resisting system at the foundation level to the building height (base/height) is greater than 0.6S_a. (Commentary: Sec. A.6.2.1. Tier 2: Sec. 5.4.3.3)</td>
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<tr>
<td>Comments: B/H = 0.88</td>
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<tr>
<td>0.6S_a = 1.39</td>
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<tr>
<td>This statement is found to be noncompliant. However, this condition does not pose a significant threat to life safety.</td>
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<tbody>
<tr>
<td>TIES BETWEEN FOUNDATION ELEMENTS: The foundation has ties adequate to resist seismic forces where footings, piles, and piers are not restrained by beams, slabs, or soils classified as Site Class A, B, or C. (Commentary: Sec. A.6.2.2. Tier 2: Sec. 5.4.3.4)</td>
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<td>Comments:</td>
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</table>
## ASCE 41-17
### Collapse Prevention Structural Checklist For Building Type W1-W1A

### OW AND MODERATE SEISMICITY

#### SEISMIC-FORCE-RESISTING SYSTEM

<table>
<thead>
<tr>
<th>Description</th>
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<tbody>
<tr>
<td>REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.2.1.1, Tier 2: Sec. 5.5.1.1)</td>
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<td>Comments:</td>
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<tr>
<td>SHEAR STRESS CHECK: The shear stress in the shear walls, calculated using the Quick Check procedure of Section 4.4.3.3, is less than the following values: (Commentary: Sec. A.3.2.7.1, Tier 2: Sec. 5.5.3.1.1)</td>
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<tr>
<td>Structural panel sheathing 1,000 lb/ft (14.6 kN/m).</td>
<td>C</td>
<td>NC</td>
<td>N/A</td>
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<tr>
<td>Diagonal sheathing 700 lb/ft (10.2 kN/m).</td>
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<tr>
<td>Straight sheathing 100 lb/ft (1.5 kN/m).</td>
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<tr>
<td>All other conditions 100 lb/ft (1.5 kN/m).</td>
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<tr>
<td>Comments:</td>
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<tr>
<td>Shear stress check is not satisfied</td>
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<tr>
<td>N-S direction:</td>
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<tr>
<td>Elevation 425'-5&quot;: Shear Stress = 2132 pfl</td>
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<tr>
<td>E-W Direction:</td>
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<tr>
<td>Elevation 425'-5&quot;: Shear Stress = 2330 pfl</td>
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<tr>
<td>STUCCO (EXTERIOR PLASTER) SHEAR WALLS: Multi-story buildings do not rely on exterior stucco walls as the primary seismic-force-resisting system. (Commentary: Sec. A.3.2.7.2, Tier 2: Sec. 5.5.3.6.1)</td>
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<td>Comments:</td>
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<tr>
<td>GYPSUM WALLBOARD OR PLASTER SHEAR WALLS: Interior plaster or gypsum wallboard is not used for shear walls on buildings more than one story high with the exception of the uppermost level of a multi-story building. (Commentary: Sec. A.3.2.7.3, Tier 2: Sec. 5.5.3.6.1)</td>
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<tr>
<td>Comments:</td>
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<tr>
<td>NARROW WOOD SHEAR WALLS: Narrow wood shear walls with an aspect ratio greater than 2-to-1 are not used to resist seismic forces. (Commentary: Sec. A.3.2.7.4, Tier 2: Sec. 5.5.3.6.1)</td>
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<td>Comments:</td>
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</tbody>
</table>

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**WALLS CONNECTED THROUGH FLOORS:** Shear walls have an interconnection between stories to transfer overturning and shear forces through the floor. (Commentary: Sec. A.3.2.7.5. Tier 2: Sec. 5.5.3.6.2)

Comments:

**HILLSIDE SITE:** For structures that are taller on at least one side by more than one-half story because of a sloping site, all shear walls on the downhill slope have an aspect ratio less than 1-to-1. (Commentary: Sec. A.3.2.7.6. Tier 2: Sec. 5.5.3.6.3)

Comments:

**CRIPPLE WALLS:** Cripple walls below first-floor-level shear walls are braced to the foundation with wood structural panels. (Commentary: Sec. A.3.2.7.7. Tier 2: Sec. 5.5.3.6.4)

Comments:

**OPENINGS:** Walls with openings greater than 80% of the length are braced with wood structural panel shear walls with aspect ratios of not more than 1.5-to-1 or are supported by adjacent construction through positive ties capable of transferring the seismic forces. (Commentary: Sec. A.3.2.7.8. Tier 2: Sec. 5.5.3.6.5)

Comments:

**CONNECTIONS**

<table>
<thead>
<tr>
<th>Description</th>
<th>C</th>
<th>NC</th>
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</thead>
<tbody>
<tr>
<td>WOOD POSTS: There is a positive connection of wood posts to the foundation.</td>
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<tr>
<td>Comments:</td>
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<tr>
<td>WOOD SILLS: All wood sills are bolted to the foundation.</td>
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<td>Comments:</td>
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<tr>
<td>GIRDER-COLUMN CONNECTION: There is a positive connection using plates,</td>
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<tr>
<td>connection hardware, or straps between the girder and the column support.</td>
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<tr>
<td>Comments:</td>
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**ASCE 41-17**  
**Collapse Prevention Structural Checklist For Building Type W1-W1A**

### HIGH SEISMICITY (COMPLETE THE FOLLOWING ITEMS IN ADDITION TO THE ITEMS FOR LOW AND MODERATE SEISMICITY)

#### CONNECTIONS

<table>
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<th>NC</th>
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<tbody>
<tr>
<td>WOOD SILL BOLTS: Sill bolts are spaced at 6 ft or less with acceptable edge and end distance provided for wood and concrete. (Commentary: Sec. A.5.3.7. Tier 2: Sec. 5.7.3.3)</td>
<td>C</td>
<td>NC</td>
<td>N/A</td>
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</table>

**Comments:**

#### DIAPHRAGMS

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<tr>
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<th>N/A</th>
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</thead>
<tbody>
<tr>
<td>DIAPHRAGM CONTINUITY: The diaphragms are not composed of split-level floors and do not have expansion joints. (Commentary: Sec. A.4.1.1. Tier 2: Sec. 5.6.1.1)</td>
<td>C</td>
<td>NC</td>
<td>N/A</td>
<td>U</td>
</tr>
</tbody>
</table>

**Comments**

<table>
<thead>
<tr>
<th>Description</th>
<th>C</th>
<th>NC</th>
<th>N/A</th>
<th>U</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROOF CHORD CONTINUITY: All chord elements are continuous, regardless of changes in roof elevation. (Commentary: Sec. A.4.1.3. Tier 2: Sec. 5.6.1.1)</td>
<td>C</td>
<td>NC</td>
<td>N/A</td>
<td>U</td>
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</tbody>
</table>

**Comments**

<table>
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<th>NC</th>
<th>N/A</th>
<th>U</th>
</tr>
</thead>
<tbody>
<tr>
<td>STRAIGHT SHEATHING: All straight-sheathed diaphragms have aspect ratios less than 2-to-1 in the direction being considered. (Commentary: Sec. A.4.2.1. Tier 2: Sec. 5.6.2)</td>
<td>C</td>
<td>NC</td>
<td>N/A</td>
<td>U</td>
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</table>

**Comments**

<table>
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<th>NC</th>
<th>N/A</th>
<th>U</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPANS: All wood diaphragms with spans greater than 24 ft (7.3 m) consist of wood structural panels or diagonal sheathing. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2)</td>
<td>C</td>
<td>NC</td>
<td>N/A</td>
<td>U</td>
</tr>
</tbody>
</table>

**Comments**

---

**Note:**  
- **C** = Compliant  
- **NC** = Noncompliant  
- **N/A** = Not Applicable  
- **U** = Unknown
<table>
<thead>
<tr>
<th>C</th>
<th>NC</th>
<th>N/A</th>
<th>U</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DIAGONALLY SHEATHED AND UNBLOCKED DIAPHRAGMS:** All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 40 ft (12 m) and have aspect ratios less than or equal to 4-to-1. (Commentary: Sec. A.4.2.3. Tier 2: Sec. 5.6.2)

**Comments:** Blocking is provided

<table>
<thead>
<tr>
<th>C</th>
<th>NC</th>
<th>N/A</th>
<th>U</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**OTHER DIAPHRAGMS:** The diaphragms do not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Commentary: Sec. A.4.7.1. Tier 2: Sec. 5.6.5)

**Comments:**

---

**Note:**
- **C** = Compliant
- **NC** = Noncompliant
- **N/A** = Not Applicable
- **U** = Unknown
Appendix C – UCOP Seismic Safety Policy Falling Hazards
Assessment Summary
<table>
<thead>
<tr>
<th>Description</th>
<th>P</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy ceilings, features or ornamentation above large lecture halls, auditoriums, lobbies, or other areas where large numbers of people congregate (50 ppl or more)</td>
<td>P</td>
<td>N/A</td>
</tr>
<tr>
<td>Heavy masonry or stone veneer above exit ways or public access areas</td>
<td>P</td>
<td>N/A</td>
</tr>
<tr>
<td>Unbraced masonry parapets, cornices, or other ornamentation above exit ways or public access areas</td>
<td>P</td>
<td>N/A</td>
</tr>
<tr>
<td>Unrestrained hazardous material storage</td>
<td>P</td>
<td>N/A</td>
</tr>
<tr>
<td>Masonry chimneys</td>
<td>P</td>
<td>N/A</td>
</tr>
<tr>
<td>Unrestrained natural gas-fueled equipment such as water heaters, boilers, emergency generators, etc.</td>
<td>P</td>
<td>N/A</td>
</tr>
<tr>
<td>Other:</td>
<td>P</td>
<td>N/A</td>
</tr>
<tr>
<td>Other:</td>
<td>P</td>
<td>N/A</td>
</tr>
<tr>
<td>Other:</td>
<td>P</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Falling Hazard Risk: Low
Appendix D – Quick Check Calculations
## Site & Seismicity Information

**Foothill Housing (1082)**

UC Berkeley  
Berkeley, California

### Site Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Latitude</td>
<td>37.8764</td>
<td>(Source: Google Earth)</td>
</tr>
<tr>
<td>Site Longitude</td>
<td>-122.2565</td>
<td>(Source: Google Earth)</td>
</tr>
</tbody>
</table>

### 2015 Site-Specific Seismic Hazard Analyses

<table>
<thead>
<tr>
<th>Event</th>
<th>Value</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_{x_{5,BSE-1N}}$</td>
<td>1.710 g</td>
<td>Table 5, &lt; 10 ft Soil</td>
</tr>
<tr>
<td>$S_{x_{1,BSE-1N}}$</td>
<td>0.610 g</td>
<td>Table 5, &lt; 10 ft Soil</td>
</tr>
</tbody>
</table>

### Table 2-4. Level of Seismicity Definitions

<table>
<thead>
<tr>
<th>Level of Seismicity</th>
<th>$S_{DS}$</th>
<th>$S_{DI}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very low</td>
<td>&lt;0.167 g</td>
<td>&lt;0.067 g</td>
</tr>
<tr>
<td>Low</td>
<td>≥0.167 g</td>
<td>≥0.067 g</td>
</tr>
<tr>
<td>Moderate</td>
<td>≥0.33 g</td>
<td>&lt;0.133 g</td>
</tr>
<tr>
<td></td>
<td>&lt;0.50 g</td>
<td>&lt;0.20 g</td>
</tr>
<tr>
<td>High</td>
<td>≥0.50 g</td>
<td>≥0.20 g</td>
</tr>
</tbody>
</table>

*a The higher level of seismicity defined by $S_{DS}$ or $S_{DI}$ shall govern.

**Level of Seismicity = HIGH**
Determine BSE-2E Spectral Response Acceleration Parameters

Foothill Housing (1082)
UC Berkeley
Berkeley, California

Site Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Latitude</td>
<td>37.8764</td>
<td>(Source: Google Earth)</td>
</tr>
<tr>
<td>Site Longitude</td>
<td>-122.2565</td>
<td>(Source: Google Earth)</td>
</tr>
</tbody>
</table>

Site Data

<table>
<thead>
<tr>
<th>Classification</th>
<th>Geologic Hazards &amp; Site Classification, Geomatrix Plate 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquefaction Potential</td>
<td>Low</td>
</tr>
</tbody>
</table>

2015 Site-Specific Seismic Hazard Analyses

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Code Reference</td>
<td>ASCE 41-17</td>
<td></td>
</tr>
<tr>
<td>EQ Hazard Level</td>
<td>BSE-2E</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_{X5,BSE-2E}$, Max 0.2s to 5s</td>
<td>2.570 g</td>
<td>Table 6, &lt; 10 ft Soil Per ASCE41-17, Sect. 2.4.2.1 &amp; ASCE7-16, Sect. 21.4</td>
</tr>
<tr>
<td>% Multiplier</td>
<td>90%</td>
<td>Per ASCE41-17, Sect. 2.4.2.1 &amp; ASCE7-16, Sect. 21.4</td>
</tr>
<tr>
<td>$S_{X5,BSE-2E}$</td>
<td>2.313 g</td>
<td></td>
</tr>
<tr>
<td>$S_{X1,BSE-2E}$</td>
<td>0.850 g</td>
<td>Table 6, &lt; 10 ft Soil</td>
</tr>
</tbody>
</table>
Determine Building Period per ASCE 41-17 Section 4.4.2.4

\[ T = C_t h_n^\beta \] (4-4)

Values of Period Parameters \( C_t \) and \( \beta \)

<table>
<thead>
<tr>
<th>Structure Type</th>
<th>( C_t )</th>
<th>( \beta )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel moment-resisting frames (S1, S1a)</td>
<td>0.035</td>
<td>0.80</td>
</tr>
<tr>
<td>Concrete moment-resisting frames (C1)</td>
<td>0.018</td>
<td>0.90</td>
</tr>
<tr>
<td>Steel eccentrically braced frames (S2, S2a)</td>
<td>0.030</td>
<td>0.75</td>
</tr>
<tr>
<td>All other framing systems</td>
<td>0.020</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Structure Type | Longitudinal | Transverse |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>W1a</td>
<td>W1a</td>
<td></td>
</tr>
<tr>
<td>Wood Light Frames, Multi-Story, Multi-Unit, Residential</td>
<td>Wood Light Frames, Multi-Story, Multi-Unit, Residential</td>
<td></td>
</tr>
</tbody>
</table>

Height of Roof Level Above Base = 46.6 ft

<table>
<thead>
<tr>
<th>Period, ( T ), ASCE 41-17 Equation 4-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>( C_t )</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>( \beta )</td>
</tr>
<tr>
<td>( h_n )</td>
</tr>
<tr>
<td>( T = C_t h_n^\beta )</td>
</tr>
</tbody>
</table>
Weight of Materials

### Roof
- 3/4" Plywood Shlg: 2.50 psf
- Wood Joists: 3.00 psf
- Steel Beams: 0.00 psf
- Wood Posts: 2.00 psf
- Wood Walls: 2.00 psf
- Roofing: 5.00 psf
- Distributed MEP: 1.00 psf
- Ceiling: 1.00 psf
- Misc: 1.00 psf
- Partitions: 5.00 psf

**Total: 22.50 psf**

### Typical Floor
- 3/4" Plywood Shlg: 2.50 psf
- Wood Joists: 3.00 psf
- Steel Beams: 2.00 psf
- Wood Posts: 3.00 psf
- Wood Walls: 2.00 psf
- Flooring: 1.00 psf
- Distributed MEP: 1.00 psf
- Ceiling: 1.00 psf
- Misc: 1.00 psf
- Partitions: 10.00 psf

**Total: 26.50 psf**
<table>
<thead>
<tr>
<th>Floor Area (sf)</th>
<th>Floor Area (sf)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>416'-1 1/2&quot;</strong></td>
<td><strong>453'-3 1/2&quot;</strong></td>
</tr>
<tr>
<td>17 6.5</td>
<td>17 6.5</td>
</tr>
<tr>
<td>5 11</td>
<td>5 11</td>
</tr>
<tr>
<td>17 6.5</td>
<td>17 6.5</td>
</tr>
<tr>
<td>22 17.5</td>
<td>22 17.5</td>
</tr>
<tr>
<td>41 37.6</td>
<td>41 37.6</td>
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<tr>
<td>1540</td>
<td>23.5</td>
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<table>
<thead>
<tr>
<th><strong>425'- 5&quot;</strong></th>
<th><strong>462'-7&quot;</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>17 6.5</td>
<td>17 6.5</td>
</tr>
<tr>
<td>5 11</td>
<td>5 11</td>
</tr>
<tr>
<td>22 17.5</td>
<td>22 17.5</td>
</tr>
<tr>
<td>41 12.7</td>
<td>41 12.7</td>
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<tr>
<td>297</td>
<td>23.5</td>
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<table>
<thead>
<tr>
<th><strong>434'- 8 1/2&quot;</strong></th>
<th><strong>444'-0&quot;, 453'-3 1/2&quot;</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>17 6.5</td>
<td>17 6.5</td>
</tr>
<tr>
<td>5 11</td>
<td>5 11</td>
</tr>
<tr>
<td>17 6.5</td>
<td>17 6.5</td>
</tr>
<tr>
<td>39 24</td>
<td>39 24</td>
</tr>
<tr>
<td>41 12.625</td>
<td>41 12.625</td>
</tr>
<tr>
<td>12 2.625</td>
<td>12 2.625</td>
</tr>
<tr>
<td>12 8</td>
<td>12 8</td>
</tr>
<tr>
<td>12 8</td>
<td>12 8</td>
</tr>
<tr>
<td>12 0</td>
<td>12 0</td>
</tr>
<tr>
<td>12 2.625</td>
<td>12 2.625</td>
</tr>
<tr>
<td>10 9.125</td>
<td>10 9.125</td>
</tr>
<tr>
<td>13 4</td>
<td>13 4</td>
</tr>
<tr>
<td>142 44.63</td>
<td>142 44.63</td>
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<tr>
<td>145.7</td>
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<thead>
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<th><strong>Roof</strong></th>
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<td>5 11</td>
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<tr>
<td>17 6.5</td>
<td>17 6.5</td>
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<tr>
<td>39 24</td>
<td>39 24</td>
</tr>
<tr>
<td>41 12.0</td>
<td>41 12.0</td>
</tr>
<tr>
<td>12 2.625</td>
<td>12 2.625</td>
</tr>
<tr>
<td>10 9.125</td>
<td>10 9.125</td>
</tr>
<tr>
<td>13 4</td>
<td>13 4</td>
</tr>
<tr>
<td>12 0</td>
<td>12 0</td>
</tr>
<tr>
<td>12 2.625</td>
<td>12 2.625</td>
</tr>
<tr>
<td>119 37</td>
<td>119 37</td>
</tr>
<tr>
<td>122.1</td>
<td>122.1</td>
</tr>
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</table>

| **5005** | **6967** |

---

*Evaluator: QW*

*Date: 5/9/2019*
### WALL GEOMETRY

<table>
<thead>
<tr>
<th>X-DIRECTION</th>
<th>Y-DIRECTION</th>
</tr>
</thead>
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<tr>
<td>17</td>
<td>6.5</td>
</tr>
<tr>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>17</td>
<td>6.5</td>
</tr>
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<td>17</td>
<td>6.5</td>
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<td>17</td>
<td>6.5</td>
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<td><strong>192</strong></td>
<td><strong>82.5</strong></td>
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</table>

<table>
<thead>
<tr>
<th>X-DIRECTION</th>
<th>Y-DIRECTION</th>
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</thead>
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<tr>
<td>192</td>
<td>199</td>
</tr>
<tr>
<td>182</td>
<td></td>
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</tbody>
</table>
## Summary of Seismic Weight

### Original Building

<table>
<thead>
<tr>
<th>Flat Unit Weight (psf)</th>
<th>Flat Area (sf)</th>
<th>Flat Weight (kips)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof 22.50</td>
<td>3493</td>
<td>79</td>
</tr>
<tr>
<td>462'-7&quot;</td>
<td>26.50</td>
<td>133</td>
</tr>
<tr>
<td>453'-3 1/2&quot;</td>
<td>5005</td>
<td>185</td>
</tr>
<tr>
<td>444'-0&quot;</td>
<td>6967</td>
<td>185</td>
</tr>
<tr>
<td>434'-8 1/2&quot;</td>
<td>5974</td>
<td>158</td>
</tr>
<tr>
<td>425'-5&quot;</td>
<td>3252</td>
<td>86</td>
</tr>
</tbody>
</table>

**Total Seismic Weight = 825 K**

### Building Weight Summary:

<table>
<thead>
<tr>
<th>Room</th>
<th>Weight (kips)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof</td>
<td>79</td>
</tr>
<tr>
<td>462'-7&quot;</td>
<td>133</td>
</tr>
<tr>
<td>453'-3 1/2&quot;</td>
<td>185</td>
</tr>
<tr>
<td>444'-0&quot;</td>
<td>185</td>
</tr>
<tr>
<td>434'-8 1/2&quot;</td>
<td>158</td>
</tr>
<tr>
<td>425'-5&quot;</td>
<td>86</td>
</tr>
</tbody>
</table>

**Total Building Seismic Weight = 825 kips**
Determine Pseudo Seismic Force per ASCE 41-17 Section 4.4.2.1

\[ V = C S_a W \]  \hspace{1cm} (4-1)

Number of Stories = 4

### Table 4-7. Modification Factor, C

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Number of Stories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood and cold-formed steel shear wall (W1, W1a, W2, CFS1)</td>
<td>1.3 1.1 1.0 1.0</td>
</tr>
<tr>
<td>Moment frame (S1, S3, C1, PC2a)</td>
<td></td>
</tr>
<tr>
<td>Shear wall (S4, S5, C2, C3, PC1a, PC2, RM2, URMa)</td>
<td>1.4 1.2 1.1 1.0</td>
</tr>
<tr>
<td>Brood frame (S2)</td>
<td></td>
</tr>
<tr>
<td>Cold-formed steel strap-brace wall (CFS2)</td>
<td></td>
</tr>
<tr>
<td>Unreinforced masonry (URM)</td>
<td>1.0 1.0 1.0 1.0</td>
</tr>
<tr>
<td>Flexible diaphragms (S1a, S2a, S5a, C2a, C3a, PC1, RM1)</td>
<td></td>
</tr>
</tbody>
</table>

\* Defined in Table 3-1.

<table>
<thead>
<tr>
<th>Building Type</th>
<th>W1a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>0.357</td>
</tr>
<tr>
<td>S_XS</td>
<td>2.313</td>
</tr>
<tr>
<td>S_X1</td>
<td>0.850</td>
</tr>
<tr>
<td>S_X1 / T</td>
<td>2.383</td>
</tr>
<tr>
<td>S_a</td>
<td>2.313</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
</tr>
<tr>
<td>W</td>
<td>825 kips</td>
</tr>
<tr>
<td>V</td>
<td>1908 kips</td>
</tr>
</tbody>
</table>

\[ 0.6S_a \] 1.39
\[ D \] 41
\[ H \] 46.6
\[ D/H \] 0.88
\[ D/H > 0.6S_a \] No

ASCE 41-17, Section 4.4.2.3, Eq. 4-3
Story Shear Forces per ASCE 41-17 Section 4.4.2.2

\[ F_x = \frac{w_x h_x^k}{\sum_{i=1}^{n} w_i h_i^k} V \]  
\[ (4-2a) \]

\[ V_j = \sum_{x=j}^{n} F_x \]  
\[ (4-2b) \]

**Original Building**

\[ V = 1908 \text{ kips} \]
\[ k = 1.00 \]

<table>
<thead>
<tr>
<th>Level</th>
<th>Weight (kips)</th>
<th>Height (ft)</th>
<th>w x h^k</th>
<th>C_vx</th>
<th>F_x (kips)</th>
<th>V_j (kips)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof</td>
<td>79</td>
<td>54.2</td>
<td>4257</td>
<td>0.16</td>
<td>310</td>
<td>310</td>
</tr>
<tr>
<td>462'-7&quot;</td>
<td>133</td>
<td>46.5</td>
<td>6162</td>
<td>0.24</td>
<td>449</td>
<td>760</td>
</tr>
<tr>
<td>453'-3 1/2&quot;</td>
<td>185</td>
<td>37.2</td>
<td>6862</td>
<td>0.26</td>
<td>500</td>
<td>1260</td>
</tr>
<tr>
<td>444'-0&quot;</td>
<td>185</td>
<td>27.9</td>
<td>5147</td>
<td>0.20</td>
<td>375</td>
<td>1635</td>
</tr>
<tr>
<td>434'-8 1/2&quot;</td>
<td>158</td>
<td>18.6</td>
<td>2942</td>
<td>0.11</td>
<td>215</td>
<td>1850</td>
</tr>
<tr>
<td>425'-5&quot;</td>
<td>86</td>
<td>9.29</td>
<td>801</td>
<td>0.03</td>
<td>58</td>
<td>1908</td>
</tr>
</tbody>
</table>

\[ \sum_{i=1}^{n} (w_i h_i) = 26172 \]
Quick Check - Shear Stress in Shear Walls

\[ \frac{v_{avg}}{v_j} = \frac{1}{M_s} \left( \frac{V_j}{A_w} \right) \]  \hspace{1cm} (4-8)

Table 4-8. \( M_s \) Factors for Shear Walls

<table>
<thead>
<tr>
<th>Wall Type</th>
<th>Level of Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>reinforced concrete, precast concrete, wood, reinforced masonry, and cold-formed steel</td>
<td>CP(^a)</td>
</tr>
<tr>
<td>Unreinforced masonry</td>
<td>1.75</td>
</tr>
</tbody>
</table>

\(^a\) CP = Collapse Prevention, LS = Life Safety, IO = Immediate Occupancy.

<table>
<thead>
<tr>
<th>X Direction</th>
<th>Y Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>N-S Direction</td>
<td>E-W Direction</td>
</tr>
<tr>
<td>425'-5&quot;</td>
<td>425'-5&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lw</th>
<th>199 ft</th>
<th>182 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>1908 K</td>
<td>1908 K</td>
</tr>
<tr>
<td>Ms</td>
<td>4.5</td>
<td>4.5</td>
</tr>
<tr>
<td>( v_{avg} )</td>
<td>2132 plf</td>
<td>2330 plf</td>
</tr>
</tbody>
</table>

Limiting Shear Stress

Acceptable?   | FAILS   | FAILS |
DCR           | 2.13    | 2.33  |