Independent Seismic Review and Concept Retrofit Design

Stewart Building
1125 16th Street
Arcata, CA

Performed for Compliance with CSU Seismic Requirements

Maryann T. Phipps
Megan E. Doxzen
Benjamin Biddick
January 31, 2025

Introduction

Independent Seismic Review of 1125 16th Street in Arcata, CA (aka the Stewart Building) has been conducted for compliance with the CSU Seismic Requirements (2024 Policy), which require an Independent Seismic Review Report for all acquisitions. The review concludes the Stewart Building does not meet the CSU Seismic Requirements (see "Building Classification" on page 9) and a concept retrofit has been developed to bring the building into compliance.

The review and retrofit were based on visual observations during site visits conducted on April 14, 2022 by Megan Doxzen and on January 17, 2025 by Benjamin Biddick. Original structural drawings were not available for review. However, available documents including an appraisal by Childs Appraisal Service dated September 17, 2021 and a Phase 1 Environmental Site Assessment prepared by SHN Consulting Engineers dated October 2021 were reviewed. Additionally, as-built documents for various remodel projects were examined on site, but none contained substantial structural information. The seismic evaluation was guided by engineering judgment and the Tier 1 assessment procedures of ASCE 41-17 *Seismic Evaluation and Retrofit of Existing Buildings,* in accordance with *CSU Seismic Policy.* The concept retrofit was developed according to the *2022 California Existing Building Code.*

Site Conditions and Building Description

The two-story structure was dedicated in 1925 as the Stewart School and is located approximately 330 feet from the nearest known fault. According to published maps made available by the California Geological Survey (CGS), the building lies within the mapped Earthquake Fault Zone (Figure 1). According to the CSU Seismic Requirements:

> *All planned construction within the Earthquake Fault Zone shall have detailed geologic studies of the building site to determine if a fault trace passes through, or is within 50 feet, of the building perimeter.*

In order to determine whether future development at this location would be permitted, a report entitled "Fault Study Hazard Evaluation, Fine Arts Facility, Arcata High School" conducted for an adjacent parcel on behalf of the Northern Humboldt Union High School District (by SHN Consulting Engineers & Geologists, September 2012) was reviewed by CSU Seismic Review Board member and Geotechnical Engineer John Egan. John determined that the results of that evaluation (i.e., the trenching and interpretations) are sound and can be extrapolated south along the mapped Fickle Hill fault trace to indicate that the Stewart Building site has sufficiently low risk of surface fault rupture to permit future renovation and occupancy by CSU.

The building is built into a shallow hillside such that the ground floor walls at the east end retain approximately 5 feet of soil. The east-west slope along 16th Street is approximately 3% (Figure 2). As of the date of this report, the property has not been evaluated by CGS for liquefaction or seismic landslide hazards. However, geologic maps and un-adopted hazard maps for the City of Arcata indicate liquefaction potential for the property is likely low.

The ground floor story is a maximum of 11'-0" tall but varies due to the stepped ground floor slab. The second story is approximately 12'-0" tall, except below the high roof where the second story is approximately 18'-0" tall. The attic is approximately 5'-0" tall and the high roof centered on the south side of the building extends an additional 5'-0" (Figure 3). The building is approximately rectangular in plan measuring 296'-0" in the east-west direction, 66'-6" in the north-south direction and contains 42,010 gross square feet.

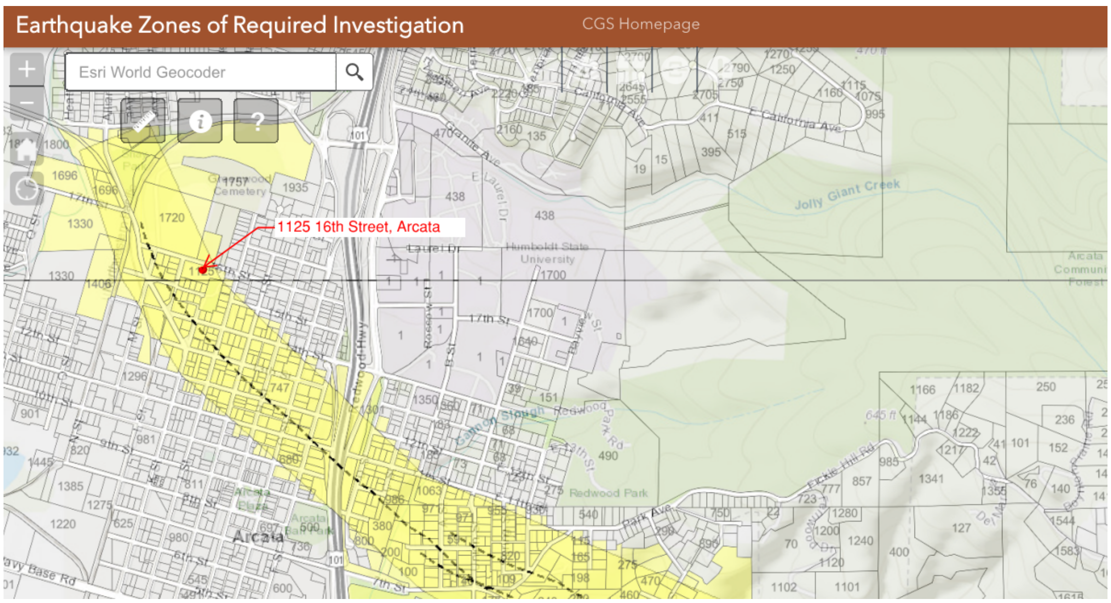


Figure 1 – Earthquake Fault Zone from CGS

Figure 2 – North side of 1125 16th Street, which slopes down to the west

Figure 3 – South side of 1125 16th Street with high roof

Gravity Load-Resisting System

The main roof and high roof are constructed of S-shaped clay tiles around the perimeter and asphalt shingles and panels elsewhere (Figure 4). The roofing is supported on 1x straight sheathing spanning to 2x4 and 2x6 wood joists at 16” on center. At the high roof, the joists span to wood and steel trusses that extend the full width of the high roof in the north-south direction. At the main roof, the joists span to wood beams that are supported by wood posts at the interior and reinforced concrete bearing walls around the perimeter.

The attic at the main roof is constructed with 2x6 joists at 16” on center along the main corridor, and 2x14 joists at 32” on center alternating with 2x4 joists at 32” on center elsewhere. There is ½” plywood sheathing on the underside of the attic framing, which appears to be a seismic retrofitting measure implemented at some time in the past (discussed under “Lateral Force-Resisting System”). The attic at the high roof is constructed with 3/8” plywood sheathing on top of 2x joists spanning to the wood and steel trusses.

The second floor is constructed with straight sheathing over 1x8 diagonal sheathing. The floor is framed with 2x10 and 2x16 joists at 16” on center that span to either wood bearing walls or wood beams and posts, and reinforced concrete bearing walls at the perimeter. The perimeter concrete walls and two interior concrete walls extend the full height of the building (Figures 5 and 6). The first floor is constructed of a concrete slab-on-grade. It is expected that all concrete walls and interior bearing walls are supported on continuous footings and the interior posts are supported on spread footings. There are several open excavations in the unfinished portion of the ground floor where wood posts and spread footings were added.

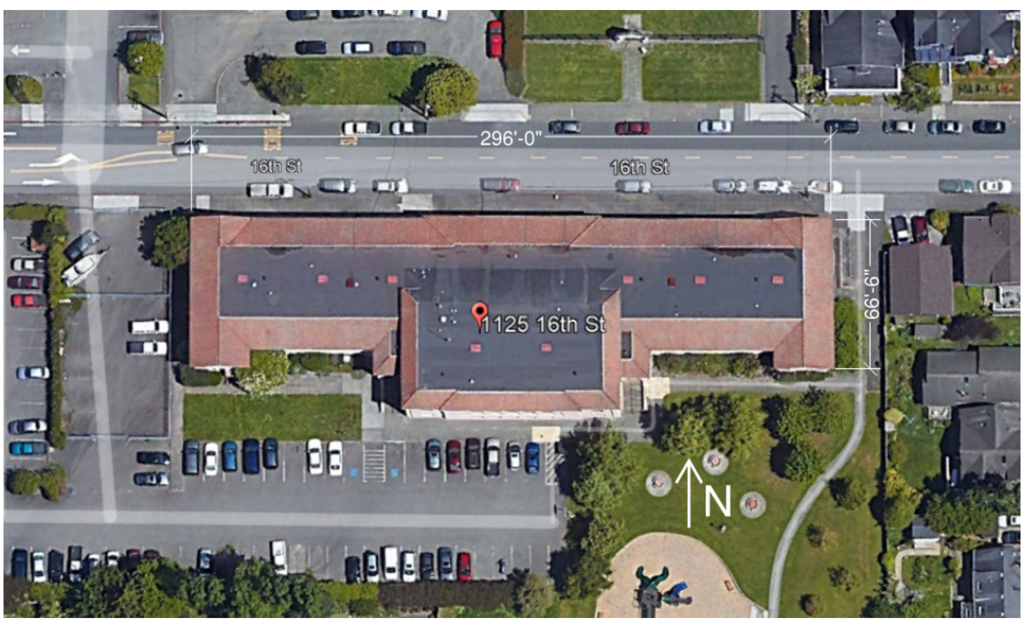


Figure 4 – Roof plan from Google Earth

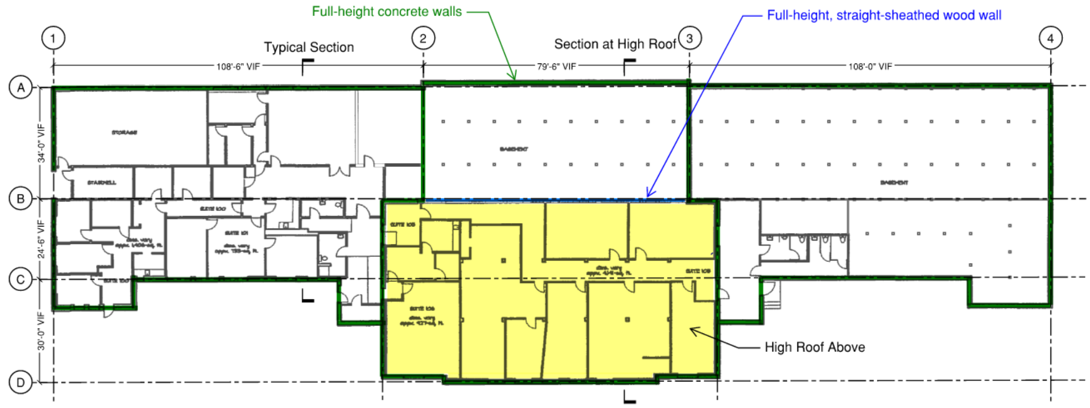


Figure 5 – First Floor Plan

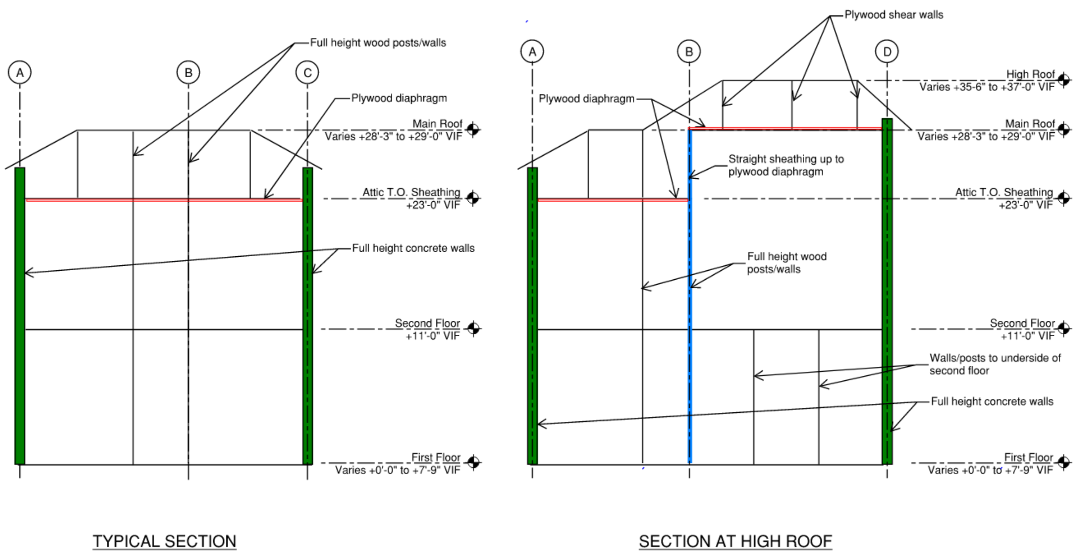


Figure 6 – Schematic Building Sections

Lateral Force-Resisting System

The lateral force-resisting system consists of reinforced concrete shear walls in both the north-south and east-west directions. The walls are 8" thick at the second floor and approximately 12" thick at the first floor. One layer of vertical 3/8" square reinforcing bars spaced at roughly 24" on center were observed extending up from the top of the wall at one location. The window and door openings typically align between floors. The concrete walls are finished with 1" thick plaster (Figure 7). There is a full-height, straight-sheathed wood wall at the north side of the high roof that may also carry some lateral load.

The 1x straight-sheathed main roof diaphragm spans between the concrete walls. There is a 1'-2" gap between the diaphragm and the top of the concrete walls (Figure 8). Due to the attic diaphragm discussed below, the main roof diaphragm is only required to transfer its own self-weight to the walls.

There is evidence of seismic upgrading in the attic space. Below the main roof, a plywood diaphragm at the underside of the attic joists connects to the perimeter and interior concrete walls. The diaphragm is blocked, has approximately 5" on center edge nailing, and has infrequent metal straps and anchors tying the diaphragm and concrete walls together (Figure 9). Below the high roof, east-west plywood shear walls connect the high roof diaphragm to an intermediate plywood diaphragm just below the top of the concrete walls on three sides (Figure 10). On the north side, where there is not a concrete wall, there appears to have been some effort to tie the plywood diaphragm into the full-height, straight-sheathed wood wall (Figures 5 and 6).

Where the high roof slopes to meet the top of the concrete walls, short wood-framed cripple walls sit on top of the concrete walls and are braced with 1x diagonal straps. The wood sill plate is punctured by the 3/8" square bars where they occur (Figure 11).

At the second floor, the diaphragm is tied into the walls with 1/2" diameter bars extending out of the concrete wall and bent through the joists (aka "government anchors"). The bars were observed to be spaced at 64" located only on the sides where the joists are perpendicular to the concrete walls (Figure 12).

Figure 7 – Perimeter concrete wall at second floor with plaster finish.

Figure 8 – Main roof at exterior concrete wall with attic framing below.

Figure 9 – Out-of-plane wall anchored to attic joist with plywood below.

Figure 10 – Plywood walls and diaphragm below high roof

Figure 11 – Cripple wall with diagonal bracing on top of concrete wall at high roof

Figure 12 – Rebar extending out from the concrete wall and hooked through a second floor joist

Seismic Evaluation

In accordance with the ASCE 41-17 Tier 1 and Tier 2 assessment procedures for existing buildings, the following deficiencies were identified:

- Out-of-plane wall anchorage at flexible diaphragms: The observed anchorage at the attic and second floor diaphragms is insufficient to reliably brace the concrete walls out-of-plane.
- Transfer of in-plane loads from flexible diaphragms to shear walls: At the sloped high roof, the cripple walls cannot adequately transfer shear to the concrete walls. At the main roof, the 1'-2" gap between the diaphragm and the top of the concrete walls indicates there is no load path to deliver in-plane shear to the concrete walls.
- Wood diaphragm spans: The main roof diaphragm was found to be noncompliant using ASCE 41-17 Tier 2 assessment procedures. However, it was found to be acceptable using ASCE 7-16 design procedures and is judged to be adequate since it only carries its own self-weight. The second floor diaphragm is not sufficient for the large spans of up to 108 feet.
- Continuous cross ties between diaphragm chords: Continuous cross ties were not found at joist splices.
- Falling hazards: The clay tiles are not positively attached to the roof sheathing.

Building Classification

CSU's intended occupancy of 1125 16th Street is classified as Building Occupancy Category II in accordance with Table 1604.5 of the 2022 CBC. Accordingly, a minimum seismic rating of IV is required for occupancy according to the CSU Seismic Policy. Seismic performance rating Level IV is defined as a building expected to provide a life-safe performance in a BSE-R Earthquake (earthquake ground shaking with a 20% probability of exceedance in 50 years and mean return period of 225 years) and prevent collapse in a BSE-C Earthquake (ground shaking with a 5% probability of exceedance in 50 years and a mean return period of 975 years).

In its current condition, the Stewart Building is judged to have a Seismic Performance Level Rating of **V** based on the ASCE 41-17 assessment. In accordance with the CSU Seismic Requirements,

> *A building with a Level V rating may be occupied or continue to be occupied only if the comprehensive and feasible budget and retrofit plan are in place at acquisition to retrofit it to achieve a Level IV within five years.*

Concept Seismic Retrofit

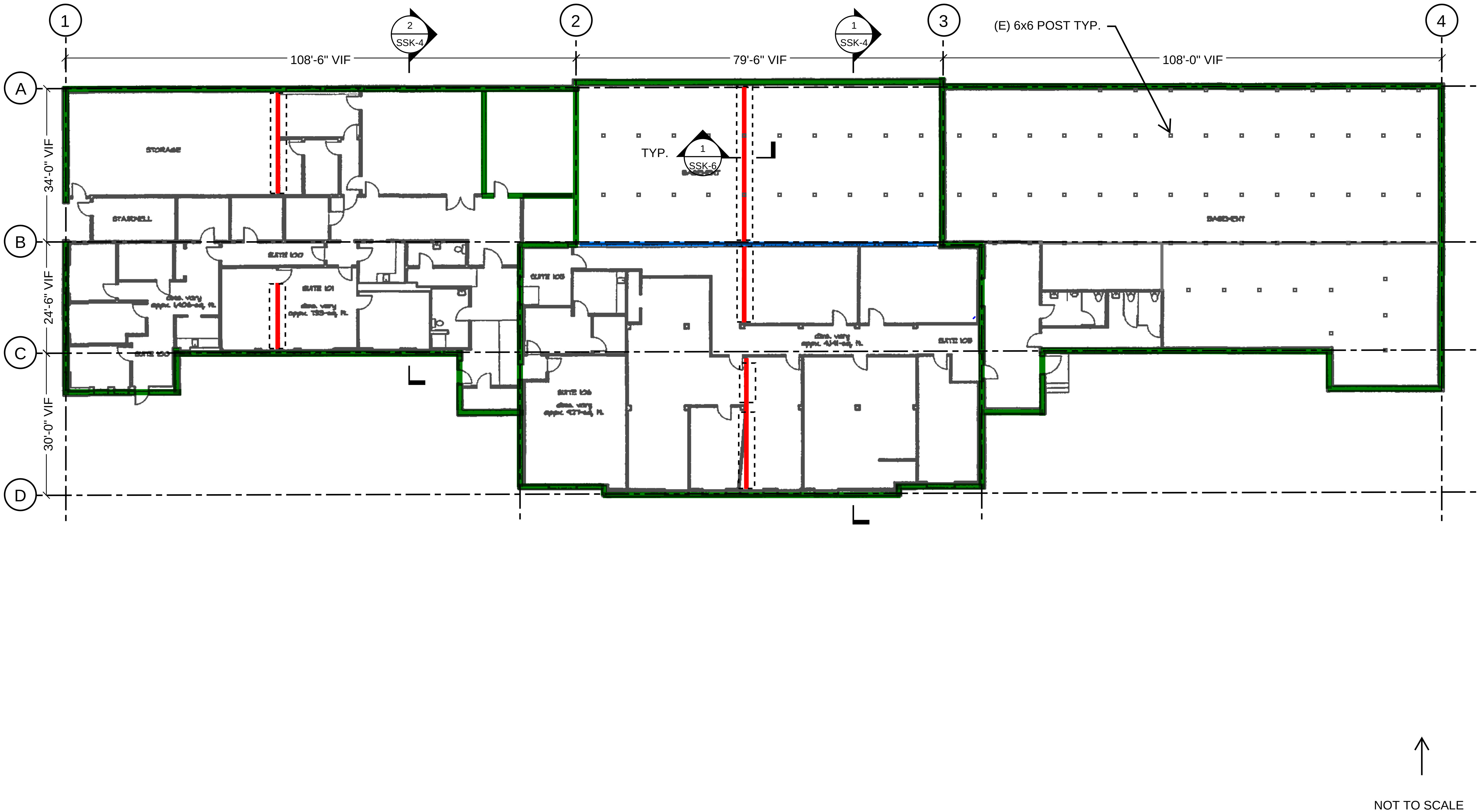
Concept seismic retrofit measures have been developed to address the deficiencies discussed above and achieve a minimum Seismic Performance Level Rating of IV. The concept retrofit is designed to 75% of the 2022 California Building Code forces as allowed by the 2022 California Existing Building Code 202.3.2. The attached sketches include plans, sections and key details to assist with preliminary pricing. The retrofit measures include the following:

- Out-of-plane wall anchorage at flexible diaphragms: Additional concrete anchors will be installed to brace the concrete walls to the attic and second floor diaphragms.
- Transfer of in-plane loads from flexible diaphragms to shear walls: At the high roof, plywood sheathing will be installed on the cripple walls below the high roof. At the main roof, the 1’-2” gap will be filled with plywood blocking fastened to the straight sheathing above and the concrete wall below.
- Wood diaphragm spans: New plywood shear walls will be installed at the first floor in the north-south direction to reduce the second floor diaphragm spans.
- Continuous cross ties between diaphragm chords: Tension ties will be installed at joist splices at the attic and second floor diaphragms.
- Falling hazards: Tie wires will be installed through each clay tile and fastened to the roof sheathing.

The proposed seismic retrofit measures illustrate one feasible approach to achieving a Level IV rating. The concepts represent the expected scope and nature of retrofitting required and are appropriate for planning purposes. Alternate designs should be considered when a retrofit project is undertaken. Any retrofit project will also trigger work to architectural and building systems, which will need to be included in planning and budgeting.

SHEET NOTES:

- (E) CONCRETE SHEAR WALL WITH OPENINGS
- (E) WOOD SHEAR WALL WITH STRAIGHT SHEATHING AND OPENINGS
- (N) PLYWOOD SHEAR WALLS UP TO UNDERSIDE OF SECOND FLOOR ONLY
- (N) STRIP FOOTINGS UNDER (N) PLYWOOD SHEAR WALLS
- (E) FOOTINGS NOT SHOWN



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ARCATA, CA
CAL POLY HUMBOLDT

DATE
01/31/2025

SKETCH TITLE
FOUNDATION AND FIRST FLOOR FRAMING PLAN

SKETCH #
SSK-1

SHEET NOTES:

- (E) CONCRETE SHEAR WALL WITH OPENINGS
- (E) WOOD SHEAR WALL WITH STRAIGHT SHEATHING AND OPENINGS
- (N) WOOD SHEAR WALL BELOW
- OUT-OF-PLANE WALL TIE AT 32" O.C. (EVERY OTHER JOIST), TYPICAL AT CONCRETE WALLS WEST OF GRIDLINE 3 WHERE JOISTS ARE PERPENDICULAR
- OUT-OF-PLANE WALL TIE AT 36" O.C., TYPICAL AT CONCRETE WALLS WEST OF GRIDLINES 3 WHERE JOISTS ARE PARALLEL
- OUT-OF-PLANE WALLS TIES AT 5'-0" O.C. TYPICAL AT INTERIOR CONCRETE WALLS WHERE JOISTS ARE PARALLEL
- CROSS-TIES IN N-S DIRECTION AT SPLICED JOISTS AT 8'-0" O.C. TYPICAL AS SHOWN ABOVE (E) WOOD BEARING WALLS OR BEAMS
- CROSS-TIES IN E-W DIRECTION AT LOCATIONS OF SPLICED TOP PLATES OR BEAMS AT THE (E) WOOD BEARING WALLS
- DEMOLISH AND RE-BUILD RAISED FLOOR AT TYICAL SECOND FLOOR ELEVATION

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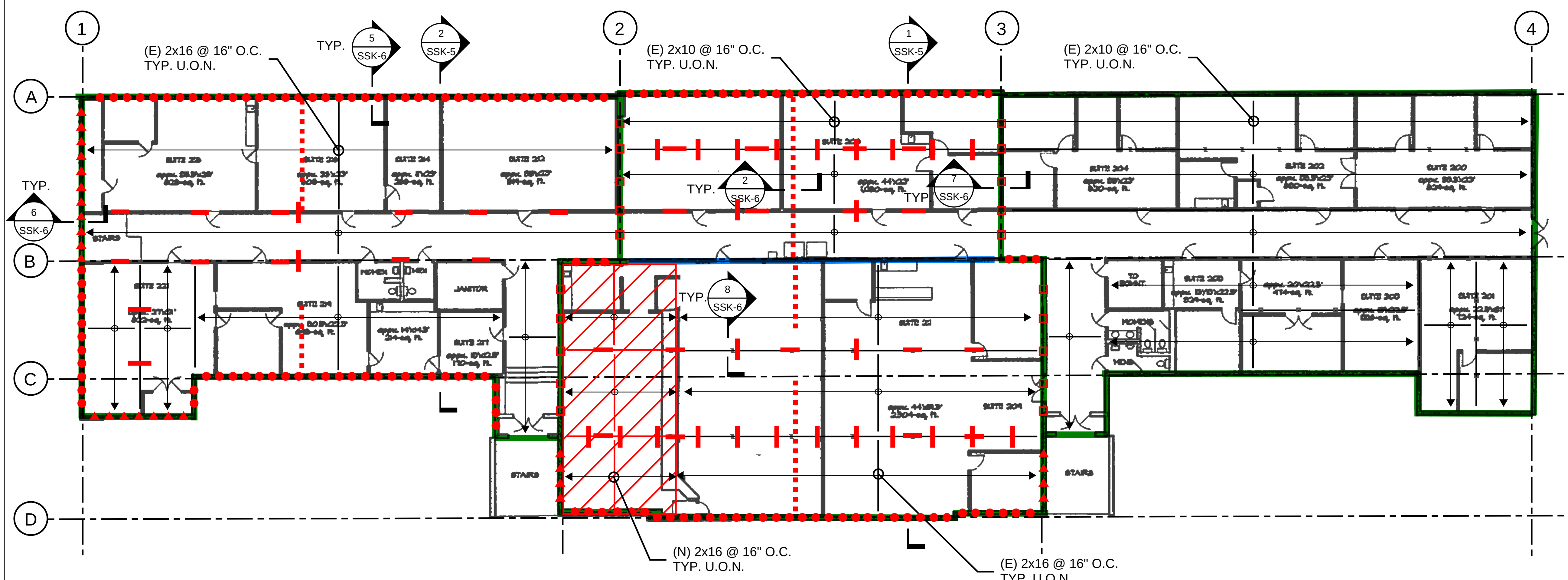

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SKETCH TITLE

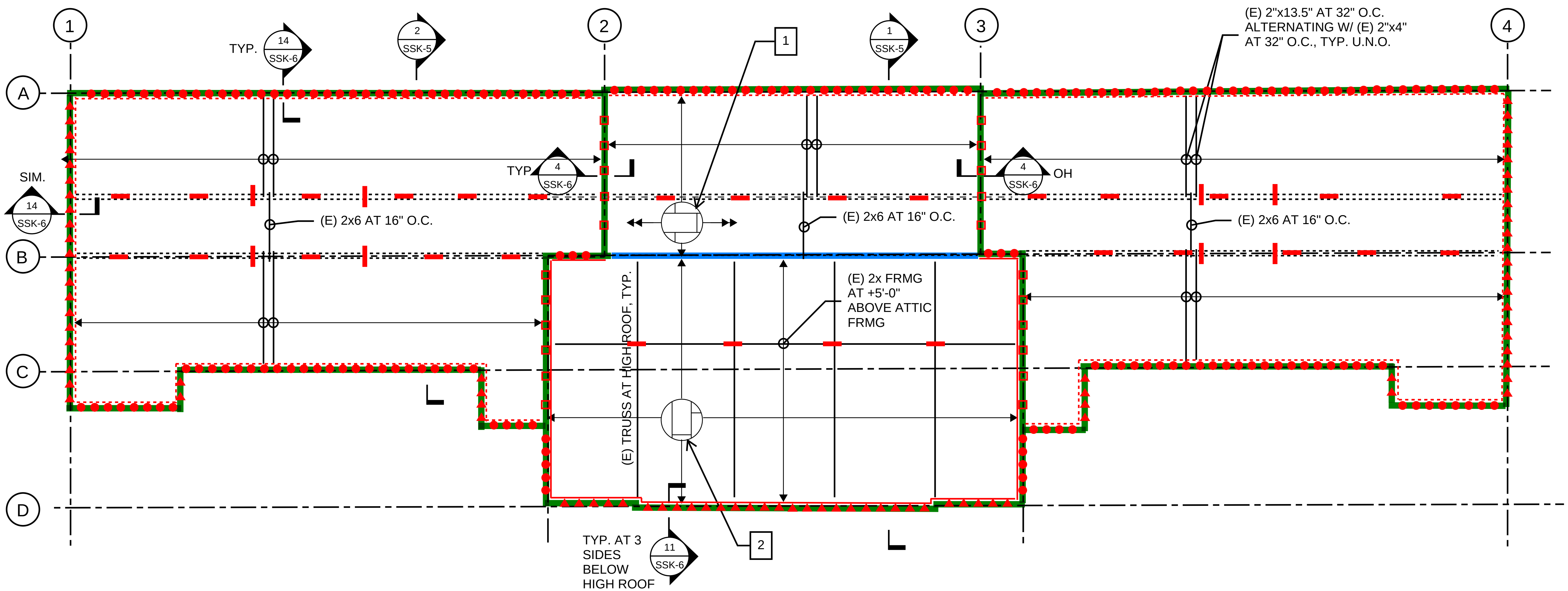
SECOND FLOOR FRAMING PLAN

SKETCH #

SSK-2

SHEET NOTES:

- (E) CONCRETE SHEAR WALL WITH OPENINGS BELOW
- (E) WOOD SHEAR WALL WITH STRAIGHT SHEATHING AND OPENINGS
- (E) WOOD BEARING WALL
- 1 (E) 1/2" PLYWOOD SHEATHING AT UNDERSIDE OF ATTIC FRAMING W/ EDGE NAILING AT 5" O.C., ALL EDGES BLOCKED
- 2 (E) 3/8" PLYWOOD SHEATHING OVER 2x FRMAING AT +5'-0" ABOVE ATTIC FRAMING
- OUT-OF-PLANE WALL TIE AT 32" O.C. (EVERY 2"x13.5" JOIST), TYPICAL WHERE JOISTS ARE PERPENDICULAR TO WALL
- OUT-OF-PLANE WALL TIE AT 36" O.C., TYPICAL WHERE JOISTS ARE PARALLEL TO WALL
- OUT-OF-PLANE WALL TIE AT 5'-0" O.C. AT INTERIOR CONCRETE WALLS WHERE JOISTS ARE PARALLEL
- CROSS-TIES IN N-S DIRECTION AT SPLICED JOISTS AT 8'-0" O.C. TYPICAL ABOVE (E) WOOD BEARING WALLS
- CROSS TIES IN E-W DIRECTION AT LOCATIONS OF SPLICED TOP PLATES OR BEAMS AT (E) WOOD BEARING WALLS. LOCATIONS TO BE FIELD VERIFIED.
- PLYWOOD AT (E) CRIPPLE WALL AT HIGH ROOF ATTIC
- PLYWOOD SPANNING FROM MAIN ROOF SHEATHING ABOVE TO CONCRETE WALL BELOW AT PERIMETER OF MAIN ROOF



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SKETCH TITLE
ATTIC FRAMING PLAN

SKETCH #
SSK-3

SHEET NOTES:

(E) CONCRETE SHEAR WALL BELOW WITH OPENINGS BELOW

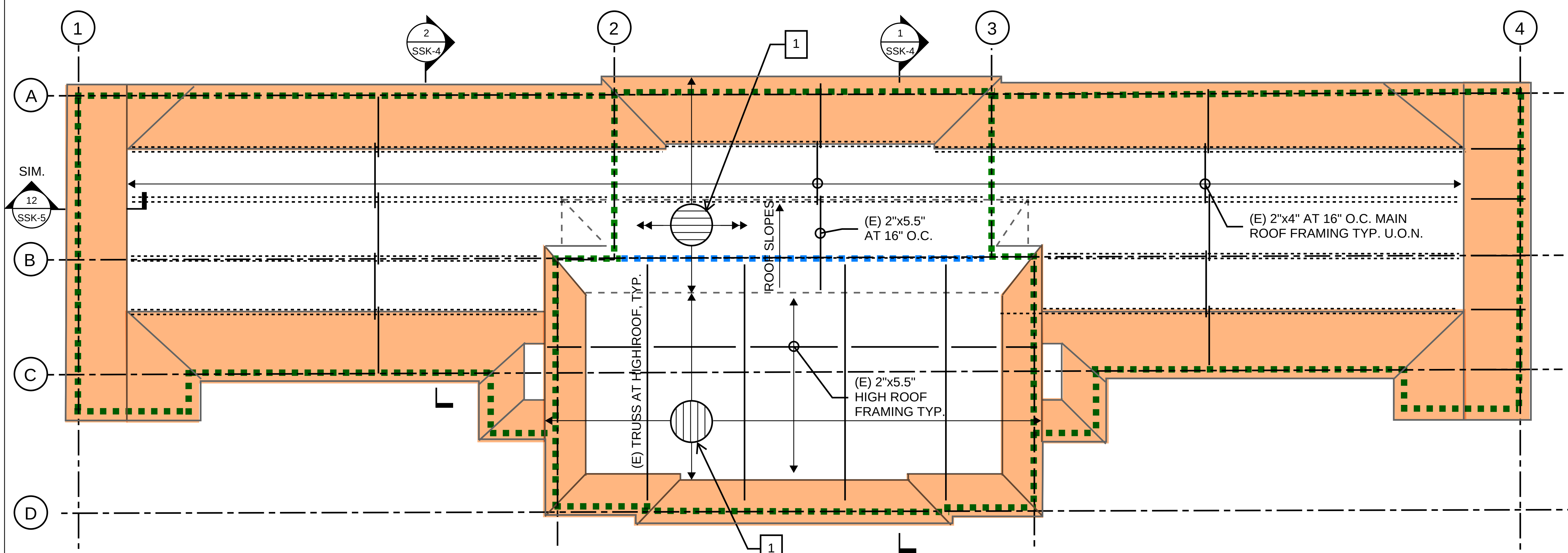
(E) WOOD SHEAR WALL BELOW WITH STRAIGHT SHEATHING AND OPENINGS

(E) WOOD BEARING WALL OR CRIPPLE WALL BELOW

(E) CLAY TILES TO BE FASTENED TO (E) STRAIGHT SHEATHING WITH STAINLESS STEEL TIE WIRES AND SCREWS.

(E) SHINGLES AND ROLLED ROOFING TO REAIN.

1 (E) 1x6 STRAIGHT SHEATHING TO REMAIN.



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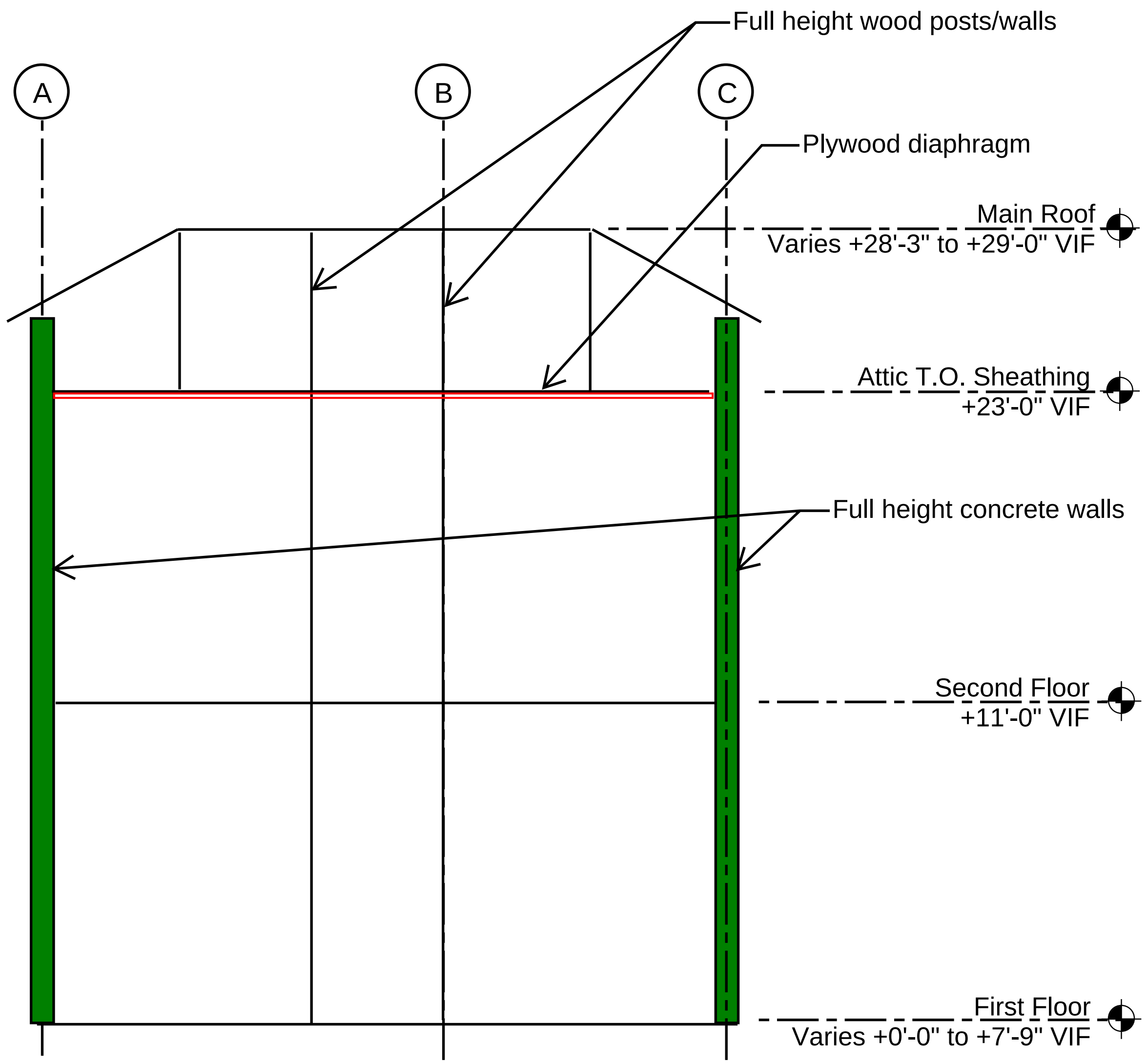
SKETCH TITLE
ROOF FRAMING PLAN

SKETCH #
SSK-4



2 TYPICAL SECTION
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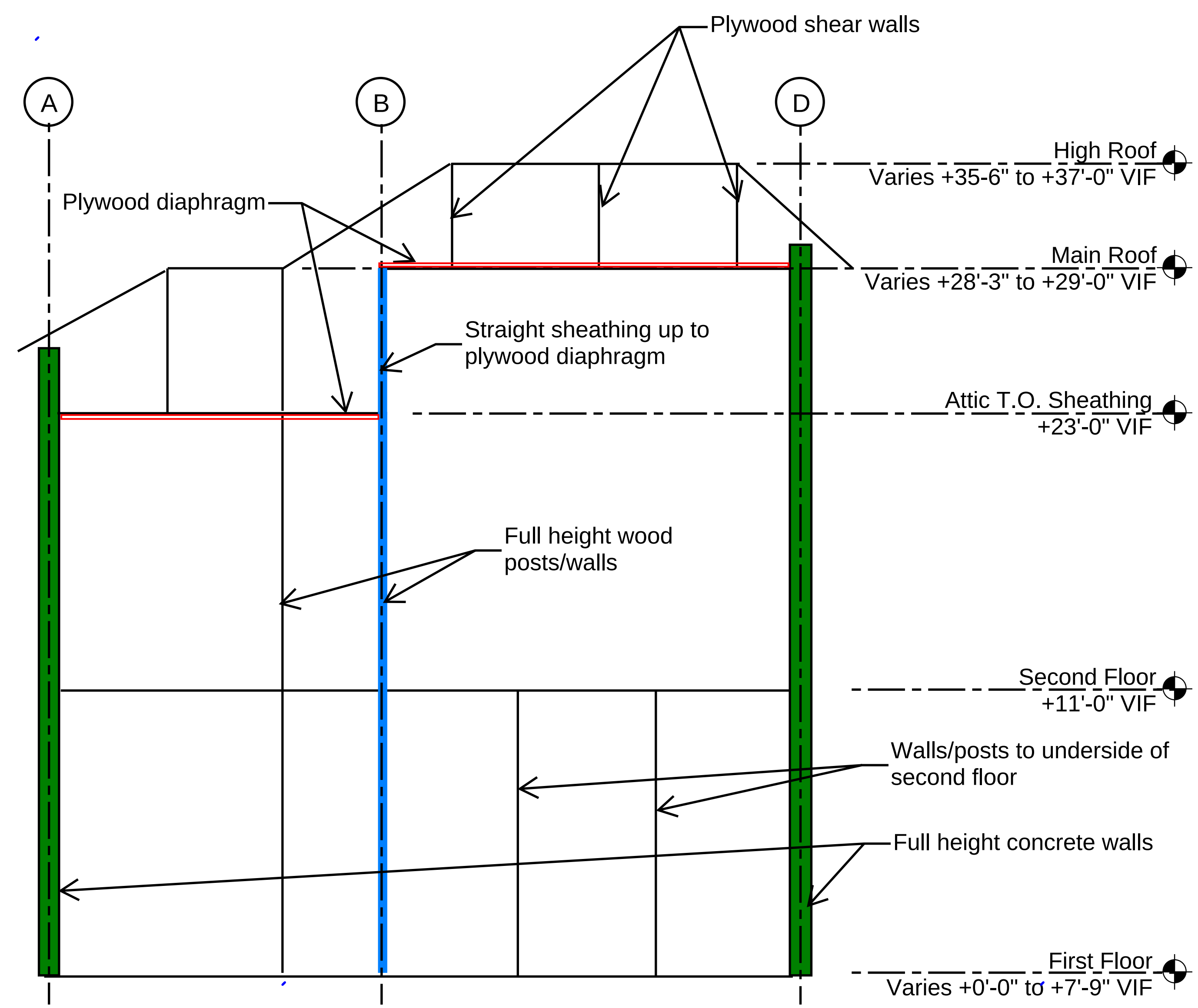

1 SECTION AT HIGH ROOF
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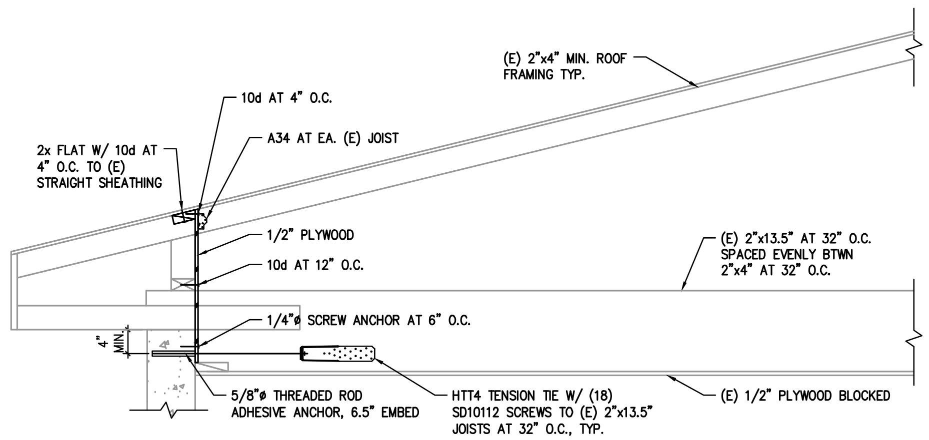
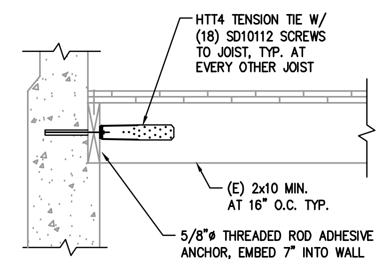
SKETCH TITLE
TYPICAL SECTIONS

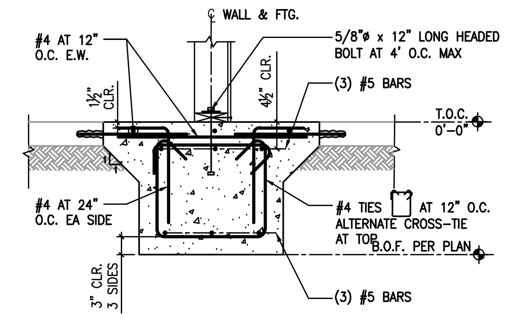
SKETCH #
SSK-5



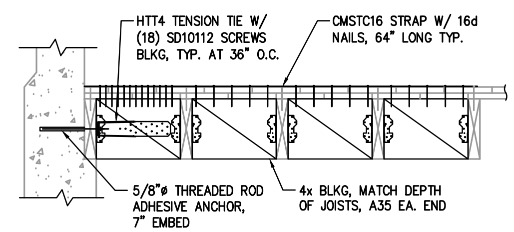
14 OOP WALL ANCHOR AT ATTIC LONGITUDINAL WALLS AND IN-PLANE SHEAR TRANSFER FROM ROOF TO EXTERIOR WALLS
NOT TO SCALE



5 OOP WALL ANCHOR AT SECOND FLOOR LONGITUDINAL WALLS
NOT TO SCALE



1 (N) FDN AT WOOD SHEAR WALL
NOT TO SCALE



6 OOP WALL ANCHOR AT SECOND FLOOR EXT. TRANSVERSE WALLS
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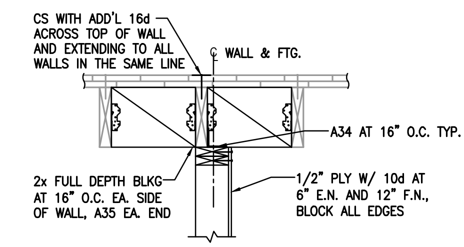
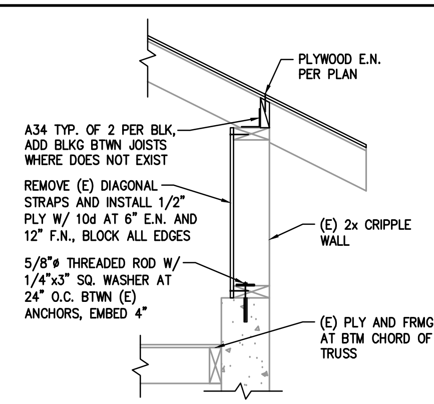
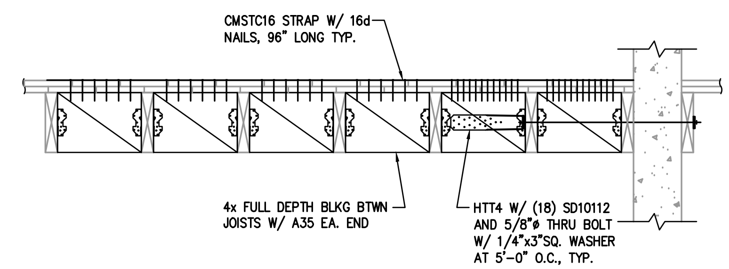


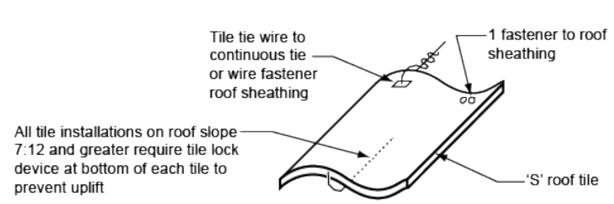
2 TOP OF (N) WOOD SHEAR WALL
NOT TO SCALE



11 CRIPPLE WALL AT HIGH ROOF
NOT TO SCALE

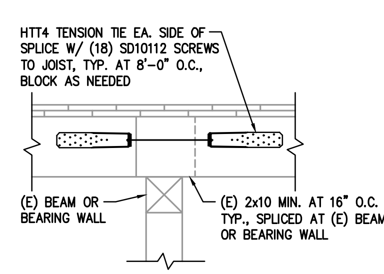


7 OOP WALL ANCHOR AT SECOND FLOOR INTERIOR TRANSVERSE WALLS
NOT TO SCALE

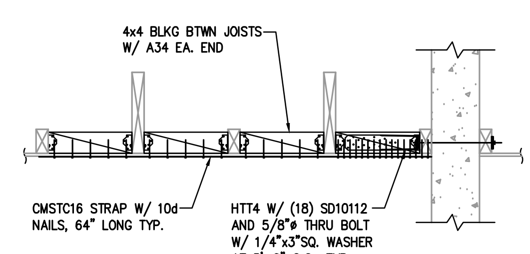


NOTE: DETAIL TAKEN FROM DSA IR 15-1.

12 SECURING CLAY TILES
NOT TO SCALE



8 CROSS-TIE AT JOIST SPLICE
NOT TO SCALE



4 OOP WALL ANCHOR AT ATTIC INTERIOR TRANSVERSE WALLS
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