

Procedure for Identifying UC Buildings with a Seismic Performance Rating of Va

The purpose of a Va rating is to identify those buildings that pose less potential risk during a major seismic event than a building rated V. A building can be classified as a Va by a Consulting Structural Engineer if it complies with the steps below and none of the exclusions apply.

Application of the Procedure

The choice to pursue identification of Va buildings is optional and at the discretion of the individual campus. The categorization can be made by the Consulting Structural Engineer (CSE) who evaluated the building or by a different CSE. It only applies for Risk Category I, II, and III buildings. UCOP reserves the right to select and audit buildings that campuses have submitted as Va ratings and have the submittal reviewed by the UC Seismic Advisory Board (SAB). In such cases, the UC SAB's determination of Va vs. V status will govern.

Required Steps of the Procedure

Step 1: Conduct a seismic evaluation and assign a rating as required by the *UC Seismic Safety Policy* and *UC Seismic Program Guidelines*. This will typically either be an ASCE/SEI 41-23 Tier 1 or Tier 2 evaluation when drawings are available, or a FEMA P-154 Level 2 evaluation when drawings are not available. If an ASCE/SEI 41-23 Tier 3 evaluation has resulted in an SPR of V, then the building is not eligible for using this categorization procedure. A previous seismic evaluation may be used if it meets the requirements of the *UC Seismic Program Guidelines*. If a SPR V rating is determined, move to Step 2.

Step 2: Confirm the building is eligible for the procedure. It must be a Risk Category I, II, or III structure.

Step 3: For buildings with an SPR=V rating, identify those with any of the features indicated in Table 1. Such buildings are considered to have a higher risk of collapse in strong shaking; their performance during a major seismic event is anticipated to result in significant structural and nonstructural damage and/or falling hazards that would represent appreciable life hazards. These features *preliminarily* remove the building from being identified with a Va rating (see *Step 6*).

Table 1: Features that Preliminarily Remove the Building from Possible Va Status

ASCE/SEI 41-23 Common Building Type	Description	Feature/Discussion
All	Significant Deterioration or Damage	Tier 1 on-site evaluation per ASCE/SEI 41-23 Section 4.2.1 and Table 4-1 finds construction defects, damage, or deterioration that would have a significant effect on seismic performance.
All	Significant Load Path Deficiency	Tier 1 drawing review or on-site evaluation per ASCE/SEI 41-23 finds a significant load path deficiency, in either an unretrofitted building or a retrofitted building, such as an incomplete retrofit where connections between the diaphragm and the vertical elements of the lateral force-resisting system are missing.

ASCE/SEI 41-23 Common Building Type	Description	Feature/Discussion
W1/W2	Wood frame	<p><i>The building has one or more of the following features:</i></p> <p><i>It is on a slope with a grade change of more than one-half story within the building footprint and the seismic force-resisting system on the downslope side is not wood shear wall (unless the bottom story uses concrete shear walls, and they meet the Tier 1 Quick Check requirements). It is on a slope with a grade change of more than one-half story within the building footprint and poor strength on the downslope side wood shear walls. These include “hillside homes,” many of which had severe damage or collapsed in the 1994 Northridge Earthquake. Poor <u>strength</u> resistance in this context goes beyond the ASCE/SEI 41-23 Tier 1 W1 and W2 Collapse Prevention Structural checklist definition of a hillside site where a non-compliant statement requires all walls on the downhill side to have a vertical-to-horizontal aspect ratio of more than 1-to-1. Poor strength resistance on the downslope side here is defined as (1) an overall sum of wall lengths less than half the sum of the wall length of the parallel upslope walls (when upslope walls at the lowest story are present) or (2) shear stress Quick Check of the seismic force-resisting system on downslope wall line with less than 50% of the required capacity, assuming tributary area distribution to the downslope line.</i></p> <p><i>It has an extreme weak ground story:</i> These include tuckunder buildings which collapsed and caused fatalities in the 1994 Northridge Earthquake. A comparative threshold such as an extreme weak story irregularity could be used. ASCE/SEI 7-16 uses 65% of the strength of the story above for its definition of extreme weak story. For consistency, the same definition is used here. This is less restrictive than the ASCE/SEI 41-23 Tier 1 Collapse Prevention Basic Configuration Checklist criteria of 80%.</p>

ASCE/SEI 41-23 Common Building Type	Description	Feature/Discussion
S1/S1a	Steel moment frames	<p><i>The building has Pre-Northridge moment frame details plus one of the following features:</i></p> <p><i>Failure of Tier 1 or Tier 2 strong column-weak beam (SCWB) requirements.</i></p> <p><i>The site is in a location where strong impulsive ground motions are anticipated, defined as within 5 km of the closest edge of an Alquist-Priolo Zone.</i></p> <p>These buildings, while damaged in the 1989 Loma Prieta and 1994 Northridge Earthquakes, have not collapsed. However, it can be argued that they have not experienced design earthquake level shaking, so the lack of observed collapses does not necessarily indicate a lack of vulnerability. Having a Pre-Northridge connection is not sufficient to move a building out of the Va category (or potentially even from SPR=IV to V), but when coupled with a potential concerning weak column-strong beam (WCSB) story mechanism or impulsive ground motions, this is not permitted.</p>
S2/S2a	Steel braced frames	<p><i>The building has one of the following features:</i></p> <p><i>It does not meet the ASCE/SEI 41-23 Tier 1 S2/S2a Collapse Prevention Structural Checklist Low Seismicity “Redundancy” evaluation statement (i.e., the number of lines of braced frames in each principal direction is not greater than or equal to 2) and the building does not have a complete steel framed vertical load-carrying system. A concern with steel braced frames is that they are expected to be particularly sensitive to a lack of redundancy.</i></p> <p><i>The building has an extreme weak story deficiency, as defined above for W1/W2 buildings. An extreme weak story would be an unusual, but concerning, feature in a braced frame building, increasing the likelihood of a story mechanism and potential collapse.</i></p>
S3	Metal building frames	<p>Typically, given their historically adequate performance in earthquakes, these buildings would be assigned to the Va category, unless they have very unusual features, such as heavy cladding such as concrete or masonry, or if braces have been removed or cut. Note that S3 buildings only include one-story structures, with or without a mezzanine.</p>

ASCE/SEI 41-23 Common Building Type	Description	Feature/Discussion
S4	Dual system with backup moment frame	This is a relatively unusual building type with steel gravity framing, a backup steel moment frame design to resist 25% of the seismic design forces, and a primary system of either steel braced frames or concrete shear walls. Typically, these buildings would be assigned to the Va category unless they have an unusual feature, like an extreme weak story, as defined above for W1/W2 buildings.
S5/S5a	Steel frame with infill masonry	<i>Extreme weak story, as defined above for W1/W2 buildings.</i> Steel frame infill buildings are rarer than concrete frame infill buildings, and steel frame infill buildings have typically performed better than concrete frame infill buildings. Steel frame infill buildings would likely be assigned to the Va category unless they have an extreme weak story, as defined above for W1/W2 buildings.
C1	Concrete moment frames	<p><i>The building has one of the following features: It has an extreme weak story, as defined above for W1/W2 buildings. It does not meet the Tier 1 or Tier 2 strong column-weak beam requirements. The seismic force-resisting system is a frame consisting of columns and a slab or plate without beams. It does not meet the Tier 1 captive column evaluation statement criterion.</i></p> <p>Pure C1 buildings are relatively rare, so empirical evidence is limited. However, older concrete moment frames with these characteristics are at risk of a brittle story mechanism and are not eligible for the Va rating. Note that the C1 building type is presumed to only have moment frames as the seismic force-resisting system, and not have infill frames (which would be C3/C3a infills) or small walls (which would be C2).</p>

ASCE/SEI 41-23 Common Building Type	Description	Feature/Discussion
C2/C2a	Concrete shear walls	<p><i>The building has one of the following features</i></p> <p><i>Extreme weak story, as defined above for W1/W2 buildings.</i></p> <p><i>Shear wall Tier 1 Quick Check demand-to-capacity ratios over 1.5 in either principal direction and the Tier 1 torsion evaluation statement criterion is not met.</i></p> <p><i>Shear wall Tier 1 Quick Check demand-to-capacity ratios over 1.75 in either principal direction and the Tier 1 torsion evaluation statement criterion is met.</i></p> <p><i>In a C2a building, wall-to-diaphragm connections that (a) rely on cross grain bending, (b) use strap anchors that twist and connect to the side of the top of purlins, or (c) are other connections with a Tier 2 demand-to-capacity ratio over 1.6.</i></p> <p>This is one of the most common and most challenging building types to evaluate. The ATC-78 project focused on this building type and led to FEMA P-2018. Its evaluation method is not consistent though with the ASCE/SEI 41-23 and UC Seismic Performance Rating framework. Buildings with extreme weak stories, high shear wall demands and cross grain or other poor wall-to-diaphragm connections (in a C2a building) pose a potential risk of collapse.</p>
C3/C3a	Concrete frame with infill masonry	<p><i>The building has one of the following features:</i></p> <p><i>Extreme weak story, as defined above for W1/W2 buildings.</i></p> <p>Weak story nonductile concrete infill buildings have collapsed in many earthquakes.</p> <p><i>In a C3a building, wall-to-diaphragm connections that (a) rely on cross-grain bending, (b) use strap anchors that twist and connect to the side of the top of purlins, or (c) are other connections with a Tier 2 demand-to-capacity ratio over 1.6.</i></p> <p><i>It does not meet the ASCE/SEI 41-23 Tier 1 C3/C3a Collapse Prevention Structural Checklist Low and Moderate “Shear Stress Check” evaluation statements (for reinforced masonry or unreinforced masonry as applicable).</i></p>

ASCE/SEI 41-23 Common Building Type	Description	Feature/Discussion
PC1/RM1	Tilt-up and reinforced masonry with flexible diaphragms	<p><i>The building has one of the following features:</i> <i>Extreme weak story, as defined above for W1/W2 buildings.</i> This would be unusual in this building type. <i>Wall-to-diaphragm connections that (a) rely on cross-grain bending, (b) use strap anchors that twist and connect to the side of the top of purlins, or (c) are other connections with a Tier 2 demand-to-capacity ratio over 1.6.</i> There are examples of collapse and partial collapse of buildings with cross-grain bending details in the 1964 Anchorage, 1971 San Fernando, 1987 Whittier, 1989 Loma Prieta, and 1994 Northridge Earthquakes. Note that buildings with original or retrofit details that do not rely on cross-grain bending, have complete load paths, and have some form of cross ties, but have reasonable wall-to-diaphragm connections that do not meet the full strength demands of ASCE/SEI 41-23 or ASCE/SEI 7-16 could typically be assigned to the Va category.</p>
RM2	Reinforced masonry with rigid diaphragms	<p><i>The building has an extreme weak story, as defined above for W1/W2/W1a buildings.</i> This would be unusual in this building type. This building type is much less common than RM1 in California.</p>
URM	Unreinforced masonry bearing wall buildings with flexible diaphragms	<p><i>Unretrofitted or partially retrofitted URM.</i> An unretrofitted URM is thought by many to be one definition of an SPR=VI building, so it would be unusual for it to have even received an SPR=V rating after the initial evaluation. There are many examples of URM building collapses in earthquakes around the world and in California. To be eligible for an SPR=V, the retrofit needs to be comprehensive and address the full load path and key structural elements. The building must have been evaluated and retrofit to the Special Procedure or the General Procedure of the ABK, Los Angeles Division 88, UCBC, IEBC; ASCE/SEI 41 Special Procedure for Unreinforced Masonry standard; or a similar standard. Buildings retrofit to lower performance objectives are not eligible for a rating of Va.</p>
URMa	Unreinforced masonry bearing wall buildings with rigid diaphragms	<p><i>Unretrofitted or partially retrofit URM.</i> URMa buildings are much less common in California than URM buildings, but there are examples. Though heavier, URMa buildings are expected to behave somewhat better than URM buildings. It would still be unusual for them to have even received an SPR=V rating after the initial evaluation.</p>

Step 4: If the site is located in a mapped Seismic Hazard Zone for surface fault rupture, liquefaction, or landslides, the geologic hazard must be assumed to be present, unless it can be demonstrated not to exist at the site. If a geological hazard is present, or assumed to be present, the building is not eligible for the Va rating, unless appropriate justification is provided to assign Va.

Step 5: If there are potentially significant falling hazards associated with the building, such as unbraced parapets or unanchored gable walls over exit paths, the building is not eligible for the Va rating, unless appropriate justification is provided to assign Va.

Step 6: Apply engineering judgment to make a final proposed assignment of Va when warranted. For example, substantial strength or redundancy could be a mitigating factor for some of the deficiencies in the table above. There could be other features that also mitigate risk that are not typical and cannot be added to the general table above, but should be considered in the categorization on a building-specific basis. Similarly, there may be building-specific deficiencies of significance not identified in Step 3 that would downgrade a preliminary Va assignment to a final V assignment.

Step 7: Complete draft version of *UC Seismic Program Guidelines Certificate of Va Seismic Performance Rating Determination*.

Step 8: Confirm the Va assignment with review by a peer reviewer or a campus seismic review committee. If the CSE and the peer reviewer/campus seismic review committee do not agree, the UC SAB can be consulted to make the final resolution. During the peer review process, the peer reviewer should review the original report, and non-compliant ASCE/SEI 41-23 statements should be discussed with the CSE. The importance of ASCE/SEI 41-23 non-compliant statements varies, and the features of leading to some non-compliant statements may not necessarily have a significant impact on the likelihood of collapse.

Step 9: Provide final stamped documentation of the Va rating and the supporting rationale to UCOP. This will be an update, as needed, of the preliminary documentation in Step 7 that incorporates any revisions following peer review, identifies the peer reviewer or seismic review committee, and includes the statement that the peer reviewer or seismic review committee was in agreement with the categorization.