
VOLUNTARY SEISMIC UPGRADE: 2022 CAC

Disciplines: Structural**History:** Issued 03/19/24 Under 2022 CAC

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PURPOSE

This Interpretation of Regulations (IR) clarifies requirements for construction work voluntarily proposed by a school district (i.e., building owner) to improve the performance of an existing building in a seismic event when a rehabilitation is not required by the regulations. Voluntary modifications for the benefit of seismic response are addressed by both the California Administrative Code (CAC) and the California Existing Building Code (CEBC). This clarification is intended to encourage voluntary improvement of school buildings' seismic performance by elevating knowledge of these regulations and bringing greater consistency to their enforcement.

SCOPE

This IR is applicable to design and construction work proposed in existing buildings categorized as alterations and some types of additions and reconstructions. Within the context of these projects, this IR applies when a school district (i.e., building owner) elects to perform construction work to improve the performance of the building subject to an earthquake in the absence of a code mandate to do so. It is not applicable to new construction, structurally detached additions, or rehabilitation projects.

This IR does not address conditions requiring rehabilitation per CAC Section 4-309(c), which are addressed in *IR EB-4: Rehabilitation Required by Cost* and *IR EB-5: Rehabilitation Required by Scope*.

BACKGROUND

The CAC contains numerous provisions addressing new construction work in existing certified school buildings, which is generally categorized as reconstruction, alteration, addition, or rehabilitation. Refer to *IR EB-1: Existing Building Regulations Overview* for further information concerning different types of work in existing buildings.

When a rehabilitation is not mandated by the regulations, both the CAC and CEBC provide for work that increases the strength or stiffness of a building under lateral loading, generally referring to this as “voluntary lateral force-resisting system modifications”. CAC Section 4-309(d) refers the code user to California Building Code (CBC) Section 1609A for wind loading conditions and CEBC Section 317.11 for earthquake loading conditions. CEBC Section 317.11 further refers to CEBC Section 319.12, which defines certain limitations the proposed work is required to comply with.

1. GENERAL

While CAC Section 4-309(d) addresses voluntary modifications to strengthen or stiffen a building's lateral force resisting system under either wind or seismic load conditions, it is recognized that such work is most commonly undertaken to improve the building response to a seismic event. Furthermore, the provisions of the CEBC pertaining to “voluntary lateral force-resisting system modifications” are specific to seismic response.

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For these reasons and as suggested by its title, this IR focuses on voluntary work purposed to improve seismic performance; however, the principles described herein may be extended to the rarer project in which the proposed work intends to improve building performance under wind loads.

1.1 Voluntary Seismic Upgrade

Throughout this IR the phrase “voluntary seismic upgrade” refers to work described by the CAC and CEBC as “voluntary lateral force resisting system modifications”.

1.1.1 Improving the performance of a building subjected to a seismic event is not always limited to “increasing the strength or stiffness of the lateral force resisting system”. For example, in an existing building with concrete or masonry walls and a flexible roof diaphragm, the greatest benefit to building performance may be strengthening the anchorage connections between the roof and walls. While such work neither strengthens nor stiffens the lateral force resisting system, when not mandated by the regulations DSA generally considers such work to fall under the umbrella of a voluntary seismic upgrade as addressed in this IR. This broader definition of voluntary seismic upgrade is supported by CEBC Section 317.11.

1.1.2 In accordance with CAC Section 4-306 and as noted in *IR EB-3: Evaluation and Design Criteria Report*, Section 1.5.5, a school district may elect to rehabilitate an existing school building when a rehabilitation is not otherwise required by the regulations. In such a case, the project is a rehabilitation, not a voluntary seismic upgrade as described in this IR, even if the rehabilitation is voluntarily performed.

1.2 Project Scope

Voluntary seismic upgrade work may be proposed as the entire scope of a project or in conjunction with other work being proposed in the existing building. Depending on the context of the proposed project scope, the voluntary seismic upgrade may occur in an alteration, reconstruction, or structurally attached addition. Refer to IR EB-1 for additional information on project types in existing buildings.

1.2.1 When the voluntary seismic upgrade work represents the entire scope of proposed work, the project is categorized as an alteration.

1.2.2 When modernization work is planned in an existing building (i.e., an alteration), design professionals are encouraged to evaluate and advise the school district concerning potential voluntary seismic upgrade work and enhanced safety. A construction cost benefit can often be realized when coordinating voluntary seismic upgrade work with demolition and new finishes that may already be included in the modernization scope of work.

1.2.3 When a reconstruction project is undertaken to repair damage caused by an earthquake or wind event, a voluntary seismic upgrade is not applicable. In accordance with CAC Section 4-309(e), such a reconstruction shall “comply with currently effective regulations.”

1.2.4 When a reconstruction project is undertaken to repair damage caused by a fire, the Exception of CAC Section 4-309(a) and Education Code Section 17280(b) may be invoked, which permits the reconstruction in accordance with the original approved construction documents of the existing building. If a voluntary seismic upgrade is proposed to be included with such a reconstruction, the project shall be submitted to DSA for review and approval.

1.2.5 When a reconstruction project is undertaken to repair damage caused by a source other than that described in Section 1.2.3 or 1.2.4 above and a rehabilitation is not required by the regulations, voluntary seismic upgrade work may be included as part of the reconstruction project.

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1.2.6 When an addition is structurally detached, a voluntary seismic upgrade is not applicable to the construction of the new addition. The independent structure comprising the addition shall be designed as new construction in accordance with the CBC. If a rehabilitation is not required by the regulations, voluntary seismic upgrade work to the existing building may be included.

1.2.7 When a new addition is structurally attached and a rehabilitation is not required by the regulations, voluntary seismic upgrade work in the existing building may be included as part of the addition.

1.3 Mandatory Strengthening Thresholds

Voluntary seismic upgrade work shall be proposed for the purpose of improving the performance of the building. It is not a mechanism to circumvent mandatory retrofit thresholds in the regulations by offsetting other proposed work that reduces the strength or stiffness of the existing lateral force resisting system.

1.3.1 CAC Section 4-309(a) requires affected components of the lateral force resisting system to be made compliant with the current regulations when certain thresholds are exceeded. In such cases, the retrofit criteria for those components is defined by the regulations and cannot be determined by the project applicant as described in Section 2 below. However, it is acceptable for a project to include a combination of some components retrofitted as required by CAC Section 4-309(a) and others retrofitted in accordance with a voluntary seismic upgrade criteria defined by the project applicant, provided that these groups are clearly identified and differentiated on the construction documents per Section 2.1 below.

1.3.2 CAC Section 4-309(c), Item 1 requires a rehabilitation of the existing building when the project cost exceeds the threshold specified by the regulation. In most cases, the project cost of voluntary seismic upgrade work can be excluded from this cost comparison. This exclusion does not apply when the building is located within 50 feet of the trace of an active fault. Refer to IR EB-4 Sections 2.1.5 and 2.2.2 for further information.

1.3.3 CAC Section 4-309(c), Item 2 requires a rehabilitation of the existing building when certain scope thresholds are exceeded. These regulations specifically exclude “any new strengthening as part of the project”, so voluntary seismic upgrade work cannot be used to avoid a rehabilitation. Refer to IR EB-5 for additional information on implementing the comparisons required by CAC Section 4-309(c), Item 2.

1.4 Limitations

While the voluntary approach offers the project applicant flexibility in the degree and priorities of seismic upgrade work, CEBC Section 319.12 establishes five specific limitations required for compliance.

1.4.1 The capacity (i.e., strength and stiffness) of an existing structural component resisting seismic forces shall not be reduced unless compliance with CEBC Section 319.8 is demonstrated, which shall be determined using the seismic demand, load combinations, and acceptance criteria required by CEBC Section 317.5 or 317.7. The Exception of CEBC Section 319.8 is not commonly applied to this case because it requires a broader evaluation of the seismic force resisting system, similar to that of a rehabilitation. See also Section 1.3.1 above.

1.4.2 The seismic load delivered to an existing component cannot be increased to the extent that its resulting required strength exceeds its capacity. The required strength and acceptance criteria of the existing component shall be determined using the seismic demand, load combinations, and acceptance criteria required by CEBC Section 317.5 or 317.7. See also Section 1.3.1 above.

1.4.3 New structural components shall comply with the detailing and connection requirements of the CBC and its adopted standards.

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1.4.4 New or relocated nonstructural components shall be anchored or braced as required by the current CBC. Regardless of whether voluntary seismic upgrade work is included in the project scope, CAC Section 4-309(b) requires existing noncompliant nonstructural components to be anchored and braced as required by the CBC.

1.4.5 A dangerous condition shall not be created.

1.4.5.1 As a general principle, voluntary seismic upgrade work should not create a structural irregularity where one did not previously exist nor make more severe an existing irregularity. Such results relative to prohibited irregularities will trigger a rehabilitation in accordance with CAC Section 4-309(c), Item 2C; refer to IR EB-5 Section 4 for additional information.

1.4.5.2 Identification of a “dangerous condition” requires a project-specific evaluation. If the project applicant is unsure if a specific condition will be deemed dangerous, it should be explained and discussed with DSA at a preapplication meeting.

1.5 Typical Project Requirements

The requirements summarized in this subsection, apply to all projects under DSA jurisdiction. Though not specific to voluntary seismic upgrade work and not inclusive of all typical project requirements, they are noted for the value of the reminder.

1.5.1 Geotechnical and geohazard investigation and reporting requirements per CBC Section 1803A apply to projects including voluntary seismic upgrade work. Refer to *IR A-4: Geohazard Report Requirements*, Section 2.6 for additional information.

1.5.2 New work in an existing building with a past uncertified project must address and resolve the certification issue. Refer to *IR A-20: New Projects Associated with Existing Uncertified Projects* for additional information.

2. DESIGN BASIS

The design basis of voluntary seismic upgrade work is defined by the project applicant within the limitations described in Section 1.4 above. The project applicant consists of the school district (i.e., building owner), with whom rests final decisions, and the design professionals who advise the school district relative to design options, seismic performance, and other technical matters. DSA will review and approve the proposed voluntary seismic upgrade relative to its compliance with the design basis established by the project applicant.

2.1 Documentation of Design Basis

In accordance with CEBC Section 319.12.2, the design basis of the voluntary seismic upgrade shall be clearly and comprehensively defined on the construction drawings. This definition includes scope, design criteria, evaluation methodology, and acceptance criteria.

2.1.1 The scope of work statement required on the cover sheet or front-end general notes sheet of all DSA projects shall identify those buildings that are subject to a voluntary seismic upgrade. The details of the design basis may be included in this same location or at another location in the drawings set (e.g., the general notes sheet of the structural drawings) that is explicitly referenced from this location.

2.1.2 The drawings shall define the scope of the voluntary seismic upgrade by differentiating between those components of the existing building that are evaluated in accordance with the design and acceptance criteria and those that are not. Among those components that are evaluated, the drawings shall further differentiate between those components that require strengthening and those that are found compliant with the defined criteria in their existing condition.

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2.1.3 The drawings shall define the seismic design criteria used in the evaluation and retrofit design of the voluntary seismic upgrade. These criteria commonly involve the definition of the seismic force level(s) in accordance with a consensus standard document. Some of the more common standards used to define seismic design criteria are described in Section 2.2 below.

2.1.4 The drawings shall define the methodology and associated acceptance criteria used in the evaluation and retrofit design of components in the voluntary seismic upgrade. This commonly includes identification of consensus standard documents, and in the case of performance-based design, definition of the performance objective.

2.1.5 Alteration, reconstruction, or addition projects that include voluntary seismic upgrade work do not require an Evaluation and Design Criteria Report (EDCR). Refer to IR EB-3 for additional information.

2.2 Potential Design Options

This section summarizes common seismic design criteria that may be considered by the project applicant. A voluntary seismic upgrade is not required to employ any of these methodologies; the project applicant may instead define an independent design basis. However, when one of these options is elected and identified per Section 2.1 above, it must be applied consistently.

Note: A voluntary seismic upgrade need not employ any of the consensus standards cited for consideration in this section, but doing so simplifies documentation of the design basis per Section 2.1 above. If the project applicant chooses a design basis that does not fully and consistently conform to a consensus standard, the documentation on the drawings must comprehensively define the methodology, design criteria, and acceptance criteria to be used.

2.2.1 The American Society of Civil Engineer (ASCE) Standard 41: Seismic Evaluation and Retrofit of Existing Buildings (ASCE 41) serves as the basis for the performance based seismic design criteria used for rehabilitation projects through its Tier 3 methodology as required by CEBC Section 317.5. ASCE 41 also establishes Tier 1 and Tier 2 procedures, which together comprise a screening and deficiency focused method. Per CEBC Section 319.12 this approach is an acceptable methodology for voluntary seismic upgrades when selected as such by the project applicant.

2.2.1.1 The Tier 1 and 2 method is limited to the performance objectives defined in ASCE 41 Section 3.4.1 and the limitations of Table 3-4.

2.2.1.2 Per ASCE 41 Section 3.4.2 the evaluation shall begin with the Tier 1 screening procedure, performed in accordance with ASCE 41 Chapters 4 and 17 and Appendix A.

2.2.1.3 If the Tier 1 screening identifies deficiencies (i.e., “noncompliant” and “unknown” checklist responses), they shall be further evaluated by the Tier 2 procedure per ASCE 41 Section 3.4.3. This deficiency-based procedure shall be performed in accordance with ASCE 41 Chapter 5 and Appendix A.

2.2.1.4 If the Tier 2 evaluation confirms deficiencies, the project must include retrofit to resolve the deficiencies in accordance with the Tier 2 procedure of ASCE 41 Chapter 5 and Appendix A. If all Tier 2 identified deficiencies are not resolved by the project, then this methodology cannot be cited as the design basis, and the criteria used to determine which deficiencies are addressed must be defined per Section 2.1 above.

2.2.1.5 Voluntary seismic upgrade work performed to remedy deficiencies in accordance with the ASCE 41 Tier 1 and 2 methodology is considered a partial retrofit and shall comply with each of the conditions required by ASCE 41 Section 2.2.5.

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2.2.2 Though not adopted by DSA, CEBC Section 304.3 defines seismic evaluation and design procedures that the project applicant may elect to use as the design basis of the voluntary seismic upgrade.

2.2.2.1 CEBC Section 304.3.1 covers compliance with full seismic forces.

2.2.2.2 CEBC Section 304.3.2 covers compliance with reduced seismic forces, including provisions for those systems specifically addressed in Appendix A of the CEBC.

2.2.2.3 When seismic forces are derived from the CBC as specified in CEBC Section 304.3, the acceptance criteria for elements and connections shall be in accordance with the material and design standards adopted by the CBC.

2.2.3 As noted above, the performance based seismic design criteria used for rehabilitation projects is defined by CEBC Section 317.5. A voluntary seismic upgrade may also use the ASCE 41 Tier 3 methodology but with an alternative (i.e., lesser) seismic performance objective as determined by the project applicant.

3. PROJECT REQUIREMENTS

3.1 Documentation of Existing Construction

The analysis and design of voluntary seismic upgrade work is greatly benefitted by access to the original construction documents from which the existing building (and any prior alterations, additions, or reconstruction) was constructed. Design professionals are encouraged to exhaust all available resources to obtain such original documents. Refer to IR EB-3 Section 1.4 for additional information.

3.1.1 Design professionals are advised that any documents in DSA archives related to the existing building can be obtained by submitting a public records request through the California Department of General Services.

3.1.2 When original construction documents cannot be obtained, the creation of “as-built” documents is not required for a voluntary seismic upgrade. This requirement in CEBC Section 319.2 is applicable to rehabilitation projects.

3.1.3 The project submission to DSA for review and approval shall include all available original construction documents, geotechnical reports, engineering reports, and other similar documents found to be informative and valuable in understanding the existing building. These shall be submitted as supporting documents in accordance with *Procedure (PR) 18-04: Electronic Plan Review for Design Professionals*.

3.2 Data Collection

The data collection requirements of CEBC Section 319.2 are applicable to rehabilitation projects. Data collection in the form of material testing and condition assessment as defined in ASCE 41 is not mandated for voluntary seismic upgrade projects but is recommended to the extent it benefits the design and construction of the new work in the existing building.

3.2.1 In accordance with ASCE 41, material testing may be used to justify expected material strengths greater than that which might otherwise be derived from the original construction documents. When material testing is used for this purpose, it shall be performed and evaluated in accordance with ASCE 41 requirements. The testing shall be conducted and summarized in a report that is included as a supporting document with the submission of the voluntary seismic upgrade project to DSA.

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3.2.2 When ASCE 41 is the standard upon which the voluntary seismic upgrade design is based per Section 2.2.1 or 2.2.3 above, knowledge factors required by ASCE 41 Section 6.2.4 and Table 6-1 shall be used according to the extent data collection is performed. This provision is not intended to compel designs to use a lesser performance objective than is otherwise sought. Where this would be the case, DSA will permit knowledge factors to be determined from Table 6-1 in the 2023 edition of ASCE 41.

3.3 Seismic Analysis

In accordance with CEBC Section 319.12, engineering analysis and structural calculations shall be provided that demonstrate compliance of the voluntary seismic upgrade.

3.3.1 Analysis and calculations shall demonstrate compliance with the design and acceptance criteria as documented on the construction documents per Section 2.1 above.

3.3.2 Analysis and calculations shall demonstrate compliance with the limitations described in Section 1.4 above.

3.4 Retrofit Design

The design of new structural elements and connections and retrofit work to increase the strength and/or stiffness of existing elements and connections shall be based on the seismic design criteria used in the evaluation as defined by the project applicant per Section 2 above. Additionally, as described in Section 1.4.3 above all new elements and connections shall comply with the prescriptive detailing and connection requirements set forth in the current code and its adopted standards; these represent best practices for ductile and capacity protected building performance.

4. COMMON CONDITIONS

Guidance is provided in this section on various conditions that have been found to regularly occur on voluntary seismic upgrade projects.

4.1 Seismic Force Resisting System Stiffness

Voluntary seismic upgrade work that introduces new vertical elements (i.e., shear walls, frames, etc.) or stiffens existing elements will change the overall stiffness and stiffness distribution of the seismic force resisting system. The impact of such stiffness changes on other elements resisting seismic forces shall be evaluated and accounted for. Refer to Sections 1.3.1 and 1.4.2 above.

4.1.1 Changes to the stiffness distribution of the seismic force resisting system on a given level will alter the required shear and flexural strength of rigid or semi-rigid diaphragms, as well as those components noted in Sections 4.1.2 and 4.1.3 below.

4.1.2 Changes to the stiffness distribution of the seismic force resisting elements on a given line will alter the required strength of collector members and connections.

4.1.3 Changes to the stiffness distribution of the seismic force resisting elements on a given line will alter the required strength of the supporting foundation elements.

4.2 Existing Concrete Construction

In addition to the requirements of the CEBC, CBC Section 1911A contains requirements applicable to existing concrete structures.

4.2.1 As noted in the code language, the testing requirements of CBC Section 1911A.1 apply to rehabilitation projects. This testing need not be performed for voluntary seismic upgrade work. See Section 3.2 above for additional information.

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4.2.2 When existing concrete is strengthened with fiber reinforced polymer (FRP) as part of a voluntary seismic upgrade, CBC Section 1911A.3 applies. When FRP is used to strengthen diaphragms or shear walls, approval as an alternate material is required.

4.3 Out-of-Plane Wall Anchorage

Strengthening the anchorage connection of existing masonry or concrete walls to flexible diaphragms shall consider all elements and connections in the entire load path from the wall to the diaphragm. Refer to Section 1.3.1 and 1.4.2 above.

REFERENCES:

2022 California Code of Regulations (CCR) Title 24

Part 1: California Administrative Code (CAC), Sections 4-309(a), 4-309(b), 4-309(c), 4-309(d), 4-309(e).

Part 2: California Building Code (CBC), Sections 1609A, 1911A, 1911A.1, 1911A.3.

Part 10: California Existing Building Code (CEBC), Sections 304.3, 304.3.1, 304.3.2, 317.5, 317.7, 317.11, 319.2, 319.8, 319.12, 319.12.2.

This IR is intended for use by DSA staff and by design professionals to promote statewide consistency for review and approval of plans and specifications as well as construction oversight of projects within the jurisdiction of DSA, which includes State of California public schools (K–12), community colleges and state-owned or state-leased essential services buildings. This IR indicates an acceptable method for achieving compliance with applicable codes and regulations, although other methods proposed by design professionals may be considered by DSA.

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