PROCEDURES FOR THE APPLICATION OF ASCE 41-13 TO EXISTING BUILDINGS

A. PURPOSE

ASCE 41-13 is one of the standards referenced in the Los Angeles Building Code (LABC) and the Los Angeles Existing Building Code (LAEBC) for seismic evaluation and retrofit of existing buildings. It is intended to serve as an alternative tool for both mandatory and voluntary seismic retrofit requirements. According to LABC and LAEBC, ASCE 41-13 is permitted only with procedures established by the Los Angeles Department of Building and Safety (LADBS). This information bulletin provides clarifications and procedures for the use of ASCE 41-13 to perform seismic evaluation and retrofit of existing buildings.

The Engineer of Record using ASCE 41-13 shall assume the responsibility that the design meets the standards and shall evaluate each structure using sound engineering judgement with additional criteria as warranted by the unique features to each structure, upon approval by the LADBS.

B. TERMS

ASCE 41-13 offers the following three tiers for the seismic evaluation and retrofit processes:

- Tier 1 Screening procedure (Sections 3.3.2, and 4.1)
- Tier 2 Deficiency-based evaluation and retrofit procedure (Section 3.3.3 and 5.1)
- Tier 3 Systematic evaluation and retrofit procedure (Section 3.3.4 and 6.1)

In addition, ASCE 41-13 offers the following five basic performance objectives:

- Basic Performance Objective for Existing Building (BPOE)
- Basic Performance Objective Equivalent to New Building Standards (BPON)
- Enhanced Performance Objective
- Limited Performance Objective
- Reduced Performance Objective

Finally, ASCE 41 offers the following four main Seismic Hazard Levels:

- BSE-1E Seismic Hazard Level for use with BPOE
- BSE-2E Seismic Hazard Level for use with BPOE
- BSE-1N Seismic Hazard Level for use with BPON
- BSE-2N Seismic Hazard Level for use with BPON

C. APPLICATION OF ASCE 41-13

1. General Requirements

To allow the use of ASCE 41-13 for compliance with the LABC-Level seismic forces, LAEBC Sections 402.4 and 403.4 require using a Tier 3 procedure and the two-level performance objective in Table 301.1.4.1 of LAEBC for the applicable risk category. Table 2-2 of ASCE 41-13 is deemed equivalent to the Table 301.1.4.1 of LAEBC, and it shall be used when using ASCE 41-13 for evaluation and retrofit of existing buildings with design lateral loads or forces in accordance with Section 1613 0f the LABC.

Table 2-2. Basic Performance Objective Equivalent to New Building Standards (BPON)

Risk Category	Seismic Hazard Level	
	BSE-1N	BSE-2N
I & II	Life Safety Structural Performance Position Retention Nonstructural Performance (3-B)	Collapse Prevention Structural Performance Nonstructural Performance Not Considered (5-D)
III	Damage Control Structural Performance Position Retention Nonstructural Performance (2-B)	Limited Safety Structural Performance Nonstructural Performance Not Considered (4-D)
IV	Immediate Occupancy Structural Performance Operational Nonstructural Performance (1-A)	Life Safety Structural Performance Nonstructural Performance Not Considered (3-D)

The building is required to be analyzed using BPON force levels (BSE-1N and BSE-2N Seismic Hazard Levels) for both structural and nonstructural performances, based on applicable risk category.

Tier 3 systematic evaluation and retrofit procedure is addressed in Chapter 6 of ASCE 41-13, and it shall include the following steps as a minimum requirement per ASCE 41-13, Section 3.3.4:

- An evaluation shall be performed to identify potential seismic deficiencies (Tier 1).
- A preliminary retrofit scheme shall be developed using one or more of the retrofit strategies defined in Section 1.5 of ASCE 41-13.
- An analysis of the building, including retrofit measures, shall be performed, to verify that the retrofit design meets the selected Performance Objective.
- Construction documents, including drawings, specifications, and a quality assurance plan, shall be developed as defined and specified in Chapter 1 of ASCE 41-13.

2. Mandatory Retrofit

Non-Ductile Concrete Retrofit Ordinance (183,893) and LABC Section 9508.2 require the strength of the lateral-force resisting system to meet or exceed 75% of the base shear specified in the current LABC seismic provisions. As an alternative, LABC Section 9508.2(2) allows the use of ASCE 41-13 with consideration the building is designed to meet or exceed the requirements specified for "Basic Performance Objectives" using ground motions and procedures established by the Department.

Under 2017 LAEBC, the building is required to meet and exceed the requirements specified for "Basic Performance Objective for Existing Buildings" of ASCE 41-13, using a Tier 3 procedures and the two-level Performance Objective for Existing Buildings (BPOE) in Table 2-1 of ASCE 41-13 for the applicable risk category. These two-level performance objectives per BPOE force levels are BSE-1E and BSE-2E Seismic Hazard Levels. To account for the possible underestimation of the earthquake forces, the forces for the BPOE level shall be scaled up to be minimum 75% of the forces for BPON level. For example, the BSE-1E forces shall be no less than 75% of the BSE-1N forces, and the BSE-2E forces shall be no less than 75% of the BSE-2N forces.

Table 2-1. Basic Performance Objective for Existing Buildings (BPOE)

	Tier 1[a]	Tier 2[a]	Tier 3	
Risk Category	**BSE-1E**	**BSE-1E**	**BSE-1E**	**BSE-2E**
I & II	Life Safety Structural Performance Life Safety Nonstructural Performance (3-C)	Life Safety Structural Performance Life Safety Nonstructural Performance (3-C)	Life Safety Structural Performance Life Safety Nonstructural Performance (3-C)	Collapse Prevention Structural Performance Nonstructural Performance Not Considered (5-D)
III	See footnote *b* for Structural Performance Position Retention Nonstructural Performance (2-B)	Damage Control Structural Performance Position Retention Nonstructural Performance (2-B)	Damage Control Structural Performance Position Retention Nonstructural Performance (2-B)	Limited Safety Structural Performance Nonstructural Performance Not Considered (4-D)
IV	Immediate Occupancy Structural Performance Position Retention Nonstructural Performance (1-B)	Immediate Occupancy Structural Performance Position Retention Nonstructural Performance (1-B)	Immediate Occupancy Structural Performance Position Retention Nonstructural Performance (1-B)	Life Safety Structural Performance Nonstructural Performance Not Considered (3-D)

[a]For Tier 1 and 2 assessments, seismic performance for the BSE-2E is not explicitly evaluated.
[b]For Risk Category III, the Tier 1 screening checklists shall be based on the Life Safety Performance Level (S-3), except that checklist statements using the Quick Check procedures of Section 4.5.3 shall be based on MS-factors and other limits that are an average of the values for Life Safety and Immediate Occupancy.

The building is required to be analyzed using BPOE force levels (BSE-1E and BSE-2E Seismic Hazard Levels) for both structural and nonstructural performances, based on applicable risk category.

Tier 3 systematic evaluation and retrofit procedure is addressed in Chapter 6 of ASCE 41-13, and it shall include the following steps as a minimum requirement per ASCE 41-13, Section 3.3.4:

- An evaluation shall be performed to identify potential seismic deficiencies (Tier 1).
- A preliminary retrofit scheme shall be developed using one or more of the retrofit strategies defined in Section 1.5 of ASCE 41-13.

- An analysis of the building, including retrofit measures, shall be performed, to verify that the retrofit design meets the selected Performance Objective.
- Construction documents, including drawings, specifications, and a quality assurance plan, shall be developed as defined and specified in Chapter 1 of ASCE 41-13.

3. Additions and Alternations

Additions and alterations to existing buildings, with or without retrofit work shall comply with LAEBC Section 402 and 403. Where alterations or additions are made to a building, with or without retrofit work, the existing structure and its additions/alterations acting together as a single structure shall be analyzed for 100% of the Design Earthquake Ground Motion as defined in LABC Section 1613.2 and as specified in LABC Section 1613.3. Alternatively, ASCE 41-13 can be used for the analysis, if the building is designed to meet or exceed BPON force levels (BSE-1N and BSE-2N Seismic Hazard Levels), using a Tier 3 systematic analysis and retrofit procedures. Newly added structural elements shall meet or exceed BPON force levels, shall comply with detailing requirements for a new building elements, and have a complete load path from the point of application all the way to the foundation.

Additions, alterations, or the retrofit work made to the structure shall not affect the existing lateral load–carrying structural elements by increasing the demand-capacity ratio (DCR) for more than 10 percent unless the existing elements are shown to be capable of resisting the increased demands. Any existing lateral load-carrying structural element whose DCR with the additions and/or alterations considered is not increased by more than 10 percent is permitted to remain unaltered, as long as they are not supporting newly added structural elements. DCR comparison shall comply with ASCE 41-13, Section 7.5.2.2 and 7.5.3.2.

When it is proposed to change the use and/or occupancy of a building to a higher Risk Category as specified in Table 1604.5 of 2017 LABC, the entire building shall be upgraded to meet the Code requirements per BPON force levels.

The conversion of any portion of an Existing Building to a Joint Living and Work Quarters (Adaptive reuse projects) shall be analyzed for 75% of the Design Earthquake Ground motion as defined in LABC Section 1613.2 and as specified in LABC Section 1613.3. Alternatively, ASCE 41-13 can be used for the analysis, if the building is designed to meet or exceed 100% BPOE force levels, or 75% of the BPON force levels, whichever is greater.

D. ANALYSIS PROCEDURES

The analysis procedure used to evaluate the building shall comply with either linear static, linear dynamic, nonlinear static, nonlinear dynamic or an acceptable alternative rational analysis. Each procedure has its own limitations and is not applicable to all buildings. The procedural selection shall be based on the structural characteristics as shown in the table below.

Irregularities	Structural Characteristics[4]		Linear Analysis		Nonlinear Analysis[5]		Alternative Rational Analysis[5]
			Linear Static Procedure (LSP)	Linear Dynamic Procedure (LDP)	Nonlinear Static Procedure (NSP)	Nonlinear Dynamic Procedure (NDP)	
NO	Structures w/ $T \leq 3.5T_s$		P	P	P	P	P
	Structures w/ $T \geq 3.5T_s$		NP	P	P	P	P
YES	Only any of the irregularities defined in Sect. 7.3.1.2		NP	P	P	P	P
	Irregularities defined in Sect. 7.3.1.1.1 or 7.3.1.1.2	$\mu_{strength}$[2] < μ_{max}[3]	NP	NP	P	P	P
		[1]$\mu_{strength}$[2] > μ_{max}[3]	NP	NP	NP	P	P
	Irregularities defined in Sect. 7.3.1.1.3 or 7.3.1.1.4 w/ DCRs[4] < min(3.0 and *m*)		P	P	P	P	P
	Irregularities defined in Sect. 7.3.1.1.3 or 7.3.1.1.4 w/ DCRs[4] > min(3.0 and *m*)	$\mu_{strength}$[2] < μ_{max}[3]	NP	NP	P	P	P
		[1]$\mu_{strength}$[2] > μ_{max}[3]	NP	NP	NP	P	P

1. NSP is permitted only if higher modes effects are not significant as defined per Sect. 7.3.2.1 (2). If higher modes are significant, the NSP shall be permitted if an LDP analysis is also performed to supplement the NSP in accordance with Sect. 7.3.2.1 (2).
2. $\mu_{strength}$ calculated in accordance with EQ. (7-31).
3. μ_{max} calculated in accordance with EQ. (7-32).
4. Demand-capacity ratios (DCRs) are the magnitude and distribution of elastic demands for existing and added primary elements and components.
5. Seismic Peer Review Panel shall be required, refer to Information Bulletin P/BC 2017-47 for additional information.

E. MATERIAL TESTING

The Tier 3 Systematic Evaluation and Retrofit Procedure is required by Section 402.4 and 403.4 of LAEBC and by the Non-Ductile Concrete Retrofit Ordinance. Valid and dependable information on the existing components of the structure becomes eminent for the Tier 3 analysis and evaluation. Since the strength of a component is affected by inherit variability of the strength of the materials comprising the individual components as well as the differences in workmanship and physical condition, material properties of the existing structure components used in Tier 3 analysis shall be obtained from the as-built construction documents if possible. The material properties obtained from the as-built construction documents shall be supplemented and verified by on-site investigations including nondestructive examination and testing of building materials and components as required by Section 6.2 of ASCE 41-13.

The extent of data collection shall be consisted of minimum, usual, or comprehensive levels of knowledge as specified in Section 6.2.1, 6.2.2, or 6.2.3. The required level of knowledge shall be determined considering the selected Performance Objective and analysis procedure in accordance with Table 6-1. To account for any uncertainty associated with component as-built information, a knowledge factor, κ, shall be used in the capacity evaluation as specified in Section 6.2.4.

Due to lack of quality control and construction oversight, inconsistencies have been found in many existing buildings; especially in older concrete buildings. When incorrect information on

existing building materials used for analysis and evaluation, the results from the analyses, evaluations, and/or building responses can be questionable. Therefore, LADBS has implemented the following requirements for establishing the concrete compressive strength in existing buildings:

- If tested compressive strength from usual data collection yields higher than the specified compressive strength shown on as-built documents, specified compressive strength shown in as-built documents shall be used for the lower bound. For the expected compressive strength, it shall be the lower of the specified compressive strength from the construction documents multiply by 1.5 as provided in Table 10-1 or the mean values of tested material properties if coefficient of variation from usual testing is less than 20%. Should coefficient of variation is greater than 20%, the expected compressive strength shall not exceed the mean values of tested material properties minus one standard deviation.
- If tested compressive strength from usual data collection yields lower than the specified compressive strength shown on as-built documents, comprehensive testing is required in determining the material strength.
- If material properties are not available from the construction documents, the material properties shall be established by comprehensive data collection method.

F. ADDITIONAL REQUIREMENTS

1. Benchmark Buildings

A benchmark building is defined as a building with its entire seismic-force-resisting system and its detailing designed and constructed or retrofitted to a specific performance level using an acceptable code or standard listed in Table 4-6 of ASCE 41-13. Existing buildings that do not meet benchmark building criteria with addition, alteration, change of use or retrofit work approved by the department using an acceptable code or standard after the benchmark year is not deemed to meet the benchmark building criteria. A benchmark building must demonstrate that the building's entire seismic-force-resisting system is meeting the benchmark provisions at the time of the addition, alteration, change of use or retrofit. A building retrofitted with BOPN Level forces is deemed to be considered as a benchmark building.

2. Previously Retrofitted Non-ductile Concrete Buildings

On November 22, 2015, Los Angeles City Council passed Ordinance 183,893, requiring mandatory seismic retrofit of non-ductile concrete buildings that were constructed prior to the 1976 Los Angeles City Building Code provisions. In accordance with the Ordinance 183,893 and Section 91.9504.2 subparagraph 2(a) of the Los Angeles Building Code (LABC), one of the options to show compliance with the ordinance is to submit proof to the Los Angeles Department of Building and Safety (LADBS) that the building was previously retrofitted in conformity with the provisions in either Chapter 85 or former Chapter 95 of the LABC.

Previous Chapter 95 of LABC "Voluntary Earthquake Hazard Reduction in Existing Reinforced Concrete Buildings and Concrete Frame Buildings with Masonry Infills" was effective August 30, 1996, per Ordinance 171,260. Chapter 85 of LABC included structural requirements for the conversion of existing buildings from commercial or industrial uses to Joint Living and Work Quarters, effective July 6, 2005, per Ordinance 176,673.

The following building permits for previous seismic retrofits, which also received a final inspection for the proposed work, are deemed to meet Section 91.9504.2 subparagraph 2(a) of the Los Angeles Building Code:

1. Previous building permits for seismic retrofit of buildings which states "**Full Compliance with Chapter 95**" in either the work description or the "Checklist Items" of the building permit.
2. Previous building permits for plans that were submitted for plan check on or after July 6, 2005 which states "**Full Compliance with Chapter 85**" in the work description of the building permit **and** the approved building plans include seismic strengthening work.
3. Previous building permits which state "**Full Compliance with FEMA 356**" in the work description and where a Modification of Building Ordinance Request was approved by the Los Angeles Department of Building and Safety (LADBS) to be an equivalent alternative to the former Chapter 95 of the LABC.
4. For all other previous building permits for seismic retrofits of buildings not meeting the three categories above, and which received final inspections, the approved retrofit plans and structural calculations are required to be submitted to LADBS in order to determine compliance with Ordinance 183,893 and LABC Section 91.9504.2 subparagraph 2 (a). These submittals will require fees to be paid based on hours needed for review and approval.

3. Condition Assessment

Material properties collected from construction documents or from field tests shall be supplemented by condition assessment by the Engineer of Record. Collection of as-built information from design drawings shall be verified by a visual condition assessment in accordance with the requirements specified in Chapter 8 through12. The visual condition assessment shall include inspection of visible portions of foundations, seismic-force-resisting members, diaphragms, and connections. Incomplete or non-existent information shall be supplemented by a comprehensive condition assessment in accordance with the requirements specified in Chapter 8 through12. The comprehensive condition assessment shall include inspection of visible portions of foundations, seismic-force-resisting members, diaphragms, and exposure of primary connections to inspect reinforcing details. The Engineer of Record shall provide a report to state that the quality of the concrete and all physical condition of components and connections are accurately identified.

4. Risk Category

Each building and structure shall be assign a proper risk category in accordance with LABC Section 1604.5. Both, the structural and nonstructural system of the building expected

performance level shall be selected based on its assigned risk category, performance levels described in Section 2.3 and the seismic hazard levels set forth in Section 2.4.

5. Building Separation

Minimum building separation distance requirements as specified in Section 7.2.13 shall be in full compliance. Risk Category I and II buildings that do not meet the minimum separation distance requirements specified in Section 7.2.13.1, or the separation exceptions listed in Section 7.2.13.2 are required to be analyzed with an analysis method that can account for the transfer of momentum and energy between structures as they impact. The analysis method to evaluate pounding effects can be obtained by performing nonlinear response history analyses of both, structures or other procedures based on rational method of analysis that accounts for the change in dynamic response of the structures caused by the impacts in accordance with principles of mechanics and approved by the Department.

Risk Category III and IV buildings that do not meet the minimum separation distance requirements specified in Section 7.2.13.1 are required to be evaluated and retrofitted with an analysis method approved by the Department. Such analysis method should account for the pounding effects and to evaluate the potential damage to both structural and nonstructural system and to achieve a level of performance to meet Enhanced Performance Objectives.

6. Nonstructural Components

The nonstructural components which are not part of the lateral-load-resisting system shall be evaluated and retrofitted based on BSE-1E and BSE-1N Seismic Hazard Level. The target Nonstructural Performance Level of the nonstructural components for Basic Performance Objective for Existing Buildings (BPOE) varies with Risk Category, as shown in Table 2-1 of ASCE 41-13. Nonstructural components which pose little or no life safety risk may be exempted from the Tier 3 analysis. However, any falling hazard such as cladding or glazing, essential egress components such as stairs or ramps, or other dangerous situations shall be evaluated and retrofitted as necessary.

Exception: Nonstructural component seismic upgrade is not required for Voluntary Seismic Structural Upgrade.