

**State of California**  
**Office of Statewide Health Planning and Development**  
**Facilities Development Division**

**SPC-4D Standard Material Testing and Condition Assessment Structural  
Review Comments**

Based on the 2016 California Building Standards Code  
(Applicable to OSHPD 1 Projects received after January 1, 2016.)

**GENERAL COMMENTS**

(1) Marked Plans and Response

Retrofit construction drawings shall show the summary of relevant approved material test results.

In the conclusion part of the material testing results report, the deviations from the original construction documents should be summarized.

The structural comments are shown on this set of report and drawings in red. Each comment is identified by a number such as S-1, S-2, S-3, etc., and is enclosed in a cloud.

The text of standard structural comments can be found in the attached list. The standard structural comments are called out on the review set by "2016(1)" etc. or circled here.

The comments are based on the California Building Code, 2016 (2016 CBC) and California Administrative Code, 2016 (2016 CAC).

In order to facilitate the back check, please respond in writing to each comment. Your response may be in the form of a letter or each response may be written on this final review set of drawings near the comment in a color other than red or green. If the responses are presented in a letter, identify the comment by drawing number and the comment number. In both cases, each response should specify how and where on the resubmitted drawings and/or report the OSHPD comments have been resolved. If you have any questions, please do not hesitate to call

The Structural Reviewer:

Reference: 2016 CBC Sections 105 and 107.

(2) Building Characteristics

Building characteristics shall be obtained from destructive and nondestructive testing and field observation of exposed conditions to verify that field conditions substantially match the construction documents.

Reference: 2016 CAC Chapter 6 Section 2.1.2.1

(3) Comprehensive Data Collection Requirements

The extent of data collection shall be at comprehensive level for structures upgraded to SPC-4D.

Draft date: 3/29/2016

- Reference: 2016 CBC 3413A.1.3
- (4) Comprehensive Condition Assessment  
If construction documents including design drawings, specifications, material test records, and quality assurance reports covering original construction and subsequent modifications to the structure are incomplete, missing information shall be supplemented by a comprehensive condition assessment, including destructive and nondestructive investigation, in accordance with ASCE 41-13 Chapters 9 through 12.  
The condition assessment program application may be submitted to the office as a separate project or combined with material testing application.  
Reference: ASCE 41-13 Section 6.2.3 Item 1 and 2 and 2016 CAC Chapter 6 Section 2.1.2.1
- (5) Comprehensive Material Testing:  
In the absence of material test records and quality assurance reports, material properties shall be determined by comprehensive materials testing in accordance with ASCE 41-13 Chapters 9 through 12, including the limitations on the coefficient of variation.  
Reference: ASCE 41-13 Section 6.2.3 item 3
- (6) Approval of the Material Testing and Condition Assessment Program (MTCAP)  
MTCAP shall require approval by the office prior to testing. MTCAP shall include building name, building description on gravity and lateral force resisting system from roof to foundation purpose of MTCAP, number of tests, calculation to determine number of tests, floor plan showing location of samples, unique sample identification for each sample, material testing program description, analysis method such as linear or nonlinear procedures for which material test results will be used, specifications for testing, details for specimen removal and repair, photographs of each sample and its repair work and original/as-built structural drawings. We recommend a table which lists sample identification, specified strength, sample location such as wall or slab, sample size, material properties to be tested, and ASTM standards be included as part of the submittal.  
Reference: 2016 CAC section 2.1.2.2  
A testing program for materials properties testing shall be approved by Seismic Compliance Unit prior to commencement of material testing work.  
Reference: 2016 CBC 3413A.1.3
- (7) Signature - Structural Engineer  
Material testing and condition assessment program shall bear the structural engineer's signature.  
Reference: 2016 CAC Section 7-115.
- (8) Default Material Properties  
Use of material properties based on historical information as default values shall not be permitted.  
Reference: 2016 CBC 3412A.1.2
- (9) Material Test Code Reference  
Approval of construction documents based on building characterization in accordance with the 2016 CAC Chapter 6 Section 2.1.2.1, material properties in accordance with the 2016 CAC

Chapter 6 Section 2.1.2.2 and 2016 CBC Section 3413A.1.3 shall be required.

Reference: 2016 CBC 3412A.2.3 item 1

(10) Expected Material Properties

Expected material properties are not permitted to be determined by multiplying lower bound values by the assumed factors specified in Chapters 8 through 12 of ASCE 41-13 and shall be based exclusively on materials test results.

Reference: 2016 CBC 3413A.1.6

(11) Incomplete Submittals

The following comments are based on a preliminary or incomplete submittal. A more thorough review will be made upon resubmittal and additional comments will follow.

Reference: 2013 CAC Section 7-121.

(12) Unrelated Data in Program

Remove unrelated data items from MTCAP. This includes Temporary Facilities and Fire and Life Safety Guidelines which will be reviewed by an OSHPD regional office.

Reference: 2016 CAC Section 7-113, 7-115 and 2016 CBC Section 107, 1603A.

(13) Availability of As-Built Drawings and Material Testing

Clarify in MTCAP if as-built drawings are available or not. If as-built drawings are available, state if specified material properties are available or not.

Reference: 2013 CAC Section 7-121.

(14) The exact location of samples

The exact location of samples shall be clearly indicated in MTCAP. Remarks such as "will be taken in the most critical seismic resisting components" without the specific location of the samples are not acceptable.

Reference: 2016 CAC Section 7-113, 7-115 and 2016 CBC Section 107, 1603A.

## ADDITIONAL STATEMENTS

(15) Permit Requirement

State in MTCAP: Prior to performing destructive and non-destructive materials test or condition assessments requiring modification to existing conditions, the owner or the owner's authorized agent shall obtain a building permit.

Reference: 2016 CAC section 2.1.2.2

(16) Repair

State in MTCAP: At test sample locations, structural members, slabs and walls shall be repaired to a state that is equivalent to their original condition. Provide repair details for approval.

Reference: 2016 CBC 3413A.1.3

(17) Photos

State in MTCAP: The final report shall include documentation including photos for verification of

both material testing and condition assessment. All visual inspections shall be documented with photos. All sampling stated in MTCAP and repair work shall be documented with photos. The photos shall clearly correlate to the location of the specified sample. Submittal of photos with no sample/location correlation is not acceptable.

Reference: 2016 CAC Section 7-113, 7-115 and 2016 CBC Section 107, 1603A.

(18) Purpose of the Material Testing

State in MTCAP: the purpose of this MTCAP is to reclassify the building to SPC-4D level of performance.

Reference: 2016 CAC Section 7-113, 7-115 and 2016 CBC Section 107, 1603A.

(19) Damaged Samples

State in MTCAP: if any sample is damaged, Seismic Compliance Unit shall be notified for determination of remediation.

Reference: 2016 CAC Section 7-113, 7-115 and 2016 CBC Section 107, 1603A.

(20) Grouping of Data

State in MTCAP: Grouping of sample results shall have rational base. For instance, grouping test results of construction in different years, or reinforcing steel with different grades is not acceptable.

Reference: 2016 CAC Section 7-113, 7-115 and 2016 CBC Section 107, 1603A.

(21) Material Test Result

State in MTCAP: statistical analysis of test results shall be submitted in final report. Based on the statistical analysis, expected strength of each material property shall be determined.

Reference: 2016 CAC Section 7-113, 7-115 and 2016 CBC Section 107, 1603A.

(22) Construction Year

State in MTCAP: If a building is comprised of original building and additions, the number of samples for original building and each addition shall meet the ASCE 41-13 requirements separately. Combining of the data of original building and additions are not allowed.

Reference: 2016 CAC Section 7-113, 7-115 and 2016 CBC Section 107, 1603A.

## STEEL TESTING COMMENTS

(23) Steel Element Testing Requirement

The following properties are required for each member type of lateral force resisting system: e.g., beams, columns, braces and each steel grade used in the structure:

- a) Ultimate tensile and yield capacities
- b) Modulus of elasticity
- c) Deformation characteristics including mode of failure
- d) Carbon equivalent
- e) Elongation data

Reference: 2016 CAC section 2.1.2.2 item 1 and ASCE 41-13 Section 9.2.2.1.1

Note: chemical composition of steel shall be complete list of components.

Other testing beyond the above requirements (such as hardness or fatigue) are not required and can be removed.

(24) Testing Requirements for Welds and Plates in connections

The following properties are required for connection materials:

- a) Chemical composition
- b) Hardness per ASTM A370

Note: chemical composition of steel shall be complete list of components.

(25) Location of Steel Samples

Sampling shall take place in regions where the decreased section strength caused by the sampling remains higher than the capacity required at the reduced section to resist the design loads. Alternately, where the reduced section strength caused by sampling becomes lower than the required capacity, the lost section shall be temporarily supported and restored by repairs to the section.

Reference: ASCE 41-13 Section 9.2.2.3

(26) Number of Steel Samples with construction drawings and specifications

If original construction documents defining material properties are inconclusive or do not exist but the date of construction is known and the material used is confirmed to be carbon steel, at least three strength coupons and three bolts and rivets shall be randomly removed from each component type. Component types include beams, columns, braces and metal deck.

Reference: ASCE 41-13 Section 9.2.2.4.2 Item 1

(27) Number of Steel Samples without construction drawings and specifications

At least two tensile strength coupons and two bolts and rivets shall be removed from each component type for every four floors or every 200,000 ft<sup>2</sup>. Component types include beams, columns, braces and metal deck. If it is determined from testing that more than one material grade exists, additional sampling and testing shall be performed until the extent of each grade in component fabrication has been established.

Reference: ASCE 41-13 Section 9.2.2.4.2 Item 2

(28) Number of Weld Samples

In the absence of construction records defining welding filler metals and processes used, at least one weld metal sample for each component type shall be obtained for laboratory testing. The sample shall consist of both local base and weld metal to determine composite strength of the connection per ASCE 41-13 Section 9.2.2.4.2 Item 3. Alternatively, the following properties may be used for weld metal per ASCE 41-13 Section 9.2.2.1.1:

- a) Chemical composition per ASTM A751. Note: chemical composition of steel shall be complete list of components.
- b) Hardness per ASTM A370.

Reference: ASCE 41-13 Section 9.2.2.4.2 Item 3

(29) Comparison of the Tested and Default Values

The results of any material testing performed shall be compared to the default values in Tables 9-1 and 9-2 of ASCE 41-13 for the particular era of building construction. The amount of testing

shall be doubled if the expected and lower-bound yield and tensile strengths determined from testing are lower than the default values.

Reference: ASCE 41-13 Section 9.2.2.4.2

(30) Expected and Lower Bound Values:

Expected material properties shall be based on mean values from test data unless specified otherwise. Lower-bound material properties shall be based on mean minus one standard deviation values from test data unless specified otherwise. The expected and lower bound material properties to be used in the analysis shall be reported in the test results report.

Reference: ASCE 41-13 Section 7.5.1.4

(31) Testing Method for steel elements:

Testing shall be performed in accordance with ASTM A370. Chemical composition tests shall be per ASTM A751.

Reference: ASCE 41-13 Section C9.2.2.3 and FEMA 274 Section C5.3.2.4

(32) Weldability-steel

Where welding to existing steel components is required as part of a retrofit, the carbon equivalent of the existing components shall be determined to establish weldability of the material, unless it is confirmed that the existing material conforms to a weldable material specification. The welding procedures shall be determined based on the chemistry of the base material and filler material, as specified in AWS D1.1 Section 8. Materials conforming to ASTM A36, ASTM A242, ASTM A307, ASTM A572, ASTM A913, ASTM A972, and ASTM A992 shall be deemed to be weldable.

Reference: ASCE 41-13 Section 9.2.2.1.1

## STEEL CONDITION ASSESSMENT COMMENTS

(33) Report for Condition Assessment of steel elements

Provide a condition assessment report including the following items:

1. The physical condition of primary and secondary components and the presence of any degradation;
2. Verification of the presence and configuration of structural elements and components and their connections, and the continuity of load paths among components, elements, and systems; and
3. Identification of other conditions, including the presence of nonstructural components that influence building performance.

Reference: ASCE 41-13 Section 9.2.3.1

(34) Steel Metal Deck:

Verify metal deck profile. Verify puddle weld pattern in terms of size, spacing and side seam fastening pattern of metal deck.

ASCE 41-13 Section 9.2.3.1

(35) Number of Tests for Steel Elements:

Draft date: 3/29/2016

At least three connections of each type (beam-column in moment frame and brace-beam column in braced frames) shall be exposed for the primary structural components. If no deviations within a connection group are observed, the sample shall be considered representative. If deviations within a connection group are observed, then additional connections shall be exposed until the extent of deviations is determined.

Reference: ASCE 41-13 Section 9.2.3.2.2

Application of non-destructive methods such as gamma radiography through the architectural fabric or borescopic review through drilled access holes may be acceptable if access is limited.

## CONCRETE TESTING COMMENTS

- (36) Concrete Element Testing Requirement:  
The following material properties are required for each lateral force resisting member types e.g., beams, columns, walls in the structure:  
a) Concrete compressive strength;  
b) Concrete unit weight;  
c) Concrete modulus of elasticity; Alternatively, ASCE 41-13 Section 10.2.2.4.2.2 may be used to determine modulus of elasticity. Reference: 2016 CAC section 2.1.2.2 item 2
- (37) Concrete Modulus of Elasticity  
The modulus of elasticity and tensile strength shall be permitted to be estimated from the compressive strength testing data.  
Reference: ASCE 41-13 Section 10.2.2.4.2.2
- (38) Location of Concrete Samples:  
When determining material properties with the removal and testing of samples for laboratory analysis, sampling shall take place in primary lateral force resisting system elements in regions with the least stress.  
Reference: ASCE 41-13 Section 10.2.2.3.1  
Samples shall be taken from elements, distributed throughout the building, that are critical to the structural behavior of the building. Multiple concrete core samples taken from the same element or same area may result in the sampling of the same truck of concrete reducing the required random nature of sampling.  
Reference: ASCE 41-13 Section 10.2.2.4.2.1 and Section 10.2.2.4.2.2.
- (39) Concrete Removal and Sampling:  
Core drilling shall be preceded by nondestructive location of the reinforcing steel, and core holes should be located to avoid damage to or drilling through the reinforcing steel. Core holes shall be filled with nonshrink concrete or grout of comparable strength.  
Reference: ASCE 41-13 Section 10.2.2.3.2
- (40) Normal or Light Weight Concrete:  
Identify concrete type, either normal weight or lightweight for concrete core samples.  
Reference: 2016 CAC Section 7-113, 7-115 and 2016 CBC Section 107, 1603A.

- (41) **Testing Method Concrete Element:**  
Removal of core samples shall use the procedures included in ASTM C42. Testing shall follow the procedures contained in ASTM C42, ASTM C39, and ASTM C496. Core strength shall be converted to in-place concrete compressive strength by an approved procedure, such as that included in ACI 214.4R.  
Reference: ASCE 41-13 Section 10.2.2.3.2
- (42) **Application of Nondestructive Test for Concrete:**  
Quantification of concrete strength via ultrasonics or other nondestructive test methods shall not be substituted for core sampling and laboratory testing.  
Reference: ASCE 41-13 Section 10.2.2.4.2.2
- (43) **Damaged Concrete:**  
Tests shall be performed on samples from components that are identified as damaged or degraded to quantify their condition. If damaged or degraded concrete is found, OSHPD shall be notified for location and degree of the damage and degradation before testing. Test results from areas of degradation shall be compared with strength values specified in the construction documents. If test values less than the specified strength in the construction documents are found, further strength testing shall be performed to determine the cause or identify the degree of damage or degradation.  
Reference: ASCE 41-13 Section 10.2.2.4.2.2
- (44) **Coefficient of Variation**  
A minimum of three tests shall be conducted to determine any property. If the coefficient of variation exceeds 20%, additional tests should be performed until the coefficient of variation is equal to or less than 20%. If additional testing does not reduce the coefficient of variation below 20%, a knowledge factor reduction per Section 10.2.4 shall be used. Alternatively, the expected concrete strength can be determined using the mean less one standard deviation per ASCE 41-13 Section 10.2.2.3.1 as approved by OSHPD.  
In determining coefficient of variation, cores shall be grouped by grades of concrete and element type. Note that no sample result can be excluded from the data set to reduce the COV unless a written documentation from the testing agency confirming that the sample was damaged prior to testing is submitted for review and approval by OSHPD. The testing lab shall provide reasons of any errors involved in the lab testing procedure including sampling, sample transportation, sample storing, calibration and operation of testing equipment etc.  
Reference: ASCE 41-13 Section 10.2.2.4.2.1 and ASCE 41-13 Section 10.2.2.3.1
- (45) **Number of Tests for Concrete Elements:**  
For each concrete element type, a minimum of three core samples shall be taken and tested. A minimum of six total tests shall be performed on a building for concrete strength determination. If varying concrete classes or grades were used in the building construction, a minimum of three samples and tests shall be performed for each class and grade.  
Reference: ASCE 41-13 Section 10.2.2.4.2.2
- (46) **Number of Tests for Concrete with known  $f'_c$ :**

For concrete elements for which the specified design strength is known and test results are not available, a minimum of three core tests shall be conducted for each floor level, 400 yd<sup>3</sup> of concrete, or 10,000 ft<sup>2</sup> of surface area, whichever requires the most frequent testing.

Reference: ASCE 41-13 Section 10.2.2.4.2.2

(47) Number of Tests for Concrete without known  $f'_c$

For concrete elements for which the design strength is unknown and test results are not available, a minimum of six core tests shall be conducted for each floor level, 400 yd<sup>3</sup> of concrete, or 10,000 ft<sup>2</sup> of surface area, whichever requires the most frequent testing.

Reference: ASCE 41-13 Section 10.2.2.4.2.2

(48) Core Diameter

Except as provided in ASTM C42 Section 7.1.2, the diameter of core specimens for the determination of compressive strength shall be at least 94 mm [3.70 in.] or at least two times the nominal maximum size of the coarse aggregate, whichever is larger.

Reference: ASTM C42-13 Section 7.1.1

If limited member thickness makes it impossible to obtain cores with length-diameter ratio (L/D) of at least 1.0 or if clear distance between reinforcement is limited, core diameters less than 94 mm [3.70 in.] are not prohibited. If a core diameter less than 94 mm [3.70 in.] is used, report the reason.

It should be noted that smaller diameter cores generally produce a large scatter in the results. Therefore, it is recommended to extract the largest diameter cores possible with constraints discussed above.

Reference: ASTM C42-13 Section 7.1.2

(49) Core Length

Except as provided in ASTM C42 section 7.1.2, the preferred length of the capped or ground specimen is between 1.9 and 2.1 times the diameter. If the ratio of the length to the diameter (L/D) of the core exceeds 2.1, reduce the length of the core so that the ratio of the capped or ground specimen is between 1.9 and 2.1. Core specimens with length-diameter ratios equal to or less than 1.75 require corrections to the measured compressive strength. A strength correction factor is not required for L/D greater than 1.75. A core having a maximum length of less than 95 % of its diameter before capping or a length less than its diameter after capping, trimming, or end grinding shall not be tested.

Reference: ASTM C42-13 Section 7.1.2

## STEEL REINFORCING TESTING COMMENTS

(50) Steel Reinforcing Testing Requirement

The following material properties are required for each lateral force resisting member type e.g., beams, columns, walls in the structure:

- a) Reinforcing steel tensile yield point;
- b) Reinforcing steel modulus of elasticity;
- c) Reinforcing steel chemical composition and carbon equivalent, and

d) Reinforcing steel surface deformation.

Reference: 2016 CAC Section 2.1.2.2.1 item 2

State the rebar size, gage length for the elongation test per ASTM A370. Measurement of deformation of reinforcing steel samples shall be submitted.

Reference: ASCE 41-13 Section 11.2.3.8

Alternatively use the following material properties for column reinforcing:

- a) Chemical composition
- b) Hardness per ASTM A370
- c) Surface deformation

Note: chemical composition of steel shall be complete list of components.

(51) Testing Method of Reinforcing Steel:

The tensile yield and ultimate strengths for reinforcing steels shall follow the procedures included in ASTM A370.

Reference: ASCE 41-13 Section 10.2.2.3.2

(52) Steel Reinforcing Test Methods

Tension testing of reinforcing bars shall be in accordance with ASTM A370 Annex A9. All test specimens shall be the full section of the bar as rolled (8-in. gage length) and shall not be reduced.

Reference: 2016 CBC 3413A.1.3

(53) Repair of Removed Reinforcing Bar

Where sampling include removal of local bar segments, the removed reinforcing shall be replaced and spliced to maintain continuity of the reinforcing bar for transfer of bar force unless an analysis confirms that replacement of the original components is not required.

Reference: ASCE 41-13 Section 10.2.2.3.2

(54) Number of Tests for Reinforcing with Known Properties

If original construction documents defining properties exist, then at least three strength coupons shall be randomly removed from each element or component type and tested.

Reference: ASCE 41-13 Section 10.2.2.4.2.3

(55) Number of Tests for Reinforcing with Known Date of Construction

If original construction documents defining properties are unavailable, but the approximate date of construction is known and a common material grade is confirmed, at least three strength coupons shall be randomly removed from each element or component type for every three floors of the building. Reference: ASCE 41-13 Section 10.2.2.4.2.3

(56) Number Of Tests For Reinforcing Without Data

If the construction date is unknown, at least six strength coupons for every three floors shall be performed.

Reference: ASCE 41-13 Section 10.2.2.4.2.3

- (57) **Prestressing Steels Sampling**  
Sampling prestressing steel tendons for laboratory testing shall only be performed on prestressed components that are part of the seismic-force-resisting system. Prestressed components in diaphragms shall be permitted to be excluded. Tendon or prestress removal shall be avoided if possible. Determination of material properties may be possible, without tendon or prestress removal, by careful sampling of either the tendon grip or the extension beyond the anchorage, if sufficient length is available. All sampled prestressed steel shall be replaced with new, fully connected, and stressed material and anchorage hardware, unless an analysis confirms that replacement of original components is not required.  
Reference: ASCE 41-13 Section 10.2.2.4.2.4
- (58) **Testing Method of Connector Steel Element**  
Properties of connector steels shall be permitted to be determined by wet and dry chemical composition tests and direct tensile and compressive strength tests as specified by ASTM A370. Where strengths of embedded connectors are required, in-place testing shall satisfy the provisions of ASTM E488.  
Reference: ASCE 41-13 Section 10.2.2.3.2
- (59) **Precast Concrete steel and reinforcing**  
Conventional reinforcing and connector steels tests shall be conducted to determine both yield and ultimate strengths of reinforcing and connector steel. Connector steel is defined as additional structural steel or miscellaneous metal used to secure precast and other concrete shapes to the building structure.  
Reference: ASCE 41-13 Section 10.2.2.4.2.3

## **CONCRETE/REINFORCING CONDITION ASSESSMENT**

- (60) **Report For Condition Assessment Of Concrete Elements**  
Provide a report including the following items:  
1. Examination of the physical condition of primary and secondary components, and the presence of any degradation shall be noted;  
2. Verification of the presence and configuration of components and their connections, and the continuity of load paths between components, elements, and systems;  
3. A review and documentation of other conditions, including neighboring party walls and buildings, presence of nonstructural components and mass, and prior remodeling;  
4. Confirmation of component orientation, plumbness, and physical dimensions.  
Reference: ASCE 41-13 Section 10.2.3.1
- (61) **Concrete Removal and Sampling Reference**  
Condition assessment exposure is defined as local minimized removal of cover concrete and other materials to inspect reinforcing system details. All damaged concrete cover shall be replaced after inspection.  
Reference: ASCE 41-13 Section 10.2.3.2.2
- (62) **Tests for Concrete Elements with construction drawings**

Exposure of at least three different primary connections shall occur, with the connection sample including different types of connections. Of particular importance is the splice, standard and hooked development of different primary connections. If no deviations from the drawings exist or if consistent deviations from the drawings exist, it shall be permitted to consider the sample as being representative of installed conditions. If inconsistent deviations are noted, then at least 25% of the specific connection type shall be inspected to identify the extent of deviation.

Reference: ASCE 41-13 Section 10.2.3.2.2

(63) Tests For Concrete Elements without construction drawings

At least three connections of each primary connection type shall be exposed for inspection. Of particular importance is the splice, standard and hooked development of each primary connection. If common detailing among the three connections is observed, it shall be permitted to consider this condition as representative of installed conditions. If variations are observed among like connections, additional connections shall be inspected until an accurate understanding of building construction is gained.

Reference: ASCE 41-13 Section 10.2.3.2.2

#### MASONRY TESTING COMMENTS

(64) Masonry Element Testing Requirement

The following material properties are required for each type of masonry in the structure:

- a) Masonry compressive strength;
- b) Masonry unit weight;
- c) Masonry modulus of elasticity;

Reference: 2016 CAC section 2.1.2.2 item 3 and ASCE41-13 Section 11.2.3.1

Note: Alternatively, masonry modulus of elasticity may be determined per ASCE 41-13 Section 11.2.3.4.

(65) Masonry Modulus of Elasticity:

Expected values of elastic modulus for masonry in compression,  $E_{me}$  shall be determined in accordance with TMS 402.

Reference: ASCE 41-13 Section 11.2.3.4

(66) Masonry Shear Modulus:

The expected shear modulus of masonry,  $G_{me}$  shall be permitted to be taken from Section 1.8.2.2.2 of TMS 402-11.

Reference: ASCE 41-13 Section 11.2.3.7

(67) Expected and Lower Bound Values:

Expected material properties shall be based on mean values from test data unless specified otherwise. Lower-bound material properties shall be based on mean minus one standard deviation values from test data unless specified otherwise.

Reference: ASCE41-13 Section 11.2.3.1

- (68) Location of Masonry Samples:  
Samples for tests shall be taken at locations representative of the material conditions throughout the entire building, taking into account variations in workmanship at different story levels, variations in weathering of the exterior surfaces, and variations in the condition of the interior surfaces due to deterioration caused by leaks and condensation of water and/or the deleterious effects of other substances contained within the building.  
Reference: ASCE 41-13 Section 11.2.3.9.3
- (69) Coefficient of Variation  
If the coefficient of variation in test measurements exceeds 25%, the number of tests performed shall be doubled. In determining coefficient of variation, cores shall be grouped by grades of concrete and element type. Note that no sample result can be excluded from the data set to reduce the COV unless a written documentation from the testing agency confirming that the sample was damaged prior to testing is submitted for review and approval by OSHPD. The testing lab shall provide reasons of any errors involved in the lab testing procedure including sampling, sample transportation, sample storing, calibration and operation of testing equipment etc.  
Reference: ASCE 41-13 Section 11.2.3.9.3
- (70) Comparison of Tested Values to Default Values:  
If mean values from in situ material tests are less than the default values prescribed in ASCE 41-13 Section 11.2.3.10, the number of tests performed shall be doubled.  
Reference: ASCE 41-13 Section 11.2.3.9.3
- (71) Partially Grouted Masonry:  
In masonry prism test, if CMU walls are partially grouted, same number of prism samples shall be taken to perform material test for grouted and un-grouted prism samples.  
Reference: ASTM C1314
- (72) Masonry Compressive strength test method:  
Test prisms shall be extracted from an existing wall and tested in accordance with ASTM C1314 per TMS 602 Section 1.4.B.3. The expected compressive strength shall be based on the net mortared area.  
Reference: ASCE 41-13 Section 11.2.3.3
- (73) Number of Tests with Specified Material Properties:  
A minimum of three tests shall be performed for each masonry class, and for each three floors of construction or 3,000 ft<sup>2</sup> of wall surface. At least two tests shall be performed for each wall or line of wall elements providing a common resistance to seismic forces. A minimum of eight tests shall be performed for each building.  
Reference: ASCE 41-13 Section 11.2.3.9.3
- (74) Number of Tests without Specified Material Properties:  
A minimum of six tests shall be performed for each masonry class, and for each three floors of construction or 3,000 ft<sup>2</sup> of wall surface. At least two tests shall be performed for each wall or line of wall elements providing a common resistance to seismic forces. A minimum of eight tests

shall be performed for each building.

Reference: ASCE 41-13 Section 11.2.3.9.3

(75) Variation In Material Strength Properties:

Additional tests shall be done to estimate material strengths in regions where properties differ, or nondestructive condition assessment tests in accordance with Section 11.2.2.2 shall be used to quantify variations in material strengths.

Reference: ASCE 41-13 Section 11.2.3.9.3

## MASONRY CONDITION ASSESSMENT

(76) Report for Condition Assessment of Masonry Elements

Provide a report including the following items:

The physical condition of primary and secondary components and the presence of any degradation. The condition of existing masonry shall be evaluated for unit surface or mortar joint deterioration due to weathering caused by freeze-thaw cycles or frequent moisture saturation.

The presence and configuration of components and their connections and the continuity of load paths among components, elements, and systems

Other conditions, including the presence and attachment of veneer, neighboring party walls and buildings, presence of nonstructural components, prior remodeling, and limitations for retrofit that may influence building performance.

Reference: ASCE 41-13 Section 11.2.2

Note: Identify if the wall is partially or fully grouted, stack or running bond.

(77) Type of Tests for Masonry Elements

Nondestructive tests shall be permitted to quantify and confirm the uniformity of construction quality and the presence and degree of deterioration for comprehensive data collection, including but not limited to the following:

1. Ultrasonic or mechanical pulse velocity to detect variations in the density and modulus of masonry materials and to detect the presence of cracks and discontinuities;
2. Impact-echo tests to confirm whether reinforced walls are grouted;
3. Radiography to confirm location of reinforcing steel; and
4. Infrared thermography.

Reference: ASCE 41-13 Section 11.2.2.2

(78) The location and the number of tests for Condition Assessment

The location and the number of nondestructive tests shall be determined in accordance with the requirements of Section 11.2.3.9.3

Reference: ASCE 41-13 Section 11.2.2.2

## WOOD AND COLD-FORMED STEEL TESTING COMMENTS

- (79) Wood Elements Testing Requirement:  
The following material properties are required for each type of wood element in the structure:  
a) Identification of Wood Species, and  
b) Grade Material. This may be established by visual inspection or stamped labels on the element.  
Reference: 2016 CAC section 2.1.2.2 item 4
- (80) Cold-Formed Steel Light-Frame Elements Testing Requirement  
The material properties (i.e., base steel thickness and grade) of the in-place CFS light-frame components shall be established by one or more of the following methods:  
1. Inspection of manufacturers' product identification;  
2. Examination of samples by an experienced metallurgist;  
3. Measurements to establish base steel thickness; or  
4. Materials testing to establish grade.  
  
Base steel thickness shall exclude the thickness of any coatings (e.g., zinc or paint).  
Reference: ASCE 41-13 Section 12.2.2.1.2
- (81) Wood Testing Method:  
Grading shall be performed using the ASTM D245 grading methodology or an approved grading handbook for the assumed wood species and application.  
Reference: ASCE 41-13 Section 12.2.2.1.1
- (82) Wood Testing Location:  
Samples shall be obtained in a manner that does not compromise the strength or stiffness of the structure.  
Reference: ASCE 41-13 Section 12.2.2.1.1
- (83) Cold-Formed Steel Testing Method:  
Tests shall be conducted in accordance with ASTM A370.  
Reference: ASCE 41-13 Section 12.2.2.1.2
- (84) Cold-Formed Steel Testing Location:  
Samples shall be obtained in a manner that does not compromise the strength or stiffness of the structure.  
Reference: ASCE 41-13 Section 12.2.2.1.1
- (85) Number of Tests with Specified Material Properties:  
At least one location for each story is to be randomly verified by observing product marking or by compliance with wood grading rules for each component type identified as having a different material grade.  
Reference: ASCE 41-13 Section 12.2.2.4.2
- (86) Number of Tests with Known Date of Construction:  
At least three locations are to be randomly verified-by sampling and testing or by observing grade stamps and conditions-for each component type, for every two floors in the building.

Reference: ASCE 41-13 Section 12.2.2.4.2

(87) Number of Tests with no Knowledge:

At least six locations are to be randomly verified-by sampling and testing or by observing product marking and conditions-for each element and component type, for every two floors or 200,000 ft<sup>2</sup> of floor area of construction.

Reference: ASCE 41-13 Section 12.2.2.4.2

(88) Number of Test for More Than one Material Grade:

If it is determined from testing or observation that more than one material grade exists, additional observations and testing are to be conducted until the extent of use for each grade has been established.

Reference: ASCE 41-13 Section 12.2.2.4.2

(89) Number of Test for Connector:

In the absence of construction records defining connector features present, the configuration of at least three connectors are to be documented for every floor or 100,000 ft<sup>2</sup> of floor area in the building.

Reference: ASCE 41-13 Section 12.2.2.4.2

#### **WOOD AND COLD-FORMED STEEL CONDITION ASSESSMENT**

(90) Report For Condition Assessment

Provide a report including the following items:

1. The physical condition of primary and secondary components and the presence of degradation,
2. The presence and configuration of components and their connections, and the continuity of load paths among components, elements, and systems,
3. Other conditions, including neighboring party walls and buildings, presence of nonstructural components, and prior remodeling.

Reference: ASCE 41-13 Section 12.2.3.1

(91) Access for Condition Assessment:

If coverings or other obstructions exist, either partial visual inspection through the use of drilled holes and a fiberscope shall be used or visual inspection shall be performed by local removal of covering materials.

Reference: ASCE 41-13 Section 12.2.3.2.2

(92) Number of Tests with Construction Document:

At least three different primary connections are to be exposed for each connection type. If no capacity-reducing deviations from the construction documents exist, the sample is considered representative. If deviations are noted, then all coverings from primary connections of that type are to be removed, unless the connection strength is ignored in the seismic evaluation.

Reference: ASCE 41-13 Section 12.2.3.2.2

(93) Number of Tests without Construction Document:

At least 50% of the top and at least 50% of the base connections for each type of vertical element in the seismic-force-resisting system, as well as collectors, boundary components, and tie-downs, are to be exposed and inspected or inspected with a fiberscope. If common detailing is observed, this sample is considered representative. If any details or conditions are observed that result in a discontinuous load path, all primary connections are to be exposed.

Reference: ASCE 41-13 Section 12.2.3.2.2

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