REQUEST FOR PROPOSALS (RFP)
FOR
STRUCTURAL ENGINEERING SERVICES
RFP NO.: 18-029

CITY OF SANTA ANA
Santa Ana Public Works Agency
20 Civic Center Plaza
Santa Ana, CA 92701

Tyrone Chesanek, P.E.
Project Manager
(714) 647-5045 Office
tchesanek@santa-ana.org

Approved for Release: ____________________________
Edwin "William" Galvez, P.E.
Acting Executive Director
Public Works Agency

KEY RFP DATES (Subject to change at discretion of City):

Issue Date: Tuesday, April 3, 2018
Letter of Intent: Tuesday, April 17, 2018
Deadline for Requests for Information: Tuesday, April 24, 2018
Proposal Due Date: Tuesday, May 1, 2018; 12:00 pm.
Projected Award Date: Tuesday, June 19, 2018
NOTICE INVITING PROPOSALS

NOTICE IS HEREBY GIVEN that proposals will be received from qualified firms for Structural Engineering Services.

Responses to this Request for Proposals (RFP) will be accepted until Tuesday, May 1, 2018, at 12:00 p.m. Proposals received after this date/time will not be considered. It is the responsibility of the proposer to ensure that any proposals submitted have sufficient time to be received by the City of Santa Ana prior to this proposal due date and time.

Proposals shall be enclosed in a sealed envelope and marked clearly with following information, formatted as follows:

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“SEALED PROPOSAL FOR
RFP NO.: 18-029
STRUCTURAL ENGINEERING SERVICES
IN THE CITY OF SANTA ANA
DO NOT OPEN WITH REGULAR MAIL.”

City of Santa Ana
Attn.: Tyrone Chesaneck
Public Works Agency;
20 Civic Center Plaza; Ross Annex, 3rd Floor Reception
Santa Ana, CA 92701
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Proposals shall be mailed, hand delivered, or sent by courier service. Proposals shall NOT be sent via telegraphic, electronic or facsimile.

All notifications, updates and addenda will be posted on the City’s RFP Bid page at www.santa-ana.org/bids-rfps. Proposers shall be responsible for monitoring the site to obtain information regarding this solicitation. Failure to respond to required updates may result in a determination of a nonresponsive proposal.

LETTER OF INTENT - Interested firms shall submit a Letter of Intent of their pending proposal to the noted Project Manager by the required date as shown on the cover page of this RFP. Letters shall be forwarded via certified mail or email and shall include the following information:
1. Use formal company letterhead.
2. Indication of company interest in the RFP.
3. Acknowledgement of candidate's responsibility to monitor the City's website for any amendments or modifications to the RFP.
4. Provision of correct, complete contact information.
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I. INTRODUCTION / PROJECT DESCRIPTION

Nature of Work:
The City of Santa Ana is seeking Contractors to provide structural seismic retrofit design services. A detailed Scope of Work is included in the Appendix of this RFP as Attachment 1.

Number of Proposals and Signature:
Five (5) hard copies and one (1) digital file on labeled USB Flash Drive (or equivalent). One of the hard copies shall be marked as “ORIGINAL” and shall be signed by a company official with the power to bind the company and submitted to the City of Santa Ana. One (1) copy of your Fee Proposal shall be submitted.

The Statement of Qualifications shall be limited to a maximum of (10) double-sided pages (excluding front and back covers, section dividers and attachments such as resumes, forms). Font size shall be minimum 11-point Arial. Proposal exhibits shall be maximum 11” x 17”.

Proposal Evaluation and Rating:
The criteria for evaluating the proposals submitted will take the following items into consideration:

- Firm/Team Experience 25%
- Understanding of Need 25%
- Relevant Project Experience 30%
- Schedule 10%
- References 10%

The City has established a proposal review committee to evaluate proposers based on the response to the RFP, which includes adherence to outlined directions and format, and the City evaluation criteria set forth above. A final score will be calculated for each submitted proposal and used to rank the proposers.

Prevailing Wages:
In accordance with the California State Labor Code, prevailing wage rates apply. Copies of the prevailing rate of per diem wages are on file with the Public Works Agency and shall be made available to any interested party on request.

Term of Contract Agreement:
The City desires to enter into a contract with the selected firm(s) for a period to be negotiated with the successful proposer based on the proposed schedule in the successful proposal and the needs of the City. This term will be specified in the Standard Consultant Agreement, as contained in the Appendix of this RFP as Attachment 2.
II. INSTRUCTIONS TO PROPOSERS

A. CITY RESPONSIBILITIES
   The City will provide information in its possession relevant to preparation of required
   information in RFP. The City will provide only the staff assistance and documentation
   specifically referred to herein.

B. PROPOSER RESPONSIBILITIES
   Point of Contact: The selected proposer will assume responsibilities for all services in its
   proposal. The selected proposer shall identify a sole point of contact with the greatest
   knowledge in regard to the required service operations and contractual matters, including
   payment of any and all charges resulting from the Agreement.

   Evidence of Financial Capacity: Proposer may be requested to submit its most recent audited
   financial statement, evidencing proposer’s financial capacity to fully perform the required
   services, including provision of equipment and personnel expenses over a ninety (90) day
   period. If said financial statement does not reflect full ninety (90) day operational capacity,
   proposer may include a letter of credit as evidence of supplemental capacity.

C. REQUEST FOR INFORMATION OR CLARIFICATION
   All questions or requested clarifications shall be made in writing via e-mail to the Project
   Manager (contact information as noted on the cover page to this RFP) no fewer than five (5)
   calendar days prior to the date and time set for opening of proposals. No verbal requests or
   responses will be accepted. Significant interpretations or clarifications will be addressed via
   addenda to this RFP.

D. ADDENDA
   Any changes in RFP from the date of release to date of submittal will result in an addendum
   or amendment. Notification of such addendum or amendment shall be posted on City’s
   website, santa-ana.org/bids-rfps as set forth in the Notice Inviting Proposals. Addenda shall
   become part of the agreement documents.

E. LICENSES & PERMITS
   The selected proposer shall be required to obtain a City of Santa Ana Business license within
   ten (10) business days of selection and must provide a copy to the City projects manager or
   designee prior to commencing any work in Santa Ana.

   Additionally, Proposer will be responsible for obtaining any licenses/permits required by the
   Scope of Work.

F. INSURANCE
   The Selected Proposer shall provide the required evidence of insurance coverage as set forth in
   the Scope of Work within ten (10) business days after receipt of notice that the contract has been
   awarded. Failure to provide the required insurance certificates shall be cause for the annulment
   of the award.
G. PAYMENT INFORMATION PACKET
The selected proposer shall return a completed payment information packet within ten (10) business days after the successful proposer has received notice that the contract has been awarded. The packet is available on the City’s website: santa-ana.org/bids-rfps.

H. PRE-PROPOSAL MEETING
Should a pre-proposal be scheduled, the date, time and location is identified on the cover page of this RFP. The meeting will include discussion of the project scope and a question-and-answer session. It is highly recommended that the Proposer’s key team members attend this meeting. Significant interpretations or clarifications will be addressed via addenda to this RFP, as described above in “Section D: Addenda.”

I. CITY RIGHT TO REJECT
The City reserves the right to reject any or all proposals submitted and no representation is made hereby that any contract will be awarded pursuant to this RFP or otherwise.

The City reserves the right to accept or reject the combined or separate components of this proposal in part or in its entirety or to waive any minor inconsistency, informality or technical defect in the proposal.

The City reserves the right to reject, replace and approve any and all subcontractors. All subcontractor(s) shall be identified in the response to the RFP. Subcontractors shall be the responsibility of the successful proposer and the City shall assume no liability of such subcontractors.

J. BID PROTESTS
Proposers with concerns or rebuttal of any staff determination of non-responsiveness or non-responsibility may submit, in writing within five (5) business days, to the Project Manager, any concerns regarding the RFP process or staff determination. Such writing shall be considered by the City Manager or his designated representative, and may be acted upon within five (5) business days. If no action is taken within such time, there shall be no change to the staff determination. The exercise by Proposer of its right to submit written concerns shall be a condition precedent to seeking judicial review of any award of a contract hereunder.
III. SUBMITTAL REQUIREMENTS

A. GENERAL

I. The number of Proposal Copies and signature is specified in:
   RFP SECTION I - INTRODUCTION / PROJECT DESCRIPTION.

II. Deadline:
   Proposals are due to the City of Santa Ana at the date, time, and location specified in the
   Notice Inviting Proposals.

B. PROPOSAL CONTENTS

The proposal format and page limitation, if any, is specified in:
RFP SECTION I - INTRODUCTION / PROJECT DESCRIPTION.

1. STATEMENT OF QUALIFICATIONS

   a. Cover Letter – Proposals shall include a letter signed by a principal or authorized
      representative who can make legally binding commitments for the entity.

   b. Contract Agreement Statement: Proposal shall include a statement outlining your
      concurrence or concerns with any and all provisions as contained in the Agreement
      attached herein as Attachment 2 in the Appendix.

   c. Firm and Team Experience: Proposal shall include a profile of the firm’s experience.
      Include resumes of project team/sub-consultants that will be providing services which
      outline their technical and design experience. At a minimum, this should include the
      project manager/principal agent, associates in charge when project manager/principal
      agent is unavailable, key personnel, firm size, and an organization chart identifying
      only those who will perform work for the proposed project and the percentage of each
      individual’s time devoted to this project. The project manager/principal agent shall
      be the primary contact person to represent your firm and will be the person to conduct
      the presentation, if invited for an interview.

   d. Understanding of Need: Proposal shall include an outline which demonstrates the
      firm’s understanding of the work. This outline should include anticipated approach,
      tasks necessary for successful completion, deliverables, and suggestions or special
      concerns that the City should be made aware of. Identify any assumptions and/or
      exclusions used in preparation of the scope of work and associated fee estimate.

   e. Relevant Project Experience: Proposal shall include a list of projects which your firm
      or personnel have completed within the last 5 years, including significant work with
      public agencies. Project information should include project description, year
      completed, client name, along with a person to contact and their telephone number.
f. References: Proposal shall include a listing of relevant projects with references for three public entities for which Proposer has performed similar work within the past five (5) years.

2. SCOPE OF SERVICES AND SCHEDULE:
   Proposal shall include a Scope of Services and Schedule which details the work phases to be completed, the tasks to be accomplished, the deliverables to be provided, and the schedule / timeline to complete the project, based upon the requested Scope of Work detailed in Attachment 1 of this RFP.

3. FEE PROPOSAL:
   The fee proposal shall be submitted concurrently with the technical proposal, but in a separately sealed envelope, clearly labeled as “Fee Proposal.” This shall include the firm’s Standard Hourly Fee Schedule, a table outlining the tasks and team hourly effort for each of the major tasks, and a Project Fee Schedule as outlined in the Scope of Work.

   The fee proposal will not be opened until the proposals have been evaluated by the proposal selection committee. The City will select the consultant based on qualifications, and then negotiate a contract price based on available funding.

4. CERTIFICATIONS:
   The following forms shall be signed and included as part of the proposal submittal package:
   - Attachment 3-1: Non-Collusion Affidavit
   - Attachment 3-2: Non-Lobbying Certification
   - Attachment 3-3: Non-Discrimination Certification

IV. PROPOSAL REVIEW (CONSULTANT SELECTION)

A. EVALUATION AND RATING
   The criteria for evaluating the proposals are specified in:
   RFP SECTION I - INTRODUCTION / PROJECT DESCRIPTION.

B. SELECTION
   The committee may interview the top ranking proposers. The City will recommend award of the contract to the proposer who will provide the best value to the City. City reserves the right to begin negotiations and enter into a contract without interview or further discussions.

V. CONTRACT AWARD

A. REQUEST FOR COUNCIL ACTION
Following evaluation and rating by the proposal review committee, the Project Manager will recommend award of a contract to the proposer providing the best value to the City.

B. EXECUTION OF AGREEMENT
The Scope of Services, Schedule, and Fees submitted in the proposal will be the basis of any negotiation of final terms which will lead to a completed agreement ready for execution based on the standard Agreement attached herein as Attachment 2 in the Appendix.

VI. IMPLEMENTATION

A. KICK-OFF MEETING
A kick-off meeting will be held after award of contract. Consultant and its team will meet with City of Santa Ana staff to conduct introductions, discuss scope of services, and implementation process.

B. NOTICE TO PROCEED
Following the kick-off meeting, a formal Notice to Proceed (NTP) may be issued after the agreement is fully executed, and all required bonds, insurance documents and contents of the Information Packet have been received and approved.

For “On-Call” contracts, Consultant will be notified by individual City Project Managers on a case-by-case basis to request project/task specific proposals. Written NTPs will be then issued accordingly.

VII. PUBLIC RECORDS
All data, documents and other products used, developed, or produced during response preparation of the RFP will become property of the City. All responses to the RFP shall become property of the City. Proposer information identified as proprietary information shall be maintained confidential, to the extent allowed under the California Public Records Act.

Proposals will become public record after award of contract. Proposer information identified as proprietary information shall be maintained confidential, to the extent allowed under the California Public Records Act.
Introduction and Background:

The City of Santa Ana (City) is inviting proposals from qualified engineering consultant firms (Consultant) with experience and technical qualifications to provide structural engineering services for the City Hall facility located at 20 Civic Center Plaza, Santa Ana, CA 92702. The existing concrete structure is approximately 130,000 gsf and includes eight (8) levels above grade and one subterranean level.

The City has elected to take a proactive approach to strengthen potentially vulnerable buildings by developing a seismic retrofit plan to increase life safety and minimize catastrophic building damage.

Description of Work:

The Consultant will evaluate the facility utilizing the provisions of ASCE 41-13. The Consultant will utilize a Tier 1 Screening Procedure and (if necessary) a Tier 2 Deficiency-Based Evaluation Procedure. The Consultant will alternatively utilize a Tier 3 Systematic Evaluation Procedure if required by the Authority Having Jurisdiction (AHJ), ASCE 41 and/or the California Building Standards Code.

The work associated with the evaluation will be performed in accordance with ASCE 41, and will include, but not necessarily be limited to the following:

- Assist City in the determination of the seismic Performance Objectives, including the Structural Performance Level, the Nonstructural Performance Level and the Seismic Hazard Level.
- Attend a pre-project meeting with all Authorities Having Jurisdiction to confirm evaluation procedure and determine additional permitting requirements.
- Obtain and review as-built information in accordance with ASCE 41, Section 3.2, including at least one site visit.
- Evaluate the structure using the Tier 1/Tier 2 procedures; or the Tier 3 procedure.
- Prepare and submit an evaluation report that complies with ASCE 41, Section 1.4.5, with the following additional information:
  - The information described in ASCE 41, Section C1.4.5, Items 1 through 3.
Schematic-level drawings, specifications and detailing depicting proposed retrofit schemes.
- Describe any deviations determined to be required, and the reasoning behind them.
- If needed, a schematic-level cost estimate for proposed retrofit schemes.

There is also a desire to evaluate whether or not this building can be classified as an essential services building (Risk Category IV) to allow an Emergency Operations Center (EOC) or similar use to be provided and maintained within this building during a catastrophic event. The selected consultant will need to provide a recommendation at the start of the project to determine feasibility and additional costs associated with the evaluation necessary to upgrade this building to Risk Category IV. In accordance with California Existing Building Code (CEBC) Section 407.4, a two-stage Tier 3 evaluation will be required, and will utilize BSE-1N and BSE-2N seismic hazards.

The proposals should outline the scope of work for a Tier 1-only evaluation; a Tier 1 and Tier 2 evaluation; and a Tier 3 evaluation.

The selected consultant will evaluate the current conditions and research applicable code, ADA, and environmental clearance requirements, and submit a practical and cost effective retrofit plan. If needed, the Consultant will prepare a schematic level Cost Estimate and prepare all necessary materials to transition into the design development phase of the project. As-built plans will be available upon request.

**Fee Proposal:**

In addition to Section III.B.3 (Submittal Requirements: Fee Proposal) fee schedule shall be structured as follows:

The cost proposal must include the projected staff hours, hourly rates, unit prices and reimbursable expenses for the project, as follows:

1. Itemized separate estimated breakdown for a Tier 1-only evaluation; a Tier 1 and Tier 2 evaluation; and a Tier 3 evaluation.

   a) Personnel costs - Itemized to show the following:

   1. Personnel by classification/responsibilities.
   2. Hourly rate for each classification.
   3. Estimated hours for each personnel category.
   4. Subtotal cost for each category.
   5. Total estimated personnel cost.

   b) Estimated reimbursable Expenses:

   1. Costs of supplies and materials (itemized).
   2. Travel - Transportation and per diem or subsistence listed separately, if any.
3. Any other direct charges.
4. Total estimated reimbursable expenses.

For services under this category, the Consultant shall be paid according to the rates set forth herewith and the actual reimbursable expenses.

c) Subtotal of a and b.

The fee proposal shall be for the following services as follows:

A. Fee to provide an ASCE 41, Tier 1 evaluation for the general screening of the building.

B. Fee to provide an ASCE 41, Tier 1 and Tier 2 evaluation for the general screening of the building.

C. Fee to provide an ASCE 41, Tier 3 evaluation for the general screening of the building.

The City reserves the right to award an agreement to the successful firm to provide any evaluation listed above or any combination of the service options outlined.
Appendix
ATTACHMENT 2
STANDARD AGREEMENT
CONSULTANT AGREEMENT  
CITY OF SANTA ANA

THIS AGREEMENT is made and entered into this [##] day of [Month], 20[##] by and between [Consultant Company Name] (“Consultant”), and the City of Santa Ana, a charter city and municipal corporation organized and existing under the Constitution and laws of the State of California, (“City”).

RE bâtALS

A. On [Month] [##], 20[##], the City issued Request for Proposal No. [##-###] (“RFP”), by which it sought a consultant to [briefly describe the expertise sought].

B. Consultant submitted a responsive proposal that was selected by the City. Consultant represents that it is able and willing to provide the services described in the scope of work that was included in the RFP.

C. In undertaking the performance of this Agreement, Consultant represents that it is knowledgeable in its field and that any services performed by Consultant under this Agreement will be performed in compliance with such standards as may reasonably be expected from a professional consulting firm in the field.

NOW THEREFORE, in consideration of the mutual and respective promises, and subject to the terms and conditions hereinafter set forth, the parties agree as follows:

1. SCOPE OF SERVICES

Consultant shall perform during the term of this Agreement, the tasks and obligations including all labor, materials, tools, equipment, and incidental customary work required to fully and adequately complete the services described and set forth in Scope of Services - Exhibit A, attached hereto and incorporated by reference.

2. COMPENSATION

a. City agrees to pay, and Consultant agrees to accept as total payment for its services for City, the rates and charges identified in Compensation - Exhibit B. The total amount to be expended under this Agreement shall not exceed [One Million Two Hundred Thirty-Four Thousand Five Hundred Sixty-Seven Dollars and Eighty-Nine Cents ($1,234,567.89)] during the term of this Agreement, including and extension periods exercised under Section 3.

b. Payment by City shall be made within 45 days (forty-five) days following receipt of proper invoice evidencing work performed, subject to City accounting procedures. Payment need not be made for work which fails to meet the standards of performance set forth in the Recitals which may reasonably be expected by City.

3. TERM

This Agreement shall commence on [Month ##, 20##] -OR- [the date first written above] and terminate on [Month] [##], 20[##], unless terminated earlier in accordance with Section 16, below. The term of this Agreement may be extended for [number #-year] period upon a writing executed by the City Manager and City Attorney.
4. **PREVAILING WAGES**

Consultant is aware of the requirements of California Labor Code Section 1720, et seq., and 1770, et seq., as well as California Code of Regulations, Title 8, Section 16000, et seq., (“Prevailing Wage Laws”), which require the payment of prevailing wage rates and the performance of other requirements on “public works” and “maintenance” projects. If the services being performed are part of an applicable “public works” or “maintenance” project, as defined by the Prevailing Wage Laws, and the total compensation is $1,000 or more, Consultant agrees to fully comply with such Prevailing Wage Laws. Consultant shall defend, indemnify and hold the City, its elected officials, officers, employees and agents free and harmless from any claim or liability arising out of any failure or alleged failure to comply with the Prevailing Wage Laws.

5. **INDEPENDENT CONTRACTOR**

Consultant shall, during the entire term of this Agreement, be construed to be an independent contractor and not an employee of the City. This Agreement is not intended nor shall it be construed to create an employer-employee relationship, a joint venture relationship, or to allow the City to exercise discretion or control over the professional manner in which Consultant performs the services which are the subject matter of this Agreement; however, the services to be provided by Consultant shall be provided in a manner consistent with all applicable standards and regulations governing such services. Consultant shall pay all salaries and wages, employer's social security taxes, unemployment insurance and similar taxes relating to employees and shall be responsible for all applicable withholding taxes.

6. **OWNERSHIP OF MATERIALS**

This Agreement creates a non-exclusive and perpetual license for City to copy, use, modify, reuse, or sublicense any and all copyrights, designs, and other intellectual property embodied in plans, specifications, studies, drawings, estimates, and other documents or works of authorship fixed in any tangible medium of expression, including but not limited to, physical drawings or data magnetically or otherwise recorded on computer diskettes, which are prepared or caused to be prepared by Consultant under this Agreement (“Documents & Data”). Consultant shall require all subcontractors to agree in writing that City is granted a non-exclusive and perpetual license for any Documents & Data the subcontractor prepares under this Agreement. Consultant represents and warrants that Consultant has the legal right to license any and all Documents & Data. Consultant makes no such representation and warranty in regard to Documents & Data which were provided to Consultant by the City. City shall not be limited in any way in its use of the Documents and Data at any time, provided that any such use not within the purposes intended by this Agreement shall be at City’s sole risk.

7. **INSURANCE**

Prior to undertaking performance of work under this Agreement, Consultant shall maintain and shall require its subcontractors, if any, to obtain and maintain insurance as described below:

a. Commercial General Liability Insurance. Consultant shall maintain commercial general liability insurance naming the City, its officers, employees, agents, volunteers and representatives as additional insured(s) and shall include, but not be limited to protection against claims arising from bodily and personal injury, including death resulting therefrom and damage to property, resulting from any act or occurrence arising out of Consultant’s operations in the performance of this Agreement, including, without

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limitation, acts involving vehicles. The amounts of insurance shall be not less than the following: single limit coverage applying to bodily and personal injury, including death resulting therefrom, and property damage, in the total amount of $1,000,000 per occurrence, with $2,000,000 in the aggregate. Such insurance shall (a) name the City, its officers, employees, agents, and representatives as additional insured(s); (b) be primary and not contributory with respect to insurance or self-insurance programs maintained by the City; and (c) contain standard separation of insureds provisions.

b. Business automobile liability insurance, or equivalent form, with a combined single limit of not less than $1,000,000 per occurrence. Such insurance shall include coverage for owned, hired and non-owned automobiles.

c. Worker’s Compensation Insurance. In accordance with the provisions of Section 3700 of the Labor Code, Consultant, if Consultant has any employees, is required to be insured against liability for worker’s compensation or to undertake self-insurance. Prior to commencing the performance of the work under this Agreement, Consultant agrees to obtain and maintain any employer’s liability insurance with limits not less than $1,000,000 per accident.

d. If Consultant is or employs a licensed professional such as an architect or engineer: Professional liability (errors and omissions) insurance, with a combined single limit of not less than $1,000,000 per claim with $2,000,000 in the aggregate.

e. The following requirements apply to the insurance to be provided by Consultant pursuant to this section:

   (i) Consultant shall maintain all insurance required above in full force and effect for the entire period covered by this Agreement.

   (ii) Certificates of insurance shall be furnished to the City upon execution of this Agreement and shall be approved by the City.

   (iii) Certificates and policies shall state that the policies shall not be canceled or reduced in coverage or changed in any other material aspect without thirty (30) days prior written notice to the City.

   (iv) Consultant shall supply City with a fully executed additional insured endorsement.

f. If Consultant fails or refuses to produce or maintain the insurance required by this section or fails or refuses to furnish the City with required proof that insurance has been procured and is in force and paid for, the City shall have the right, at the City’s election, to forthwith terminate this Agreement. Such termination shall not affect Consultant’s right to be paid for its time and materials expended prior to notification of termination. Consultant waives the right to receive compensation and agrees to indemnify the City for any work performed prior to approval of insurance by the City.
8. **INDEMNIFICATION**

   Consultant agrees to defend, and shall indemnify and hold harmless the City, its officers, agents, employees, contractors, special counsel, and representatives from liability: (1) for personal injury, damages, just compensation, restitution, judicial or equitable relief arising out of claims for personal injury, including death, and claims for property damage, which may arise from the negligent operations of the Consultant, its subcontractors, agents, employees, or other persons acting on its behalf which relates to the services described in section 1 of this Agreement; and (2) from any claim that personal injury, damages, just compensation, restitution, judicial or equitable relief is due by reason of the terms of or effects arising from this Agreement. This indemnity and hold harmless agreement applies to all claims for damages, just compensation, restitution, judicial or equitable relief suffered, or alleged to have been suffered, by reason of the events referred to in this Section or by reason of the terms of, or effects, arising from this Agreement. The Consultant further agrees to indemnify, hold harmless, and pay all costs for the defense of the City, including fees and costs for special counsel to be selected by the City, regarding any action by a third party challenging the validity of this Agreement, or asserting that personal injury, damages, just compensation, restitution, judicial or equitable relief due to personal or property rights arises by reason of the terms of, or effects arising from this Agreement. City may make all reasonable decisions with respect to its representation in any legal proceeding. Notwithstanding the foregoing, to the extent Consultant’s services are subject to Civil Code Section 2782.8, the above indemnity shall be limited, to the extent required by Civil Code Section 2782.8, to claims that arise out of, pertain to, or relate to the negligence, recklessness, or willful misconduct of the Consultant.

9. **INTELLECTUAL PROPERTY INDEMNIFICATION**

   Consultant shall defend and indemnify the City, its officers, agents, representatives, and employees against any and all liability, including costs, for infringement of any United States’ letters patent, trademark, or copyright infringement, including costs, contained in the work product or documents provided by Consultant to the City pursuant to this Agreement.

10. **RECORDS**

   Consultant shall keep records and invoices in connection with the work to be performed under this Agreement. Consultant shall maintain complete and accurate records with respect to the costs incurred under this Agreement and any services, expenditures, and disbursements charged to the City for a minimum period of three (3) years, or for any longer period required by law, from the date of final payment to Consultant under this Agreement. All such records and invoices shall be clearly identifiable. Consultant shall allow a representative of the City to examine, audit, and make transcripts or copies of such records and any other documents created pursuant to this Agreement during regular business hours. Consultant shall allow inspection of all work, data, documents, proceedings, and activities related to this Agreement for a period of three (3) years from the date of final payment to Consultant under this Agreement.

11. **CONFIDENTIALITY**

   If Consultant receives from the City information which due to the nature of such information is reasonably understood to be confidential and/or proprietary, Consultant agrees that it shall not use or disclose such information except in the performance of this Agreement, and further agrees to exercise the same degree of care it uses to protect its own information of like importance, but in no event less than reasonable care. “Confidential Information” shall include all nonpublic information.
information includes not only written information, but also information transferred orally, visually, electronically, or by other means. Confidential information disclosed to either party by any subsidiary and/or agent of the other party is covered by this Agreement. The foregoing obligations of non-use and nondisclosure shall not apply to any information that (a) has been disclosed in publicly available sources; (b) is, through no fault of the Consultant disclosed in a publicly available source; (c) is in rightful possession of the Consultant without an obligation of confidentiality; (d) is required to be disclosed by operation of law; or (e) is independently developed by the Consultant without reference to information disclosed by the City.

12. CONFLICT OF INTEREST CLAUSE

Consultant covenants that it presently has no interests and shall not have interests, direct or indirect, which would conflict in any manner with performance of services. Conflict may be further specified in Certifications - Exhibit C, attached hereto and incorporated in this Agreement by reference.

13. DISCRIMINATION

Consultant shall not discriminate because of race, color, creed, religion, sex, marital status, sexual orientation, age, national origin, ancestry, or disability, as defined and prohibited by applicable law, in the recruitment, selection, training, utilization, promotion, termination or other employment related activities. Consultant affirms that it is an equal opportunity employer and shall comply with all applicable federal, state and local laws and regulations and as further specified in Certifications - Exhibit C, attached hereto and incorporated in this Agreement by reference.

14. EXCLUSIVITY AND AMENDMENT

This Agreement represents the complete and exclusive statement between the City and Consultant, and supersedes any and all other agreements, oral or written, between the parties. In the event of a conflict between the terms of this Agreement and any attachments hereto, the terms of this Agreement shall prevail. This Agreement may not be modified except by written instrument signed by the City and by an authorized representative of Consultant. The parties agree that any terms or conditions of any purchase order or other instrument that are inconsistent with, or in addition to, the terms and conditions hereof, shall not bind or obligate Consultant or the City. Each party to this Agreement acknowledges that no representations, inducements, promises or agreements, orally or otherwise, have been made by any party, or anyone acting on behalf of any party, which is not embodied herein.

15. ASSIGNMENT

Inasmuch as this Agreement is intended to secure the specialized services of Consultant, Consultant may not assign, transfer, delegate, or subcontract any interest herein without the prior written consent of the City and any such assignment, transfer, delegation or subcontract without the City's prior written consent shall be considered null and void. Nothing in this Agreement shall be construed to limit the City's ability to have any of the services which are the subject to this Agreement performed by City personnel or by other consultants retained by City.
16. TERMINATION

This Agreement may be terminated by the City upon thirty (30) days written notice of termination. In such event, Consultant shall be entitled to receive and the City shall pay Consultant compensation for all services performed by Consultant prior to receipt of such notice of termination, subject to the following conditions:

a. As a condition of such payment, the Executive Director may require Consultant to deliver to the City all work product(s) completed as of such date, and in such case such work product shall be the property of the City unless prohibited by law, and Consultant consents to the City’s use thereof for such purposes as the City deems appropriate.

b. Payment need not be made for work which fails to meet the standard of performance specified in the Recitals of this Agreement.

17. WAIVER

No waiver of breach, failure of any condition, or any right or remedy contained in or granted by the provisions of this Agreement shall be effective unless it is in writing and signed by the party waiving the breach, failure, right or remedy. No waiver of any breach, failure or right, or remedy shall be deemed a waiver of any other breach, failure, right or remedy, whether or not similar, nor shall any waiver constitute a continuing waiver unless the writing so specifies.

18. JURISDICTION - VENUE

This Agreement has been executed and delivered in the State of California and the validity, interpretation, performance, and enforcement of any of the clauses of this Agreement shall be determined and governed by the laws of the State of California. Both parties further agree that Orange County, California, shall be the venue for any action or proceeding that may be brought or arise out of, in connection with or by reason of this Agreement.

19. PROFESSIONAL LICENSES

Consultant shall, throughout the term of this Agreement, maintain all necessary licenses, permits, approvals, waivers, and exemptions necessary for the provision of the services hereunder and required by the laws and regulations of the United States, the State of California, the City of Santa Ana and all other governmental agencies. Consultant shall notify the City immediately and in writing of its inability to obtain or maintain such permits, licenses, approvals, waivers, and exemptions. Said inability shall be cause for termination of this Agreement.

20. MISCELLANEOUS PROVISIONS

a. Additional provisions, if any, are identified in Additional Provisions - Exhibit D, attached hereto and incorporated into this Agreement by reference.

b. Each undersigned represents and warrants that its signature herein below has the power, authority and right to bind their respective parties to each of the terms of this Agreement, and shall indemnify City fully, including reasonable costs and attorney’s fees, for any
injuries or damages to City in the event that such authority or power is not, in fact, held by the signatory or is withdrawn.

c. All Exhibits referenced herein and attached hereto shall be incorporated as if fully set forth in the body of this Agreement.

21. NOTICE

Any notice, tender, demand, delivery, or other communication pursuant to this Agreement shall be in writing and shall be deemed to be properly given if delivered in person or mailed by first class or certified mail, postage prepaid, or sent by fax or other telegraphic communication in the manner provided in this Section, to the following persons:

To CITY:

Clerk of the City Council  
City of Santa Ana  
20 Civic Center Plaza (M-30)  
P.O. Box 1988  
Santa Ana, CA 92702  
Fax: (714) 647-6956

With courtesy copies to:

Executive Director, Public Works Agency  
City of Santa Ana  
20 Civic Center Plaza (M-21)  
P.O. Box 1988  
Santa Ana, CA 92702  
Fax: (714) 647-5635

City Attorney  
City of Santa Ana  
20 Civic Center Plaza (M-29)  
P.O. Box 1988  
Santa Ana, CA 92702  
Fax: (714) 647-6515

To CONSULTANT:

First Last  
Title  
Consultant Company Name  
Address  
City, State Zip  
Fax: (###) ###-####

A party may change its address by giving notice in writing to the other party. Thereafter, any communication shall be addressed and transmitted to the new address. If sent by mail, communication shall be effective or deemed to have been given three (3) days after it has been deposited in the United States mail, duly registered or certified, with postage prepaid, and addressed as set forth above. If sent by fax, communication shall be effective or deemed to have been given twenty-four (24) hours after the time set forth on the transmission report issued by the transmitting facsimile machine, addressed as set forth above. For purposes of calculating these time frames, weekends, federal, state, County or City holidays shall be excluded.
IN WITNESS WHEREOF, the parties hereto have executed this Agreement on the date and year first above written.

ATTEST:  

______________________________  ________________________________
MARIA D. HUIZAR  
Clerk of the Council  

RAUL GODINEZ II  
City Manager

CITY OF SANTA ANA

APPROVED AS TO FORM:

SONIA R. CARVALHO  
City Attorney

CONSULTANT:  

[Consultant Company Name]

[NAME]  
[Title]  
Tax ID# [##-#####]

By:  

______________________________  ________________________________
JOHN FUNK  
Assistant City Attorney  

RECOMMENDED FOR APPROVAL:

______________________________
EDWIN “WILLIAM” GALVEZ  
Acting Executive Director  
Public Works Agency
EXHIBIT A

SCOPE OF SERVICES
EXHIBIT B

COMPENSATION
Fee Proposal including hourly rates
NON-COLLUSION AFFIDAVIT

(Title 23 United States Code Section 112 and Public Contract Code Section 7106)

In conformance with Title 23 United States Code Section 112 and Public Contract Code 7106 the BIDDER declares that the bid is not made in the interest of, or on behalf of, any undisclosed person, partnership, company, association, organization, or corporation; that the bid is genuine and not collusive or sham; that the BIDDER has not directly or indirectly induced or solicited any other BIDDER to put in a false or sham bid, and has not directly or indirectly colluded, conspired, connived, or agreed with any BIDDER or anyone else to put in a sham bid, or that anyone shall refrain from bidding; that the BIDDER has not in any manner, directly or indirectly, sought by agreement, communication, or conference with anyone to fix the bid price of the BIDDER or any other BIDDER, or to fix any overhead, profit, or cost element of the bid price, or of that of any other BIDDER, or to secure any advantage against the public body awarding the contract of anyone interested in the proposed contract; that all statements contained in the bid are true; and, further, that the BIDDER has not, directly or indirectly, submitted his or her bid price or any breakdown thereof, or the contents thereof, or divulged information or data relative thereto, or paid, and will not pay, any fee to any corporation, partnership, company association, organization, bid depository, or to any member or agent thereof to effectuate a collusive or sham bid.

Note: The above Non-collusion Affidavit is part of the Proposal. BIDDERS are cautioned that making a false certification may subject the certifier to criminal prosecution.

Signed ____________________________________________

State of California
County of __________

Subscribed and sworn to (or affirmed) before me on this _____ day of ______, 20__, by ________________________, proved to me on the basis of satisfactory evidence to be the person(s) who appeared before me

Notary Public Signature ____________________________
Notary Public Seal _______________________________
NON-LOBBYING CERTIFICATION

The prospective participant certifies, by signing and submitting this bid or proposal, to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure of Lobbying Activities," in conformance with its instructions.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

The prospective participant also agrees by submitting his or her bid or proposal that he or she shall require that the language of this certification be included in all lower tier subcontracts, which exceed $100,000 and that all such subrecipients shall certify and disclose accordingly.

Signed: ________________________________

Title: ________________________________

Firm: ________________________________

Date: ________________________________
NON-DISCRIMINATION CERTIFICATE

The undersigned contractor or corporate officer, during the performance of this contract, certifies as follows:

1. The Contractor shall not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The Contractor shall take affirmative action to ensure that applicants are employed, and that employees are treated during employment without, regard to their race, color, religion, sex, or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.

2. The Contractor shall, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, or national origin.

3. The Contractor shall send to each labor union or representative of workers with which he/she has a collective bargaining agreement or other contract or understanding, a notice to be provided advising the said labor union or workers’ representatives of the Contractor’s commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

4. The Contractor shall comply with all provisions of Executive Order 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.

5. The Contractor shall furnish all information and reports required by Executive Order 11246 of September 24, 1965, and by rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his/her books, records, and accounts by the administering agency and the Secretary of Labor for purposes of investigation, to ascertain compliance with such rules, regulations, and orders.

6. In the event of the Contractor’s non-compliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, the contract may be canceled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further Government contracts or federally assisted construction contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order 11246 of September 24, 1965, or by rule, regulations, or order of the Secretary of Labor, or as otherwise provided by law.
7. The Contractor shall include the portion of the sentence immediately preceding paragraph (1) and the provisions of paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each subcontract or purchase order as the administering agency may direct as means of enforcing such provisions, including sanctions for noncompliance; provided, however, that in the event the Contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the administering agency, the Contractor may request that the United States enter into such litigation to protect the interests of the United States.

8. Pursuant to California Labor Code Section 1735, as added by Chapter 643 Stats. 1939, and as amended, no discrimination shall be made in the employment of persons upon public works because of race, religious creed, color, national origin, ancestry, physical handicaps, mental condition, marital status, or sex of such persons, except as provided in Section 1420, and any contractor of public works violating this Section is subject to all the penalties imposed for a violation of the Chapter.

Signed:  

Title:  

Firm:  

Date:  
Seismic Evaluation and Retrofit (02-28-2018)

Seismic Evaluation and Retrofit of Existing Buildings, Standard ASCE/SEI 41-17, describes deficiency-based and systematic procedures that use performance-based principles to evaluate and retrofit existing buildings to withstand the effects of earthquakes. The standard presents a three-tiered process for seismic evaluation according to a range of building performance levels by connecting targeted structural performance and the performance of nonstructural components with seismic hazard levels. The deficiency-based procedures allow evaluation and retrofit efforts to focus on specific potential deficiencies deemed to be of concern for a specified set of building types and heights. The systematic procedure, applicable to any building, sets forth a methodology to evaluate the entire building in a rigorous manner.

This standard establishes analysis procedures and acceptance criteria, and specifies requirements for foundations and geologic site hazards; components made of steel, concrete, masonry, wood, and cold-formed steel; architectural, mechanical, and electrical components and systems; and seismic isolation and energy dissipation systems. Checklists are provided for a variety of building types and seismicity levels in support of the Tier 1 screening process. This new edition, which updates and replaces previous editions of ASCE 41, introduces revisions to the basic performance objectives for existing buildings and to the evaluation of force-controlled actions. It revises the nonlinear dynamic procedure and changes provisions for steel and concrete columns, as well provisions as for unreinforced masonry.

Standard ASCE/SEI 41-17 is a primary reference for structural engineers addressing the seismic resilience of existing buildings and for building code officials reviewing such work; it also will be of interest to architects, construction managers, academic researchers, and building owners.

SUMMARY OF THE UPDATES TO ASCE/SEI 41-17

Tuesday, December 12, 2017

By Garrett Hagen, SE & Daniel Zepeda, S.E., SEAOSC Existing Buildings Committee Co-Chairs

ASCE/SEI 41 is the standard for seismic retrofit and evaluation of existing buildings, required for all federal buildings, as well as several recently passed California ordinances. There have been several important updates to the standard in the upcoming ASCE/SEI 41-17. The updates will have significant impacts on the evaluation and retrofit approach for a variety of existing buildings.

Significant revisions were included for the standard's Basic Performance Objectives, seismic hazard used in Tier 1 and Tier 2, treatment of force-controlled components, nonlinear analysis provisions, non-structural performance levels, demands on out-of-plane wall forces, modeling parameters and acceptance criteria of steel and concrete columns, and anchor testing. The summary below covers a majority of the major updates:

- Tier 1 and Tier 2 require using the BSE-2E, instead of the BSE-1E, for Risk Category I—III BPOE.
- Both BSE-1E and BSE-2E performance objectives required to be checked for Risk Category IV BPOE.
- New nonstructural performance level, Hazards Reduced, addresses items that can have the same life safety consequences as a partial building collapse and requires that level be evaluated in the BSE-2E hazard level for the BPOE.
- Checklists changed from Life Safety to Collapse Prevention, Limited Safety, or Life Safety checklists.
- Site specific response spectra and ground motion acceleration records are developed, selected and scaled to match the requirements in ASCE 7-16.
- A 1.3 factor augments demands on force controlled actions in the LSP and LDP when the performance objective is Life Safety and higher when demands are not determined using capacity design principals.
- Minimum number of acceleration histories needed for an analysis increased to 11.
- 10 of the 11 records cannot have an “unacceptable response” for Life Safety and lower and all 11 for Damage Control and higher.
- Overstress of a critical force controlled element, using expected strengths, in any record is considered an unacceptable response. This effectively requires all critical force controlled actions be designed for the maximum force in 10 or 11 records.
- One factor that increases force controlled demands in the NSP and NDP incorporated based on the criticality of the element and another factor for Life Safety and higher performance levels.
- Out-of-plane wall force and wall anchorage force equations revised.
- The material testing requirements for concrete are revised.
- SSI provisions further restrict their use with linear procedures.
- Steel columns are classified as force controlled and the modeling and acceptance criteria for them revised as well.
- Drift limit for panel zone acceptance added.
- Modeling and acceptance criteria for concrete columns updated.
- Testing of existing post-installed anchors in concrete added, such as tilt-up wall anchors.
- Requirements for URM spandrel beams added.
- Provisions for masonry infill rewritten.
- Penalty factor added to the capacity of wood structural panel walls and diaphragms when a 2x member is present instead of the 3x member that AWC SDPWS requires, i.e. when edge nailing along panel joints is 3” or less.
- Nonstructural provisions aligned with ASCE 7-16 Chapter 13.
- Seismic isolation and energy dissipation aligned with ASCE 7-16.
- URM Special Procedure to align with the IEBC Appendix A1.
A Summary of Significant Updates in ASCE 41-17

Robert Pekelnicky, SE
Degenkolb Engineers
San Francisco, CA

Garrett Hagen, SE
Degenkolb Engineers
Los Angeles, CA

Dave Martin, PE
Degenkolb Engineers
Oakland, CA

Abstract

ASCE/SEI 41 is the standard for seismic retrofit and evaluation of existing buildings, required for all federal buildings, as well as several recently passed California ordinances. This presentation provides an overview of the recent updates to the standard in the upcoming ASCE/SEI 41-17. Significant revisions were included for the standard's Basic Performance Objectives, seismic hazard used in Tier 1 and Tier 2, treatment of force-controlled components, nonlinear analysis provisions, non-structural performance levels, demands on out-of-plane wall forces, modeling parameters and acceptance criteria of steel and concrete columns, and anchor testing. The updates will have significant impacts on the evaluation and retrofit approach for a variety of existing buildings. This paper provides a high-level summary of the changes most likely to impact practice.

Introduction

ASCE 41-13 was a major advancement in the practice of seismic evaluation and retrofit. It combined the evaluation and retrofit standard, ASCE 31-03 and ASCE 41-06, in to one standard to eliminate inconsistencies between evaluation and retrofit and made significant technical changes to both standards (Pekelnicky & Poland, 2012). An update to the ASCE 41 standard was just completed. The update includes significant changes to the Basic Performance Objective for Existing Buildings, the linear and nonlinear analysis procedures, and the material specific provisions. This paper discusses the most significant changes to the standard.

At the beginning of the standard’s update cycle, the committee discussed a number of issues that could be potential updates. A very significant concern was raised by some committee members who practiced in the Midwest related to the seismic hazard level used for the Basic Performance for Existing Buildings (BPOE). These members expressed a primary concern around the change from ASCE 31-03, which used 2/3rds of the ASCE 7 Maximum Considered Earthquake as the hazard, to ASCE 41-13, which used an earthquake with a 20% probability of exceedance in 50 years. The committee members felt the change reduced the seismic hazard intensity used for Tier 1 and Tier 2 too much. In the most extreme case, the forces used in evaluation were one-seventh (1/7) that of ASCE 31-03. ASCE 31-03 did have more generous m-factors than ASCE 41-13, because the “break” for existing buildings was accomplished by increasing the commensurate m-factors in ASCE 41-06 by about 1.3 (the reciprocal of the historic 0.75 factor applied to the base shear for assessing existing buildings). However, the resulting evaluation using ASCE 41-13 resulted in such a discrepancy from ASCE 31-03 that committee members were concerned that hazardous buildings might be given a pass. The committee spent considerable time on this issue and proposed several changes to the BPOE.

As the ASCE 41 update cycle was beginning, the ASCE 7-16 update cycle was underway. As part of that cycle, significant changes to the ground motion parameters, site factors, and nonlinear response history analysis procedure had been proposed and approved. The committee felt that the method of determining seismic hazard parameters and site factors should not be different between standards, so it chose to simply reference ASCE 7 for that material instead of reciting it.
Because the nonlinear response history analysis procedure is a significant component of the ASCE 41 standard, there was a lot of deliberation about incorporating the changes made to that procedure in ASCE 7 into ASCE 41.

As with past cycles, there were many items identified where the standard was conservative, and recent research indicated that provisions could be changed to reduce some of that conservatism. This was especially true with steel columns. There were instances where the standard was potentially unconservative or did not provide sufficient guidance, specifically with the provisions for unreinforced masonry and masonry infill buildings. A significant addition to the standard was the creation of separate provisions for cold-formed steel light frame construction. More updates were proposed to better align the unreinforced masonry and masonry infill provisions with recent research.

**BPOE Changes**

ASCE 41-13 introduced the Basic Performance Objective for Existing Buildings (BPOE). The intent of the BPOE was to represent the reduced performance level for an existing building compared to that of a new building—a concept which had historically been deemed acceptable. The performance objectives in the ASCE 31-03 standard had been based on this concept and is why ASCE 31-03 was generally less conservative than ASCE 41-06 for the same performance objective (i.e. Life Safety in the 2/3*MCE). The most significant change that the BPOE made from ASCE 31-03 was in the seismic hazard used for a Tier 1 screening and Tier 2 evaluation. Instead of using 2/3*MCE with higher m-factors, ASCE 41-13 chose to specify a lower seismic hazard intensity and use the same m-factors and analysis procedure as ASCE 41-06, with appropriate updates. The committee chose the 20% probability of exceedance in 50 years shaking intensity as the BSE-1E hazard intensity to use for Tier 1 and Tier 2. The update also provided a reduced hazard comparable to the MCE, the 5% probability of exceedance in 50 years shaking intensity, which would be checked as a second performance objective in a Tier 3 evaluation. Table 1 below identifies the consequential hazards and related performance objectives corresponding to BPOE from ASCE 41-13.

<table>
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<tr>
<th>Risk Category</th>
<th>Tier 1 &amp; 2</th>
<th>Tier 3</th>
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<td>BSE-1E</td>
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<tr>
<td>I &amp; II</td>
<td>Life Safety Structural Performance</td>
<td>Life Safety Structural Performance</td>
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<td>Life Safety Structural Performance</td>
<td>Life Safety Nonstructural Performance (3-C)</td>
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<td>Life Safety Nonstructural Performance (3-C)</td>
<td>Nonstructural Performance Not Considered</td>
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<tr>
<td>III</td>
<td>Damage Control Structural Performance Position Retention Nonstructural Performance (2-B)</td>
<td>Damage Control Structural Performance Position Retention Nonstructural Performance (2-B)</td>
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<td>Damage Control Structural Performance Position Retention Nonstructural Performance (2-B)</td>
<td>(4-D)</td>
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<tr>
<td>IV</td>
<td>Immediate Occupancy Structural Performance Position Retention Nonstructural Performance (1-B)</td>
<td>Immediate Occupancy Structural Performance Position Retention Nonstructural Performance (1-B)</td>
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<tr>
<td></td>
<td>Immediate Occupancy Structural Performance Position Retention Nonstructural Performance (1-B)</td>
<td>(3-D)</td>
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</table>

In California, this change generally resulted in similar demands on components. For example, take the case of a three story reinforced concrete shear wall building governed by shear in the walls located in Los Angeles. 2/3*MCE = 1.44 and the 20%/50-yr is 0.84. The ASCE 31-03 m-factor for shear controlled walls is 2.5 and C = 1.0. Therefore the wall would be evaluated for an equivalent base shear in ASCE 31-03 of:
V/m = 1.0*1.44W/2.5 = 0.58W

The ASCE 41-13 m-factor is 2.0 and C_mC_r = 0.8*1.4 = 1.1. In ASCE 41-13, the wall would be evaluated for an equivalent base shear of:

V/m = 1.1*0.84W/2.0 = 0.46W.

In this case the ASCE 41-13 demand is about 80% of the ASCE 31-03 demand.

However, consider the same building in Memphis, TN, where 2/3*MCE = 0.93 and the 20%/50-yr = 0.13. In that case, the ASCE 31-03 equivalent base shear is:

V/m = 1.0*0.93W/2.5 = 0.37W

And the ASCE 41-13 equivalent base shear is:

V/m = 1.1*0.13W/2.0 = 0.07W

In this case, the ASCE 41-13 shear demand in the wall is one-fifth of what was used in ASCE 31-03. As engineers in that region and other regions outside of California began to use the ASCE 41-13 standard, a growing consensus arose which considered the reduction with respect to ASCE 31-03 to be too extreme.

The concern about the low reduction was not simply based on the discrepancy between ASCE 31-03 and ASCE 41-13. If a Tier 3 evaluation were required, the same building would also have to be evaluated for Collapse Prevention in the BSE-2E. If one were to take the LA building and Memphis buildings and calculate the equivalent base shear to evaluate the walls it would be:

Los Angeles

V/m = 1.1*1.76W/3 = 0.65W

Memphis

V/m = 1.1*0.71W/3.0 = 0.26W

In the case of Los Angeles, Collapse Prevention in the BSE-2E yields a slightly more conservative demand on the walls than ASCE 31-03. In Memphis, the demand is still less than ASCE 31-03, but the discrepancy is a 30% reduction as opposed to an 80% reduction. When comparing the demand from Life Safety in the BSE-1E to Collapse Prevention in the BSE-2E, it is clear that in Memphis there is a very significant difference. Which brings up the question of whether ASCE 41-13’s Tier 1 and Tier 2 approach of deeming the performance in the BSE-2E to be met by demonstrating performance in the BSE-1E.

The reason for these discrepancies come from the nature of the seismic hazard at the different sites. In the case of Los Angeles, the hazard is characterized by the possibility of extreme earthquakes and also other major earthquakes. While Memphis’ hazard is based on an extreme event, but no other appreciable seismic sources. Therefore, both sites will have large hazard intensity parameters for the MCE and the BSE-2E, but the hazard intensity parameters for the BSE-1E (20%/50 yr) are quite different. The lack of any moderate seismic sources around Memphis leads to a very small BSE-1E intensity relative to the BSE-2E and MCE.

After considerable deliberation, the committee felt that the best way to solve this issue was to change the BPOE for Tier 1 and Tier 2 so it required explicit evaluation of the performance objective based on the BSE-2E hazard and allowed the performance objective in the BSE-1E hazard to be deemed compliant for Risk Category I, II, and III buildings.

There is a reason Risk Category IV buildings are not in the list above to only consider performance at the BSE-2E for Tier 1 and Tier 2. That is because the committee felt that the difference between the Immediate Occupancy and Life Safety performance levels was large enough that one could not be assured that meeting Life Safety in the BSE-2E would demonstrate meeting Immediate Occupancy in the BSE-1E. As such, in ASCE 41-17, a Tier 1 and Tier 2 evaluation of a Risk Category IV building for the BPOE requires looking at two performance objectives. Table 2 summarizes the updated BPOE per ASCE 41-17.

**Hazards Reduced Nonstructural**

The discussion of structural performance in the BSE-1E versus the BSE-2E, moved to a discussion about nonstructural performance. Nonstructural hazards have not been evaluated at shaking intensities greater than the design earthquake, but for new design, the design earthquake is coupled with the MCE as opposed to being a separately defined hazard. Therefore, there is likely some margin of safety in the anchorage of nonstructural components if they experience a greater-than-design-level earthquake shaking. Concerns were raised that major nonstructural hazards could be ignored if the BSE-1E was very low, but the BSE-2E was significant.

The committee identified a small subset on nonstructural components whose failure represented as much a risk to the building occupants as a partial or total collapse of a building would. It was felt that such hazards should have a significant margin of safety beyond the BSE-1E hazard. The committee did not feel that such margin was warranted for falling hazards that pose a limited risk of death or injury to an isolated individual or would simply relate to property damage. With
that philosophy, the committee chose to create a new nonstructural performance level, Hazards Reduced, which would encompass mitigating only the most egregious nonstructural hazards. ASCE 41-06 and its predecessor FEMA documents had a Hazards Reduced nonstructural performance level that attempted to accomplish a similar objective.

Items which were incorporated into the Hazards Reduced nonstructural performance level are:

- Release of hazardous materials
- Failure of heavy cladding over sidewalks where many people congregate
- Failure of heavy ceilings in assembly spaces
- Failure of large architectural appendages and marquees
- Failure of heavy interior partitions and veneers

There is a note that permits components identified above to be excluded from the Hazards Reduced nonstructural performance level if it can be demonstrated that the component does not pose a threat of serious injury to many people due to falling or failing under the Seismic Hazard Level being considered.

Recognizing that an explicit evaluation of nonstructural components at the BSE-2E hazard level could result in demands greater than required for a new building, there is a statement capping the evaluation and retrofit requirements for any nonstructural components to be no greater than what is required in Chapter 13 of ASCE 7-16.

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**Table 2 – ASCE 41-13 Basic Performance Objective for Existing Buildings (BPOE)**

**Tier 1 & Tier 2 Structural Provisions**

The most significant changes to the Tier 1 Screening provisions and the Tier 2 Evaluation provisions were made in response to the change in the BPOE, requiring evaluation at the BSE-2E. In order to evaluate structural performance at the BSE-2E, the checklists and quick check procedures had to be revised to accommodate screening for the Collapse Prevention and Limited Safety structural performance levels, in addition to Life Safety. In researching the checklist development, the committee felt that all the items identified in the Life Safety structural checklists were there because they affect the collapse probability of the building. Therefore, the structural checklists could be retitled as Collapse Prevention with little change.
In updating the checklist from Life Safety to Collapse Prevention, the quick check equations were reviewed. Most of the quick check equations allow for a simplified and conservative assessment of structural element capacity against an estimated demand. That estimated demand is arrived at by dividing the unreduced Pseudo-lateral force, calculated as $CS_{s}W$, by a global response modification factor, $M_s$. The $M_s$ factors were not changed between ASCE 31-03 and ASCE 41-13, even though the demand was reduced from $2/3$MCE to the BSE-1E. To maintain parity, the $M_s$ factors should have been reduced to account for the reduced performance “break” being moved from the capacity side to the demand side. In adjusting the $M_s$ factors for Collapse Prevention, the committee elected to fix this omission by reducing the $M_s$ factors by 75% – the historic “break” for existing buildings – and then increased the $M_s$ factors by a factor of 1.5 to translate them from Life Safety to Collapse Prevention. The 1.5 factor was based on the judgement of the committee. Section 7.6 states that the ratio of Life Safety to Collapse Prevention component $m$-factors is 0.75. However, the committee felt that for system-based $M_s$ factors, the ratio could be slightly larger. The ratio of BSE-2E to BSE-1E shaking intensity parameters for much of the western US showed a range of 1.5 to 2.5. That information coupled with the view that global system behavior may have a slightly larger spread between Life Safety and Collapse Prevention, led the committee to choose 1.5 as the scale factor. The Limited Safety $M_s$ factors are to be interpolated between the Life Safety and Collapse Prevention $M_s$ factors.

The only major change to the benchmark building table was the elimination of the URM special procedure, including the IEBC Appendix A1, UCBC, and GRSB, as a benchmark standard. This was done because the change in the BPOE indicates that a building designed or retrofit to a benchmark standard should meet Collapse Prevention in the BSE-2E hazard. The committee consensus was that the URM special procedure provided Collapse Prevention performance at the hazard used to apply the procedure. In most cases that would be a shaking intensity of 50% to 100% of the new building design hazard, the BSE-1N, which is lower than the BSE-2E.  

There were some changes to specific statements in the Tier 1 structural checklists. Typically, the changes were to clarify the intent of the statement, eliminate conservatism, or further separate the requirements for Immediate Occupancy from Collapse Prevention. Checklist for CFS light frame buildings were created. Changes to the nonstructural checklists are discussed in the nonstructural section of this paper.

The majority of the changes to the Tier 2 procedure were in clarifying the appropriate level of analysis required and what needs to be evaluated based on the checklist statement that is found noncompliant. The bigger change to the Tier 2 procedure comes from the BPOE change, which now requires explicit consideration of the BSE-2E hazard performance objective.

**Linear Analysis**

The only significant change to the linear analysis procedure related to the treatment of force-controlled actions. In ASCE 41-13 and previous editions, there was no difference in how force-controlled actions were evaluated between various performance levels. All force-controlled actions were evaluated through a capacity-based design approach or using the following equation:

$$Q_{UF} = \frac{Q_{C}}{C_1 C_2 J}$$

The J-factor was either the lowest demand-to-capacity ratio in the load path or a value between 1 and 2 based on the level of seismicity at the site.

Not adjusting the force-controlled evaluation for performance levels creates a situation that is in conflict with the definition of Life Safety performance:

“Structural Performance Level S-3, Life Safety, is defined as the post-earthquake damage state in which a structure has damaged components but retains a margin against the onset of partial or total collapse. A structure in compliance with the acceptance criteria specified in this standard for this Structural Performance Level is expected to achieve this state.

The issue relates to the concept of providing a margin against collapse. Consider the force-displacement curve shown in Figure 1. Here you have a force-controlled element which has a demand that is within 5% of its capacity. If the demand had been 10% greater, the element would have failed.

Figure 1. Force-controlled action example.
The committee decided that in order to provide a margin of safety against collapse which is called for in the definition of Life Safety, there should be some margin against failure of a force-controlled action built into the provisions. To accomplish this, the equation to evaluate force-controlled actions was changes to be:

$$Q_{UF} = Q_o \pm \frac{Q_e \chi}{C_1 C_2 J}$$

The $\chi$ factor is 1.3 for Life Safety and high performance levels and 1.0 for the Collapse Prevention performance level. This provide the same margin between Life Safety and Collapse Prevention as Section 7.6 stipulates be provided for deformation controlled actions. The committee did not feel that any further increase beyond 1.3 for higher performance levels than Life Safety was justified.

It is important to note that the $\chi$ factor only applies when the demand is calculated using the pseudo-lateral force, $Q_o$, and not when the demand is calculated based on a capacity-based design. If the shear demand in a concrete column is based on the formation of a plastic moment at each end, then no $\chi$ factor amplification is required. However, if the demand is calculated based on the force reported from the analysis model divided by $C_1 C_2$ and a $J$ factor equal to the lesser DCR of the column bending moments or 2, then the $\chi$ factor would apply.

The other major update to the linear analysis provisions related to the design forces for walls subjected to out-of-plane forces and their anchorage to floor and roof diaphragms. An issue was identified which had the ASCE 41-13 provisions providing higher design forces for walls and their anchors when evaluating Collapse Prevention at the BSE-2N (ASCE 7 MCE_R) than would be required per ASCE 7. This was not intended. The goal of the ASCE 41 provisions is that they align with ASCE 7 provisions for the Basic Performance Objective for New Buildings (BPON). The reason for this misalignment was due to out-of-plane wall and anchorage equations being calibrated to performance objective the BSE-1N, but not the BSE-2N. This discrepancy was corrected in ASCE 41-17.

**Nonlinear Analysis**

The nonlinear dynamic procedure within ASCE 41 is a key component of the standard, and its provisions are frequently used to fill gaps in ASCE 7 for new design using nonlinear response history analysis. The 2015 NEHRP Provisions update included a complete re-write of the nonlinear response history analysis provisions found in ASCE 7. Those updates were then passed on to the ASCE 7 committee, which further refined them for incorporation into ASCE 7-16. It is common to have a nonlinear response history analysis show significant variation in building performance based on the ground motions records, Figure 2. The goal of the updates was to provide provisions targeted to the 10% probability of collapse in the MCE_R objective of ASCE 7. A detailed discussion of the updates can be found in our papers in *Earthquake Spectra* Vol. 32, No. 2 (Haselton et. al., 2017a&b, Jarret et. al, 2017, and Zimmerman et. al., 2017).

The ASCE 41 BPON targets Collapse Prevention in the BSE-2N (ASCE 7 MCE_R) for Risk Category II buildings. It can be inferred that providing a 10% probability of collapse means that the provisions have a 90% reliability of achieving collapse prevention. The committee adopted this level of reliability for the nonlinear dynamic procedure and incorporated many of the ASCE 7 updates. The three most significant updates relate to how ground motion acceleration histories are selected and scaled, what an unacceptable response is, and how force-controlled actions are treated. Some modifications to the ASCE 7-16 procedures were made.

The ground motion acceleration record selection and scaling updates to ASCE 7 are discussed in detail in Haselton et. al. (2017a). ASCE 41-17 now points directly to ASCE 7-16 for provisions to develop general and site-specific response spectra and how to select and scale ground motion acceleration records. The maximum component of the acceleration record is scaled instead of the square root sum of square of the record’s two horizontal components to the target spectrum. The target spectrum can be the general response spectrum, a
site-specific response spectrum, or multiple site-specific spectra, such as the Conditional Mean Spectrum approach per Baker (2011). 11 records are now required for each target spectrum, which can be randomly oriented unless the site is within 15 km of an active fault. In that case, the records should be applied based on the fault-normal and fault-parallel directions. The only major difference between ASCE 41-17 and ASCE 7-16 is the upper-bound period in the range used for scaling and matching need only be 1.5 times the largest first-mode period in the principal horizontal direction or 1 second, as opposed to 2 times the largest first-mode period. Both amplitude scaling and spectral matching are permitted, but there are penalties for using spectral matched ground motions.

In order to achieve the desired 90% reliability of the provisions, the way the standard addressed force-controlled actions was changed. The previous edition allowed one to compute the average of the maximum demand in a force-controlled element in each record and check it against the lower-bound capacity of the element. This approach had some potential issues. The first being that an analysis could show that the force-controlled action was overstressed in multiple ground motions, while the average was still less than the capacity. This would indicate that the element could fail in that record, and had the failure of that force-controlled action been modeled in the analysis, the building might show a collapse potential or the analysis not complete due to its failure. The provisions addressed this by creating a mechanism where force-controlled actions are placed in to one of three categories: Critical, Ordinary, or Noncritical. Critical force-controlled actions are those whose failure would lead to a collapse of multiple bays of the structure, such as the failure of a column. Ordinary are those whose failure would lead to collapse of a single bay, such as the failure of a beam’s connection. All other actions are noncritical. The equation to evaluate force-controlled actions in the nonlinear procedure is:

$$\gamma \chi (Q_{uf} - Q_g) + Q_g \leq Q_{ct}$$

Where $\gamma$ is the same amplification factor for performance levels higher than Collapse Prevention, and $\chi$ is a factor to amplify forces on critical force-controlled actions by 1.3. In the ASCE 7 provisions, the factor on critical force-controlled actions is 1.5, but it is checked against mean or expected capacities. The 1.3 amplification factor on the mean response of the earthquake component of the demand was derived assuming the same lognormal probability distribution discussed in Haselton et al (2017b) with the same coefficients of 0.45 for demand prediction and 0.15 for capacity prediction. With those assumptions, the gamma factor only needs to be 1.3 with mean minus one standard deviation (ASCE 41’s definition of lower-bound) material properties on the capacity to achieve a 90% reliability of not collapsing.

Another change to the ASCE 7 and 41 provisions is to allow one unacceptable response for Life Safety and lower performance levels. An unacceptable response is defined as an analysis run which failed to converge, the demands on the deformation-controlled actions exceed the valid range of modeling, demands on a critical force-controlled actions exceed the expected (not lower-bound) capacity of that action, or members not modeled exceeded deformation limits where they are able to carry gravity loads. All of these situations could be indicators that the ground motion record being applied to the model is causing instability with the potential for collapse. Since a minimum of 11 ground motion records are applied, a predicted collapse under one record is still within the desired 90% reliability of not collapsing. See Haselton et al (2017b) for more discussion. For example, the one record with 3% story drift in Figure 2 may be indicative of a potential collapse. However, the other ten records are all within the limits. Since the provisions target 90% reliability, not absolute certainty, this is acceptable for Life Safety and Collapse Prevention performance assessments.

**Steel Provisions Updates**

The most significant update to the steel provisions were changes to the modeling and acceptance criteria for steel columns. A series of studies were conducted by NIST to benchmark ASCE 7 and ASCE 41 to each other (NIST 2015a, 2015b, and 2015c). The studies looked at steel framed buildings of different heights designed to ASCE 7-10. Each building was subjected to all four analysis procedures contained within ASCE 41-06. The results showed the buildings which met the ASCE 7-10 and AISC 341-10 criteria did not meet the BPON. The main reason for the buildings failing to achieve the expected performance objective, as they were designed to the new building standard, pointed to a potential area of conservatism in how the standard treats steel columns. A number of committee members independently identified the same potential issue with steel column criteria.

The column provisions in ASCE 41-13 and previous editions require the ductility of a column be reduced from that of a beam once the axial force including both gravity loads and seismic forces exceeds 20% of the expected axial buckling capacity in the direction of bending ($P_{el}/P_{cl,x} > 0.2$). Like beams, the ductility (m-factor and nonlinear modeling and acceptance criteria) is also reduced if the columns flanges or webs do not meet the seismic compactness requirements of AISC 341-10. The columns then become force-controlled when the axial force ratio increases to more than 50% of the expected axial buckling capacity in the direction of bending ($P_{el}/P_{cl,x} > 0.5$). The transition to force-controlled when the axial force exceeds 50% of the expected axial capacity is what both the NIST reports and the committee member
investigations independently identified as the main source of likely conservatism.

A subcommittee reviewed a number of different research reports on the performance of steel columns under combined axial load and bending. Those reports are listed in Bech et al (2017), which also outlines the methodology used to develop the new column modeling parameters and acceptance criteria. A review of the reports indicated that the ductility of steel columns were most affected by sustained axial force, as opposed to the maximum transient axial force spike it may see during an earthquake. That led to the change of the column axial load ratio from the maximum axial load divided by the expected capacity to the gravity load divided by the yield capacity. Additional research indicated that the axial buckling capacity could be replaced by the yield capacity in the denominator. A regression analysis of the data from the papers showed that the ductility of the column could be expressed as a function of the gravity axial load ratio, the web and flange compactness ratios (h/tw and b/2tf), and the length divided by the weak-axis radius of gyration (L/r_y). Both the m-factors and the nonlinear modeling and acceptance parameters were updated based on this research and will yield less conservative assessments of columns in steel buildings.

The other significant update to the steel provisions was the introduction of rotation limits to the evaluation of moment frames when panel zones yield before the beams. The provisions of earlier editions were found to be potentially unconservative because they did not distinguish if the connection of the beam to column was made with notch tough weld metal or older weld metal with a high fracture potential. Further, the panel zone criteria did not account for the flexibility of the flange or the axial load on the panel zone. The new provisions account for both in the nonlinear procedure and axial force in the linear procedure.

Concrete Provisions Updates

In the current operating structure of ASCE 41, the technical changes for concrete provisions are provided by ACI Committee 369, Seismic Repair and Rehabilitation, prior to the ASCE 41 main committee voting to approve. The primary changes from the committee in this cycle involved the testing of existing anchors, updated modeling parameters and acceptance criteria for concrete columns, updated wall stiffness provisions, and clarifications regarding the evaluation of concrete elements with net tension.

The addition of testing requirements for existing concrete anchors was one of the most critical changes for the concrete chapter. In many existing concrete buildings, there are existing cast-in-place and post-installed connections of structural and nonstructural components necessary for transferring seismic forces or anchoring falling hazards (e.g., out-of-plane wall anchorage, anchorage of heavy equipment in evacuation route). Until more recent building codes, these anchors were not designed and installed per well-defined design procedures and quality control requirements, and there were typically no testing requirements, especially for post-installed mechanical and adhesive anchors. ASCE 41-13 contained requirements to test concrete cores and steel reinforcement, however there were no requirements for critical connection elements to establish design strength. The strength of concrete anchors is exceptionally sensitive to the installation method used, and thus the expected performance of existing anchors in a seismic event is difficult to predict in the absence of testing. The committee thus decided to add minimum testing requirements for usual and comprehensive data collections for existing cast-in-place and post-installed anchors. The testing frequency was selected to mimic the number required for reinforcement testing, and the testing loads were tied to the necessary design strength.

Another major revision in the concrete provisions involved concrete columns. Ghannoum and Matamoros (2014) summarize much of the work that led to column modeling changes, resulting in column parameters in the form of equations rather than the past table form. The new equation format makes it easier to calculate modeling parameters (MP’s) for different conditions and removes the need for triple interpolation required in previous editions of ASCE 41.

The ASCE 41-13 column parameters had conservative reductions embedded in the MP table values, however the committee felt any conservatism should be placed on the acceptance criteria instead so as to avoid skewing analytical results. As such, the modeling parameter “a” and “b” values are meant to represent the “best estimate” based on extensive test data, consistent with Section 7.6 of ASCE 41. Since the column test data showed superior performance for circular columns as compared to rectangular columns, the MP’s were also broken up into separate equations for circular and rectangular columns in ASCE 41-17.

In addition to the anchor testing and column provisions, other technical concrete changes improved the evaluation of structural walls and elements with net axial tension, also leading to more consistency between linear and nonlinear procedures. Test data and fiber analysis of walls demonstrate more flexibility for structural walls than the previously employed effective stiffness modifier of 0.5. The increased flexibility in wall buildings could be critical when increased deformation demands on the non-ductile concrete gravity-force-resisting elements could lead to collapse. The stiffness modifier was thus reduced to 0.35 for walls, and commentary was added for an alternate “constant yield curvature” approach. The proposed alternate approach results in far more parity with
nonlinear fiber analysis and also captures the effects of wall reinforcing and axial demands.

The change for elements in net tension was another which had notable consequences for linear procedures. Linear analyses frequently result in high tension demands on some wall and column elements. Strict adherence to ASCE 41-13 required axial demands to be evaluated as force-controlled actions, which is appropriate for concrete elements in compression. However the committee felt that the requirements led to unnecessary conservatism for elements in net tension, which were expected to behave in a more ductile manner than their compression-loaded counterparts. Axial demands in tension were thus clarified to be analyzed as deformation-controlled actions. This change, along with the changes for wall stiffness, are expected to provide more consistency between ASCE 41 linear and nonlinear procedures.

Masonry Provisions Updates

The masonry provisions underwent a number of significant updates. There were updates to the assessment of out-of-plane actions in unreinforced masonry walls based on research. The collapse prevention evaluation can still be carried out using the table that provides maximum h/t ratios. For life safety, an assessment of the wall for dynamic stability based on Penner and Elwood (2016) has been added. The assessment is for walls with h/t > 8 and compares the 1.0s acceleration parameter against a series of coefficients multiplied together. The coefficients account for the wall aspect ratio, the diaphragm flexibility, the height of the walls in the building, and the axial force on the walls. For Immediate Occupancy, the walls must not experience any overstress in the flexural tension strength of the mortar under out-of-plane loading.

ASCE 41-13 commentary discussed the potential impact on spandrel beams on the performance of unreinforced masonry walls, but there was not sufficient research available at the time to develop provisions. There were however provisions for unreinforced masonry spandrel beams added. Equations are provided to determine the shear and flexural capacity of a spandrel beam, which are based whether there is a lintel or a masonry arch supporting the spandrel beam. Shear and flexure can be considered deformation-controlled actions.

The provisions for steel and concrete frames with masonry infill were completely rewritten and provide an easier method to model masonry as a compression strut within the frame. The panels are classified as strong or weak and flexible or stiff with respect to the frame. There are different modeling parameters and capacities if the frame is non-ductile concrete or either ductile concrete or steel framing encased in concrete. The acceptance criteria for the infill panels is based on the ratio of the strength of the frame without the panels to the strength of the infill panels and the aspect ratio of the panels. The criteria for out-of-plane actions when considering arching action has also been updated.

Additional Updates

There were a number of other updates made to the standard. Below is a summary of some:

- Revisions to the soil structure interaction provisions related to their applicability and limitations on response parameter reductions.
- Updates to the seismic isolation and energy dissipation provisions, now in separate chapters, to make them consistent with updates made to those provisions in ASCE 7-16.
- Requirements to test existing anchors securing nonstructural components.

Acknowledgements

Over 100 practitioners, academics, and industry representatives participated in the ASCE/SEI Standards Committee for Seismic Evaluation and Retrofit. Unfortunately space prohibits listing everyone, but their names can be found in ASCE 41-17. However the enormous effort that was undertaken to combine and update the standards could not have been accomplished without the painstaking volunteer work of several key individuals. Peter Somers, Brian Kehoe, and James Parker each led subcommittees and were members of the steering committee. Fred Turner, Bill Tremayne, Mark Moore, Jay Harris, Wassim Ghannoum, Phil Line, Bonnie Manley, Mahmoud Hachem, Ron Hamburger, Brue Maison and Ron Mayes all led various subcommittees or issue teams. Mike Mahoney from FEMA provided support for the effort which greatly moved the process along. Jennifer Goupil, Laura Champion, James Neckel, and John Esslinger of the American Society of Civil Engineers were instrumental in moving the standard along and allowed the committee to meet its aggressive schedule.

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http://dx.doi.org/10.6028/NIST.TN.1863-1.


http://dx.doi.org/10.6028/NIST.TN.1863-3.


Abstract

For the past 3 years the ASCE/SEI Standards Committee on Seismic Rehabilitation has been working to combine ASCE 31-03 into ASCE 41-06 while also updating both standards. The result of that humongous effort is the soon-to-be released ASCE 41-13: Seismic Evaluation and Retrofit of Existing Buildings. The new combined standard has eliminated any inconsistencies that previously existed between the two standards. Now the user decides if they want to go forward with lower performance objectives traditionally used for existing buildings, as was the case within ASCE 31 or an equivalent hazard to a new building, similar to the Basic Safety Objective in ASCE 41. In addition, the Tier 1 checklists have been significantly modified and reorganized. The use deficiency-only procedures (Tier 2) have been greatly expanded to regular buildings of greater heights. Plus, there have been a number of significant technical changes including updated analysis provisions with more emphasis on nonlinear response history analysis, provisions for bucking restrained braced frames, expanded liquefaction provisions, a new foundation rocking analysis procedure, substantially updated URM provisions, and a full updated Chapter on Seismic isolation and Energy dissipation.

Introduction

ATC 14 (1987) and FEMA 273 (1997) were both landmark documents. Each represented major turning points in how the profession addressed evaluating the seismic hazards posed by existing buildings and mitigating those hazards through retrofit. ATC 14 created the concept of screening buildings for potential deficiencies which had been observed in similar buildings in major earthquakes to increase a building’s risk to life safety. FEMA 273 was the first time that “displacement-based” methodologies were set forth and guidelines for nonlinear analysis of all types of building structures were provided. Prior to those documents, seismic evaluation and retrofit was left solely to the judgment of the practitioner as he or she attempted to use standards intended for new building design to evaluate and retrofit existing buildings.

Following the publication of both ATC 14 and FEMA 273, the Federal Emergency Management Agency (FEMA) began to support efforts to transition those documents from guidelines into national standards. Those efforts produced updated documents in pre-standard form (FEMA 178, 1992; FEMA 310, 1998; and FEMA 356, 2000). In addition to altering the text of those documents to be enforceable standards language, many technical updates were also incorporated. Also, the displacement based analysis procedures from FEMA 273 were simplified and incorporated into FEMA 310 to bring some consistency to the two documents.

The standardization efforts culminated with the publication of ASCE 31-03 Seismic Evaluation of Existing Buildings in 2003 and then in 2006 with ASCE 41-06 Seismic Rehabilitation of Existing Buildings. These documents were produced following ASCE’s standards development process, which required significant balloting of both pre-standard documents through a diverse committee of practitioners, academics, and industry representatives followed by a public comment period. All comments made throughout the process were responded to by the ASCE/SEI Standards Committee on Seismic Rehabilitation. In one instance significant public comments to ASCE 41-06 led to the publication of a supplement to that document (ASCE, 2008).

From ATC 14 through ASCE 31-03 and from FEMA 273 through ASCE 41-06, these documents have found widespread use throughout the profession, especially in California and within the Federal Building Standards RP4,
RP6 and RP 8. Regulatory agencies, such as OSHPD and DSA, public building owners, such as the US General Service Administration, and the Department of Veterans Affairs, have directly referenced or permitted the use of these documents to evaluate and retrofit existing buildings.

As the documents were used more and more, inconsistencies were discovered between ASCE 31 and ASCE 41. Many of the inconsistencies were intentional. The most significant being the ingrained philosophy that existing buildings should be given a break when being evaluated and therefore not be held to the same standards as a new building. While another philosophy held that if someone choses to carry out a seismic retrofit, they should do so to a performance level commensurate with a new building unless some other performance objective is intentionally and explicitly chosen. Other inconsistencies were created because of the simplification of the ASCE 41 analysis procedures and member acceptance criteria in ASCE 31. Lastly, inconsistencies were created because the base documents, ATC 14 and FEMA 273, were transitioned into standards documents on different schedules, out of phase with each other, with some differences in the committee membership making those revisions.

Another issue of consternation within the profession was the inconsistencies between ASCE 41 and ASCE 7 (2010). Many of these inconsistencies had been known since the publication of FEMA 273 and relate to the fundamentally different applications of the two standards. The different applications led to differences in procedures between the two documents. Because ASCE 7 was written for use in the design of new structures, it can employ “force-based” procedures which utilize a global building ductility factor, the R-factor, based on the details of construction. ASCE 41 uses “displacement-based” procedures which assess the ductility of each element action (shear, flexure, etc.) individually because the ductility of the individual elements in the structural system may not be consistent with each other. Irrespective of discrepancies within procedures, the intended performance objective for a typical Risk Category II building is the same in ASCE 7 as the Basic Safety Objective in ASCE 41. As before, ASCE 7 does not contain specific guidance on the use of nonlinear analysis procedures, ASCE 41 has often been used as the basis for new building designs which utilized nonlinear analyses.

When the standards committee met in December 2009 to kick-off the update cycle for ASCE 31 and 41, the aforementioned inconsistencies were at the forefront of everyone’s mind. Another topic that garnered a lot of discussion was a proposition to combine ASCE 31 and 41 into one standard. At that meeting, the committee broke up into 3 subcommittees. One was tasked with looking at what technical updates to ASCE 41 should be made, another was tasked with looking at what updates and simplifications could be made to the ASCE 31 Tier 1 screening, and the last was tasked with determining if the documents should be combined or stay as separate, but well-coordinated standards. Once the ASCE 41 subcommittee determined the technical updates needed, it created technical issue teams to address all of those updates.

**Combined Standard**

The committee chose to combine the standards into one document and coordinate the evaluation and retrofit procedures. The combined standards retains the three-tiered approach found in ASCE 31-03, while relying on the technical provisions in ASCE 41-06 as the basis for all the analytical procedures.

The Tier 1 Screening is essentially the same as it was in ASCE 31-03, with some reorganization and technical changes to the checklists. Those changes are discussed in more detail later in the paper. The Screening is still intended as the first pass that one would make through the building to get familiar with it. It is intended only to be used as an evaluation method and not for retrofit design.

The Tier 2 “Deficiency-Based” procedure is now intended to be used for either evaluation or retrofit. As before, the user can go further in evaluating all the potential deficiencies identified in the Tier 1 screening or simply chose to fix those potential deficiencies with a retrofit design. Unlike ASCE 41-06, there is no difference in building size when a deficiency-based retrofit can be used versus when a deficiency-only evaluation can be performed. Previously the retrofit requirements were significantly more restrictive.

In order to eliminate inconsistencies within the document, the specific Tier 2 analysis procedures and ASCE 31-03m-factors were eliminated. The user is pointed to the subsequent sections of the standard that are used for Tier 3 for analysis procedures and m-factors. The benefit to this is that there is no difference between Tier 2 and Tier 3 in terms of force demands or member acceptance criteria. The only issue with this is that users of ASCE 31-03 who are not familiar with ASCE 41 procedures may find it difficult at first due to all the additional material they have to read and greater number of possible m-factors. The committee made every possible effort to alleviate this by providing a detailed flow chart and specific pointers throughout the chapter that contains the Tier 2 procedures to the appropriate sections in the rest of the standard. The benefit, of course, is a better analysis because it is more specific.
In merging the two documents, the committee felt that the “Full-Building” Tier 2 in ASCE 31-03 was really no different than a systematic evaluation. Since the Tier 3 procedure was thought to be a systematic (as opposed to deficiency-based) evaluation or retrofit, it was felt that there was no need for this separate procedure. Therefore the “Full-Building” Tier 2 procedure was eliminated, so Tier 2 now only refers only to “Deficiency-Based” procedures and where one would previously have performed a “Full-Building” Tier 2, they now perform a Tier 3 evaluation.

The Tier 3 procedure is intended to be a systematic analysis of the building, which can be used either for evaluation or retrofit. The Tier 3 procedure encompasses all four analysis (Linear Static, Linear Dynamic, Nonlinear Static, and Nonlinear Dynamic) procedures from ASCE 41-06. The user can chose to apply any procedure, subject to specific limitations for each procedure. However, the permission to use a new building design standard for Tier 3, which was permitted in ASCE 31-03, has been eliminated because the new building standard cannot be properly applied to an existing building unless a completely new structural system is provided.

The outline of the new standard is as follows:

Chapter 1 General Requirements  
Chapter 2 Seismic Performance Objectives and Ground Motions  
Chapter 3 Evaluation and Retrofit Requirements  
Chapter 4 Tier 1 Screening  
Chapter 5 Tier 2 Deficiency-Based Evaluation and Retrofit  
Chapter 6 Tier 3 Systematic Evaluation and Retrofit  
Chapter 7 Analysis Procedures and Acceptance Criteria  
Chapter 8 Foundations and Geologic Site Hazards  
Chapter 9 Steel  
Chapter 10 Concrete  
Chapter 11 Masonry  
Chapter 12 Wood and Cold-Formed Steel  
Chapter 13 Architectural, Mechanical, and Electrical Components  
Chapter 14 Seismic Isolation and Energy Dissipation  
Chapter 15 System-Specific Performance Procedures  
Chapter 16 Tier 1 Checklists  
Appendix A Guidelines for Deficiency-Based Procedures  
Appendix B Use of ASCE 41-13 within Mitigation Programs

The new standard is based on the philosophy that procedurally there is no difference between evaluation and retrofit design. Retrofit design is simply evaluating a building in an altered state and adjusting the alterations until the building’s evaluation meets the desire performance objective. Therefore there is no difference between a Tier 2 or Tier 3 evaluation or retrofit. The analysis procedures and acceptance criteria are the same. If the user wishes to carry out an evaluation or retrofit with the intention of accepting higher risk of collapse or lesser performance, as was the case with ASCE 31-03, then the user must now explicitly choose a lesser seismic hazard or a lesser performance level.

New Earthquake Hazard Parameters

As discussed earlier, it has been a commonly accepted within the profession to evaluate existing buildings to a lower force level than new buildings. The most common way this was carried out was to use 75% of new building design forces. That concept was contained with ATC-14 and carried through to ASCE 31-03. In the Tier 2 procedures in ASCE 31-03 the 75% factor was actually buried within the m-factors. Those m-factor were approximately 1.33 (1/0.75) times their ASCE 41-06 counterparts, with some additional simplifications. Then in the Tier 3 procedure of ASCE 31-03, the user was explicitly directed to use a standard such as ASCE 41-06 or ASCE 7-05 and multiply the demand forces by 0.75.

The committee agreed that the philosophy of permitting existing buildings to be evaluated, and even upgraded, to a lower hazard should be retained. There are a number of reasons for this, which are discussed in detail in the ASCE 41-13 Chapter 2 commentary. They are:

- Permitting buildings recently built to not be immediately rendered deficient when there are minor changes to the new design standards.
- The increased risk due to the lower hazard is acceptable because of the presumption that an existing building has a shorter remaining life than a new building.
- The cost of retrofitting to achieve commensurate performance can be disproportional to the increased benefit as opposed to doing something to make the building better by mitigating the most egregious deficiencies.

With the decisions to retain the philosophy of allowing existing buildings to be evaluated and possibly upgraded to a lower hazard than new buildings, the question then became what that hazard should be. While the 0.75-factor has been engrained within the profession for many years, it is somewhat arbitrary. The committee chose to follow the path put forth in the 2010 California Building Code in the section
on accepted seismic performance for state-owned building which utilized different return period seismic hazard parameters instead of the 0.75-factor.

In Section 3417 of the CBC two reduced earthquake hazards are stipulated to correspond to the BSE-1 and BSE-2 hazards in ASCE 41-06.

In ASCE 41-06 the BSE-2 hazard is the same as the ASCE 7-05 Maximum Considered Earthquake (MCE), which is an earthquake with a 2% probability of exceedance in 50 years (a 2,475-year return period), 150% of the mean deterministic earthquake, or some pre-determined “water-level” parameters (see Part 2 of the 2009 NEHPR for discussion on the “water-level” parameters). The BSE-1 is the lesser of an earthquake with a 10% probability of exceedance in 50 years (a 475-year return period) or 2/3 of the BSE-2 parameters.

The stipulated reduced hazard for existing state owned buildings in the 2010 CBC is an earthquake with a 5% probability of exceedance in 50 years (a 975-year return period) for the BSE-2 and for the BSE-1 is an earthquake with a 20% probability of exceedance in 50 years (a 225-year return period).

The committee chose to retain the BSE-X designation for the seismic hazards. Therefore, the 5%/50 hazard was named the BSE-2E and the 20%/50 hazard was named the BSE-1E. The suffix “E” was introduced to designate that these are reduced hazards associated with existing buildings.

Since ASCE 41-06 had a performance objective that was commensurate with what was commonly accepted for new buildings, the committee felt it important to retain the option to have performance objectives equivalent to new buildings standards. Therefore the committee chose to include a second pair of seismic hazard parameters which would be the Risk Adjusted MCE (MCE_R) and the Design Basis Earthquake (DBE) from ASCE 7-10. These hazards were named the BSE-2N and BSE-1N respectively, with the “N” suffix indicating new building standards equivalent hazards.

Table 1 shows the short period, $S_{XX}$, parameter for the four different hazards and Table 2 shows the long period, $S_{XX}$, parameter for the four different hazards. These unpublished results were produced by Nico Luco at USGS for the Committee.

<table>
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<tr>
<th>Region</th>
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<th>BSE-1N</th>
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Table 2 – Long Period Hazard Parameters

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</table>

As can be seen from the tables there are some locations where the ratio of new to existing demand is close to .75; showing little change. There are isolated cases where it is higher or lower. This is a consequence primarily of the deterministic caps imposed on the ASCE 7-10 MCE. The committee felt that obviously the “E” hazard should never be greater than the “N” hazard, and thus the “E” hazards would be capped at the “N” hazard values. The committee did not believe that a different deterministic cap for the “E” hazards was appropriate. For regions where there is little to no difference between the BSE-2N and BSE-2E, it was believed that signified the seismic hazard to be great enough that the existing buildings should not be given the traditional break.

**ASCE 41-13 Performance Objectives**

The concept of marrying seismic hazard levels with structural and nonstructural performance levels to create a performance objective was retained in ASCE 41-13. Both ASCE 31-03 and ASCE 41-06 had various performance objectives set forth explicitly. ASCE 41-13 has two sets of explicitly defined performance objectives, the Basic Performance Objective for Existing Buildings (BPOE) and the Basic Performance Objective Equivalent to New Building Standards (BPON). In addition to those two sets of explicit performance objectives, ASCE 41-13 retains the Enhanced Performance Objective and Limited Performance Objective categories.

The Basic Performance Objective for Existing Buildings (BPOE) uses the BSE-1E and BSE-2E hazard levels. Unlike ASCE 41-06, the BPOE is not a single performance objective, but rather a table of different performance objectives based on the Risk Category that would be assigned to a building. The decision to map the performance objectives to Risk Categories was made because the widespread use of ASCE 31-03 and ASCE 41-06 had led to numerous building codes, various federal state and local jurisdictions, and engineers to do their own mapping of the Risk Categories to performance objectives, without consistency. The committee felt that it was important for there to be some standardization of this practice and therefore it was brought into the BPOE. Table 3 summarizes the BPOE.

This set of performance objectives are intended to be the one that approximates the performance objectives within ASCE 31-03 which accepted a higher level of risk. The BPOE is used for all three tiers of evaluations. With Tier 1 and Tier 2 only requiring evaluation at the BSE-1E level and Tier 3 requiring evaluation at both the BSE-1E and BSE-2E levels.
Table 3 – Basic Performance Objective for Existing Buildings (BPOE)

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<tr>
<th>Risk Category</th>
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<th>Tier 3</th>
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<tr>
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<td>BSE-1E</td>
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<td>Life Safety Nonstructural Performance (3-C)</td>
<td>Life Safety Nonstructural Performance (3-C)</td>
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<td>III</td>
<td>See Note 1 for Structural Performance Position Retention Nonstructural Performance (2-B)</td>
<td>Damage Control Structural Performance Position Retention Nonstructural Performance (2-B)</td>
<td>Damage Control Structural Performance Position Retention Nonstructural Performance (2-B)</td>
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<td>Immediate Occupancy Structural Performance Position Retention Nonstructural Performance (1-B)</td>
<td>Immediate Occupancy Structural Performance Position Retention Nonstructural Performance (1-B)</td>
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<tr>
<td></td>
<td></td>
<td>Life Safety Structural Performance Nonstructural Performance Not Considered (4-D)</td>
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</table>

The reason that Tier 1 and Tier 2 only need to have one seismic hazard check while Tier 3 requires a check of two hazard levels relates to the fundamental basis of the deficiency-based procedures. The deficiency-based procedures are based on decades of observations of actual damage to buildings in major earthquakes worldwide. The original documentation is contained in ATC 14. Because of a lack of specific strong motion records, all events were considered equal even though many were likely BSE 2 level events. It is fair to conclude that since the procedures were calibrated to a BSE 1 level event and many of the buildings actually experienced a BSE 2 level events successfully, only a one level check would be needed.

It is important to recognize that the inventory of damaged buildings used to infer the deficiency-based procedure was mostly of moderate size and height. The committee felt that a similar limitation was needed to designate when the deficiency-only procedures could be used. A number of criteria regarding the building’s size, structural system, and configuration was developed which must be met in order for one to be able to use the deficiency-based provisions.

However, for a Tier 3 systematic procedure which is intended to be used universally regardless of the building configuration, size or structural system, the dual-earthquake check is necessary to ensure sufficient robustness and margin of safety beyond the design-level earthquake. This covers those buildings which are outside of the historic data.

The concept of permitting the user to perform a seismic retrofit or target an evaluation to a level greater or less than the Basic Performance Objective has been retained. The Enhanced Performance Objective remains as any level greater than the BPOE. Some example application of an Enhanced Performance Objective are retrofitting for a Risk Category higher than the building would normally be assigned, an evaluation using a higher seismic hazard than stipulated, or a retrofit to a higher structural or nonstructural performance level using the same earthquake hazards as the BPOE table calls for.
ASCE 41-13 retains the Limited Performance Objective and keeps the two specific subsets – Reduced Performance Objective and Partial Retrofit Objective. The Reduced Performance Objective is the opposite of the Enhanced Performance Objective. The evaluation or retrofit targets a performance level, uses a seismic hazard, or is for a Risk Category less than the BPOE. The Partial Retrofit Objective means that some, but not all of the seismic deficiencies are mitigated.

A new performance objective included in ASCE 41-13 is the Basic Performance Objective Equivalent to New Building Standards (BPON). This set of performance objectives is intended to provide a link between ASCE 7 and ASCE 41 when a seismic evaluation or upgrade is required to be equivalent to a new building. The performance objectives are based on the Risk Category that would be assigned to the building based on the applicable building code or ASCE 7. Table 4 presents the BPON.

Because the BPON is designed to be equivalent to a new building, only a full-building systematic evaluation or upgrade can be used. The seismic hazards used for this performance level are the BSE-1N and BSE-2N. While there have not been definitive studies done on the specific equivalence between the two standards, the committee felt that by targeting Collapse Prevention in the MCE, one is achieve the similar performance to what is spelled out in the commentary in the 2009 NEHRP Provisions. Specifically, Table C11.5-1 in the 2009 NEHRP Provisions was used as the basis for the BPON.

<table>
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<th>Seismic Hazard Level</th>
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<tr>
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<td>(2-B)</td>
<td>Limited Safety Structural Performance; Nonstructural Performance Not Considered (4-D)</td>
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**Structural Performance Levels**

The three main structural performance levels, Immediate Occupancy (IO), Life Safety (LS), and Collapse Prevention (CP) have not been changed from ASCE 41-06. There are, however, two new, specifically defined, performance levels – Damage Control and Limited Safety. Those new levels were necessary to describe the target structural performance levels for Risk Category III structures in both the BPOE and BPON. Damage Control is the level halfway between IO and LS and Limited Safety is the level halfway between LS and CP.

The performance ranges between IO and LS and LS and CP, which were defined in ASCE 41-06 as Damage Control and Limited Safety, have been renamed Enhanced Safety Performance Range and Reduced Safety Performance Range in order to avoid the confusion with the newly created performance levels.

**Nonstructural Performance Levels**

There were significant changes to the nonstructural performance levels. There were two main reasons for the changes. The first was the recognition that many of the items identified in ASCE 31-03 and ASCE 41-06 as life safety hazard have never been documented in past earthquakes to actually be life safety hazards. The second one was the realization that the performance levels in ASCE 31-03 and ASCE 41-06 did not match those in ASCE 7.

In ASCE 41-13, there are now only three specific nonstructural performance levels – Operational, Position Retention, and Life Safety. These revised performance levels simplify the nonstructural provisions in ASCE 41-13 and make them consistent with ASCE 7.

The Operational performance level is the same as was defined in ASCE 41-06. The nonstructural components are in a state following the earthquake such that they can resume their pre-earthquake function. This performance level is consistent with what the intended performance of nonstructural components should be when $I_p = 1.5$ in ASCE 7 based on the 2009 NEHRP Provisions’ commentary.

The Position Retention performance level is where the nonstructural elements are damaged and may not function, but they are secured in place following the earthquake. This performance level is intended to match the intended performance of nonstructural components when $I_p = 1.0$ in ASCE 7 based on the 2009 NEHRP Commentary. This means that elements that do not require bracing per ASCE 7 because of the building being in a lower seismic hazard area will now not require bracing per ASCE 41-13.

The Life Safety performance level is where nonstructural components are damaged and dislodged from their position, but the consequences of the damage do not pose a risk to life safety. Major falling hazards are still anchored. The ASCE 41-13 Life Safety level is significantly less than what was termed Life Safety in ASCE 31-03 and 41-06. To determine what was a true life safety hazard the committee relied upon FEMA-E74 (2011) and their collective experiences observing damage following major earthquakes.

**Deficiency-Based Procedures**

There were many updates to the deficiency-based procedures. The most significant update was the limitations on when these types of procedures could be used. In ASCE 31-03, there was a table which indicated under which height Tier 1 and deficiency-only Tier 2 Evaluation would be permitted. There was a similar table in ASCE 41-06 Chapter 10 which indicated when the simplified rehabilitation, which just corrected ASCE 31-03 identified deficiencies, could be used. That concept was retained, but most of the height limits were increased. Also, as stated earlier, the same table now applies to both evaluation and upgrade. Table 5 contains some examples of the changes for systems in regions of high seismicity.

<table>
<thead>
<tr>
<th>Table 5 – Height Limits for Deficiency-Based Procedures in High Seismicity for Life Safety Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Steel Moment Frames</strong></td>
</tr>
<tr>
<td><strong>Steel Braced Frames</strong></td>
</tr>
<tr>
<td><strong>Concrete Moment Frames</strong></td>
</tr>
<tr>
<td><strong>Concrete Shear Walls</strong></td>
</tr>
<tr>
<td><strong>Light Frame</strong></td>
</tr>
<tr>
<td><strong>Tilt-up</strong></td>
</tr>
<tr>
<td><strong>URM</strong></td>
</tr>
</tbody>
</table>

The increase in height limits came primarily from the additional experiences that have come from observing coming buildings in major earthquakes over the past 20 years. Prior to this update, theses tables had never really been reviewed or revised since they were originally conceived in the mid 1990’s.

Another major change was when mixed systems can be evaluated and retrofit using deficiency-based procedures. A
mixed system, in ASCE 41-13 context, is a system which has different lateral force resisting elements in one direction. Examples could be a tilt-up shear wall building with an interior steel braced frame or a seven-story steel moment frame over a three-story concrete shear wall building. There are now explicit provisions in ASCE 41 when you can consider those types of buildings in a deficiency-based evaluation or retrofit. When the mixed system is a horizontal combination of systems, the performance level is Life Safety or lower, the diaphragm is flexible, and the building is below the more restrictive height limit of the different systems one can use the deficiency-based procedures. For vertical combinations, the performance level is Life Safety or lower, and the building is below the more restrictive height limit of the different systems one can use the deficiency-based procedures.

**Tier 1 Screening**

There were major organizational changes to the Tier 1 Checklists. A significant editorial effort was undertaken to simply and streamline the Tier 1 Screening. The first major change was the creation of a Basic Configuration Checklist, which contains all the statements for Very Low seismicity, about building configuration regularity and the geologic and foundation components, which were common to all building types and unnecessarily repeated in each ASCE 31-03 checklist. Following that, there are checklists specific to each common building type.

All the structural checklists were reorganized so that there is one checklist for Life Safety and one separate, stand-alone checklist for Immediate Occupancy for each common building type. Also, there are no longer separate checklists for buildings with stiff or flexible diaphragms. Lastly, the checklist statements are ordered such that the items for Low Seismicity come first, followed by Moderate and finally with High. Therefore someone evaluating a building in a region of Moderate seismicity need not read through a number of statements that don’t apply.

The nonstructural checklist was condensed down to one single checklist. Each checklist statement has a marker which indicates which level of seismicity and performance level (LS or IO) the statement is required to be checked for.

In addition to the editorial changes, there were a number of technical updates to the checklists. Most of the technical updates related to paring back the Life Safety checklist requirements. The committee undertook a detailed review of all the checklist statements, questioning whether each statement was really an observed life safety issue or not. This lead to a number of statements being moved from LS to IO-only or being revised to address the life safety concern in a more specific way. Additionally, the change in the definition of Nonstructural Life Safety and coordination of levels of seismicity with ASCE 7 led to a significant paring back of the nonstructural Life Safety checklist.

Recognizing that existing buildings can vary from what their drawings indicate due to construction deviations, alterations or just deterioration, the committee added more detailed direction on minimum on-site investigation and condition assessment. All the checklist statements related to condition assessment have been moved to this section. The purpose of this section is to place the responsibility on the evaluating engineer for verifying the condition of the structure and confirming the completeness and adequacy of the available drawings.

The last major change to the Tier 1 Screening was an updating of the Benchmark Building table and an expansion of the requirements for benchmarking a building. The table which indicates what the earliest code a building could be designed to which permits it to be deemed to comply with a specific performance objective was updated. Specifically, the benchmark year for concrete buildings was moved up from the 1976 UBC to the 1994 UBC due in part to observations from the 2011 Christchurch Earthquakes. There were also a series of requirements set forth that one must meet in order to benchmark a building. They relate to verifying the accuracy and completeness of the existing drawings with respect the benchmark code, minimum field verification of the existing drawings, condition assessment, and a confirmation of no geologic hazards at the site.

**Tier 2 Evaluation/Retrofit**

Conceptually there were no major changes to the Tier 2 procedure. The crux of the procedure is still to simply evaluate the identified potential deficiencies from the Tier 1 screening or to retrofit them. The major change, however, is in the procedures used to do that.

As discussed earlier, in an effort to bring consistency to the evaluation and retrofit procedures and for consistency between Tier 2 and Tier 3, the simplified analytical methods of ASCE 31-03 were abandoned for the more detailed procedures within ASCE 41. Recognizing that this was a significant change, the chapter which presents the Tier 2 procedures was completely re-written to provide as much guidance as possible to the specific sections of the analysis, foundation, or material chapters where the user needs to go to find the information to carry out the specific evaluation or retrofit procedure for each specific deficiency.
The material found in Chapter 4 of ASCE 31-03 which provided commentary on the Tier 1 and Tier 2 deficiencies has been retained, but moved to Appendix A.

Technical Updates

While the combination and reformatting of ASCE 31-03 and ASCE 41-06 took up a considerable amount of the committee’s time, there were still a number of significant technical changes that were made to the provisions. Chapters 8 through 14 contain the bulk of the analysis procedures, material and foundation modeling parameters and acceptance criteria. The format of those chapters is essentially unchanged from ASCE 41-06. All the technical updates have been incorporated into those chapters.

The following is a brief, high-level summary of the technical changes to those chapters.

Analysis

The most significant change to the analysis chapter was the expansion of the nonlinear response history analysis provisions. There have been significant advances in this analysis method and it has found more widespread use within the profession since the provisions were originally written in FEMA 273. The new provisions seek to clarify the number of ground motion records needed, how to select and apply damping, and how to apply the output to evaluation. There was clarification made to permit the modeling of force-controlled elements in the nonlinear model and permitting them to fail and allow force redistribution provided gravity load support is not compromised.

There were also some modifications made to allow for greater use of the linear procedures. In ASCE 41-06 there were certain irregularities which prohibited the use of the linear procedures. Those irregularity triggers have been relaxed.

There was also a significant change made to the knowledge-factor, which reduces the element capacities based on a lack of testing and other information about the building. Now if the user has a good set of construction drawings and is evaluating or upgrading to Life Safety or lower performance, then the knowledge-factor can be taken as 0.9 instead of 0.75.

Geotechnical/Foundation

There were three major updates to the Geotechnical and Foundation chapter. The first was revisions to the liquefaction section and a new structural analysis procedure to assess the consequences of liquefaction. The second was a significant update of the foundation rocking procedures and yielding at the soil-foundation interface. The last was an update to the soil-structure interaction provisions.

The most significant update to the liquefaction procedures is a new three-step structural analysis procedure to assess the consequences of liquefaction. Observations from the 2010 and 2011 Christchurch Earthquakes were that numerous structures were damaged by liquefaction, but did not collapse. The new liquefaction analysis procedures allow the engineer to first evaluate the structure assuming no liquefaction occurs and then a second time with ground motions and foundation parameters that have been altered due to liquefaction. Following that analysis, the anticipated lateral spread and differential settlements are imposed on the structure and it is assessed to determine if it can remain stable under those.

There has been a significant change to how foundation rocking and yielding at the soil-foundation interface are addressed. ASCE 41-06 decoupled the two actions and had separate checks for each. In reality this never occurs. If the soil is stiff, rocking will dominate the response. If the soil is soft, then yielding of the soil will govern. However, neither will occur independent of the other. The new rocking procedures provide m-factor tables and nonlinear acceptance criteria for these actions as a function of the gravity load on the foundation and the stiffness of the underlying soil.

The soil-foundation-structure interaction (SFSI) material, which was first introduced in ASCE 41-06 and based on material from FEMA 440 (2005), was reviewed and revised. NIST funded a significant effort related to SFSI which will be published soon as ATC-84 (2012). Based on work done in that project, the kinematic effects provisions (base-slab averaging and embedment) were revised and some limitations placed on them.

Steel

The only major changes to the steel section were the introduction of provisions for buckling restrained braced frames and the modification of some of the acceptance criteria for braced frames.

Concrete

There were only minor changes to the concrete chapter related to minimum reinforcement in shear walls, biaxial column effects, rebar testing requirements and concrete core sampling requirements.

Wood & Cold-Formed Steel
The Wood and Cold-Formed Steel (CFS) Light Frame provisions had some formatting changes. Provisions for wood and CFS were separated. Additionally, the applicable reference standards where one can find capacities for wood and CFS elements were updated.

**Masonry**

There were some significant changes to the masonry chapter, many of which were prompted by observations from the 2010 and 2011 Christchurch Earthquakes. Bed joint sliding was reintroduced as a deformation-controlled action. The provisions and acceptance criteria for wall and pier rocking were updated. There were also updates related to diagonal tension, out-of-plane actions, and anchorage to masonry walls.

**Seismic Isolation & Energy Dissipation**

Both the Seismic Isolation and Energy Dissipation provisions were revised. The provisions for Seismic Isolation were revised to permit the use of upper and lower-bound isolator properties in design and then specifying tolerances as opposed to requiring testing of the isolators before design could be completed. Along with this change were changes to the quality control requirements for isolator manufacturers. There were also modifications to the design and quality control requirements for energy dissipation devices. Lastly, the peer review requirements were reduced from a panel to one independent peer reviewer.

**System-Specific Procedures**

One of the last changes to ASCE 41-13 was the creation of a new chapter for system-specific procedures. The impetus for this chapter was what to do about the special procedure for unreinforced masonry buildings found in ASCE 31-03. That procedure has been in use for many years and the committee wished to retain it. Because the procedure is specific to a system which has a combination of elements of different materials, it could not be easily brought into any one of the material chapters. Therefore, it was placed in a new chapter.

The intention is that as more of these system specific procedures are developed they would eventually be placed into this chapter. The requirement being that the procedure must be able to be utilized in conjunction with a seismic hazard level specified in the standard and the performance target of the procedure must be declared in terms of one of the levels in the standard.

**Consistency with ASCE 7**

In addition to creating the BPON, referencing the MCE$_R$, and aligning the nonstructural performance levels, the committee made several changes to better align ASCE 41-13 with ASCE 7. The most significant of those changes related to the seismic hazard science, the site specific response spectra, and response history scaling. Regardless of the return period chosen for the seismic hazard, ASCE 41-13 requires the same attenuation relations and other ground motion science be used as is required in ASCE 7. The seismic hazard parameters should all be “Maximum Direction.” When a site specific response spectrum is used, the scaling with respect to the USGS response spectrum will be the same as in ASCE 7.

Another very significant change to align ASCE 41-13 with ASCE 7-10 was the correlation of ASCE 41-13 Levels of Seismicity with the ASCE 7-10 Seismic Design Categories (SDC). This eliminates confusion and helps greatly in the coordination of the nonstructural performance levels. Below is the new ASCE 41 Levels of Seismicity with the corresponding ASCE 7 SDC.

<table>
<thead>
<tr>
<th>ASCE 41 Level</th>
<th>ASCE 7 SDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Low</td>
<td>SDC A</td>
</tr>
<tr>
<td>Low</td>
<td>SDC B</td>
</tr>
<tr>
<td>Moderate</td>
<td>SDC C</td>
</tr>
<tr>
<td>High</td>
<td>SDC D, E, &amp; F</td>
</tr>
</tbody>
</table>

There are some other modifications throughout ASCE 41 to align with ASCE 7. The out-of-plane wall anchorage force equations have been updated to correlate with the changes that were made to ASCE 7-10. There were some changes made to align the nonlinear response history provisions of the two standards.

**Summary**

When published, ASCE 41-13 will represent a new state of the practice in seismic evaluation and retrofit of existing buildings. The new standard combines seismic evaluation and retrofit into one document and brings consistency to the process. The new standard has incorporated many technical advances which have occurred in the past six years along with lessons learned from many recent earthquakes.
Acknowledgements

Over 100 practitioners, academics, and industry representatives participated in the ASCE/SEI Standards Committee for Seismic Rehabilitation. Unfortunately space prohibits listing everyone, but their names can be found in ASCE 41-13. However the enormous effort that was undertaken to combine and update the standards could not have been accomplished without the painstaking volunteer work of several key individuals. Peter Somers and Brian Kehoe each led subcommittees and were members of the steering committee with the paper authors. Fred Turner, Mark Moore, Chris Tokas, Charles Roeder, Ken Ellwood, Phil Line, Bonnie Manley, and Ron Mayes all led various technical issue teams. Mike Mahoney from FEMA provided support for the effort which greatly moved the process along. Jennifer Goupil, Jim Rossberg, Paul Sgambati, and Lee Kusek of the American Society of Civil Engineers were instrumental in moving the standard along and allowed the committee to meet its extremely aggressive schedule.

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