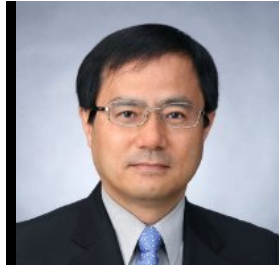




**Structural Engineers Association
of Southern California**



You're invited:	Tri-Counties Chapter Dinner Meeting;
Presentation:	Seismic Evaluation and Retrofit of Existing Structures
Date:	Wed. Nov. 9, 2011 (Dinner 5:30 - & 7:30 p.m. - Presentation 7:30 - 8:30 p.m.) <i>No fee after 7:30</i>
Program:	Young Nam, SE will present on Seismic & Retrofit of Existing Structures which offers an overview of relevant Documents as Guidelines for the Seismic Evaluation and Rehabilitation of existing buildings
Speaker:	Young Nam, SE; <u>SEAOSC</u> Director & Thornton Tomasetti Vice President
Venue:	Holiday Inn Express Hotel (Windjammer Room) 1080 Navigator Drive, Ventura, CA 93001 Tel: (805) 856-9533
Abstract and Faculty:	Young Nam will provide technical information in regards to the rehabilitation of existing structures.
Click to register; or walk in	http://seaosc.org/events_detail.cfm?pk_event=172
Host/Moderator:	<u>SEOASC</u> Director; Casey K. Hemmatyar

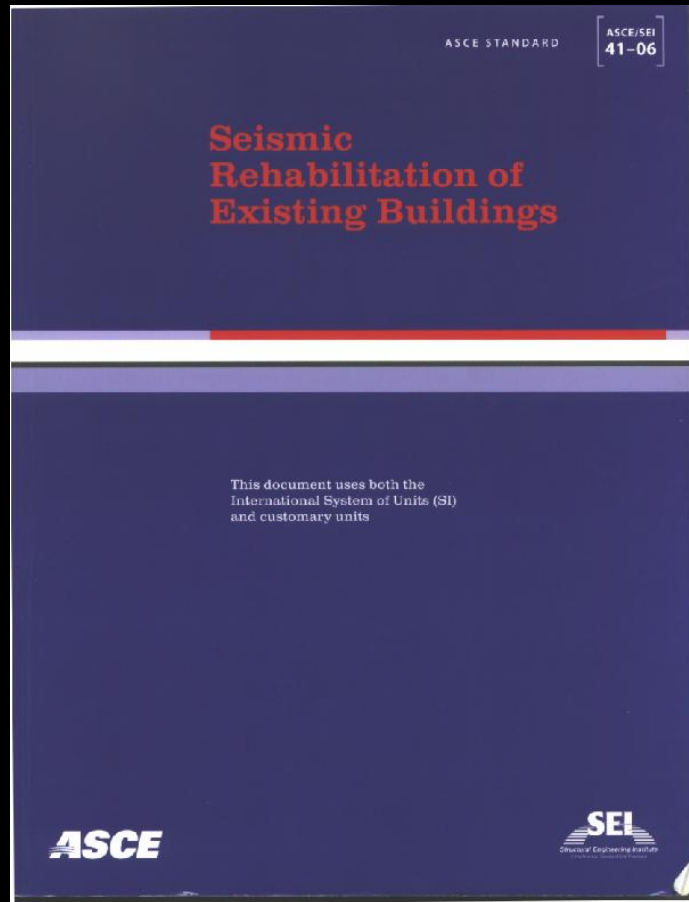




Application of ASCE 41

Presented by:
Albert Chen, S.E.
Young Nam, S.E.

November 12, 2011



ASCE 41

Seismic Rehabilitation Standard

- **FEMA 273 NEHRP Guidelines for the Seismic Retrofit of Buildings, 1997**
- **FEMA 356, Pre-standard for Seismic Rehabilitation of Buildings, 2000**
- **A “Performance-Based” design approach**
- **Applicable to All types of Buildings**

ASCE 41

- **Description of Damage States**
- **Not intended to be used for Condition Assessment of earthquake damaged buildings**
- **Techniques for repair of earthquake-damaged buildings are not included in the Standard**

ASCE 41

- **Authority**
 - **Mandatory**
 - **Voluntary**
- **Plan Check**
 - **Code official**
 - **Peer review**

Seismic Rehabilitation Process

- **Initial Consideration**
- **Selection of rehabilitation objective**
- **As-built information**
- **Select rehabilitation method**
- **Select rehabilitation measures**
- **Verification of rehabilitation design**

Seismic Rehabilitation Process

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Rehabilitation Objectives

- **Rehabilitation Goal**
 - **Target Building Performance Level**
 - **Earthquake Hazard Level**
- **50%/50 year = 72 years return period**
- **20%/50 year = 225**
- **10%/50 year = 472 (BSE-1)**
- **2% / 50 year = 2457 (BSE-2)**
 - **BSE: Basic Safety Earthquake**

Target Building Performance Level

- **Operational Performance level (1-A)**
- **Immediate Occupancy Performance level(1-B)**
- **Life Safety Performance level (3-C)**
- **Collapse Prevention Performance level (5-E)**
 - **(Structural Performance Level –
Nonstructural Performance Level)**

Target Building Performance Level

- **Structural Performance Levels**
 - Immediate Occupancy **level**(S-1)
 - Damage Control **range**(S-2)
 - Life Safety **level**(S-3)
 - Limited Safety **range**(S-4)
 - Collapse Prevention **level** (S-5)
 - Not Considered **level** (S-6)

Structural Performance Level and Damage

	Type	S-5 CP	S-3 LS	S-1 IO
Concrete Frames	Primary	Extensive cracking and hinge formation in ductile elements. Limited cracking and/or splice failure in some nonductile columns. Severe damage in short columns.	Extensive damage to beams. Spalling of cover and shear cracking (<1/8" width) for ductile columns. Minor spalling in nonductile columns. Joint cracks <1/8" wide.	Minor hairline cracking. Limited yielding possible at a few locations. No crushing (strains below 0.003).
	Secondary	Extensive spalling in columns (limited shortening) and beams. Severe joint damage. Some reinforcing buckled.	Extensive cracking and hinge formation in ductile elements. Limited cracking and/or splice failure in some nonductile columns. Severe damage in short columns.	Minor spalling in a few places in ductile columns and beams. Flexural cracking in beams and columns. Shear cracking in joints <1/16" width.
	Drift	4% transient or permanent	2% transient; 1% permanent	1% transient; negligible permanent
Steel Moment Frames	Primary	Extensive distortion of beams and column panels. Many fractures at moment connections, but shear connections remain intact.	Hinges form. Local buckling of some beam elements. Severe joint distortion; isolated moment connection fractures, but shear connections remain intact. A few elements may experience partial fracture.	Minor local yielding at a few places. No fractures. Minor buckling or observable permanent distortion of members.
	Secondary	Same as primary.	Extensive distortion of beams and column panels. Many fractures at moment connections, but shear connections remain intact.	Same as primary.
	Drift	5% transient or permanent	2.5% transient; 1% permanent	0.7% transient; negligible permanent
Braced Steel Frames	Primary	Extensive yielding and buckling of braces. Many braces and their connections may fail.	Many braces yield or buckle but do not totally fail. Many connections may fail.	Minor yielding or buckling of braces.
	Secondary	Same as primary.	Same as primary.	Same as primary.
	Drift	2% transient or permanent	1.5% transient; 0.5% permanent	0.5% transient; negligible permanent

Target Building Performance Level

- **Nonstructural Performance Levels**
 - **Architectural Components**
 - **MEP system and components**
 - **Contents**
- **Levels**
 - **Operational (N-A)**
 - **Immediate Occupancy(N-B)**
 - **Life Safety (N-C)**
 - **Hazard Reduced(N-D)**
 - **Not Considered (N-E)**

Seismic Hazard

- **Two basic EQ hazard levels**
 - **Basic Safety Earthquake 1 (BSE-1)**
 - **10% /50 years**
 - **Basic Safety Earthquake 2 (BSE-2)**
 - **MCE - 2% /50 years**
- **Hazard levels with any probability of exceedance**
- **Site-specific procedures**
- **MCE – get it from NEHRP or from Web**

Rehabilitation Objective

- **Basic Safety Objective (BSO)**
- **Enhanced Rehabilitation Objectives**
- **Limited Rehabilitation Objectives**

		Building Performance Levels			
		Operational	IO (1-A)	LS (3-C)	CP (5-E)
Earthquake Hazard Level	50%/50 year	a	b	c	d
	20%/50 year	e	f	g	h
	BSE-1 (~10%/50 year)	i	j	k	l
	BSE-2 (~2%/50 year)	m	n	o	p

Seismic Rehabilitation Process

- Initial Consideration
- Selection of rehabilitation objective
- **As-built information**
- Select rehabilitation method
- Select rehabilitation measures
- Verification of rehabilitation design

AS-BUILT information

- **Field Observation**
- **Construction Documents**
- **Reference Standards and Codes**
- **Test and examination**
- **Interview**

AS-BUILT Information

- **Building Configuration**
- **Component Properties (k- factor)**
- **Site and Foundation Information**
- **Adjacent Building**
- **Component – primary or secondary?**
- **Data Collection**
 - **Minimum**
 - **Usual**
 - **Comprehensive**

Knowledge Factor (κ)

Table 2-1 Data Collection Requirements

Data	Level of Knowledge							
	Minimum		Usual				Comprehensive	
Rehabilitation Objective	BSO or Lower		BSO or Lower		Enhanced		Enhanced	
Analysis Procedure	LSP, LDP		All		All		All	
Testing	No Tests		Usual Testing		Usual Testing		Comprehensive Testing	
Drawings	Design Drawings	Or Equivalent	Design Drawings	Or Equivalent	Design Drawings	Or Equivalent	Construction Documents	Or Equivalent
Condition Assessment	Visual	Comprehensive	Visual	Comprehensive	Visual	Comprehensive	Visual	Comprehensive
Material Properties	From Drawings or Default Values	From Default Values	From Drawings and Tests	From Usual Tests	From Drawings and Tests	From Usual Tests	From Documents and Tests	From Comprehensive Tests
Knowledge Factor (κ)	0.75	0.75	1.00	1.00	0.75	0.75	1.00	1.00

Seismic Rehabilitation Process

- Initial Consideration
- Selection of rehabilitation objective
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- **Select rehabilitation method**
- Select rehabilitation measures
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Select Rehabilitation Method

- **Simplified Rehabilitation Method**
- **Systematic Rehabilitation Method**
 - **Select an Analysis procedure**
 - **Develop a preliminary rehabilitation scheme**
 - **Verify if the rehabilitation design meets the selected Rehabilitation objectives**

Seismic Rehabilitation Process

- Initial Consideration
- Selection of rehabilitation objective
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- Select rehabilitation method
- **Select rehabilitation measures**
- Verification of rehabilitation design

Analysis Procedure

- **Linear Procedures**
 - **Linear Static Procedure (LSP)**
 - **Linear Dynamic Procedure (LDP)**
- **Non-linear Procedures**
 - **Nonlinear Static Procedure (NSP-
pushover)**
 - **Nonlinear Dynamic Procedure (NDP-
Response History)**

Limitations on Linear Analysis Procedure

Not Allowed if

- **DCRs exceed 2.0 and any of following irregularity is present**
 - **In-plane discontinuity irregularity**
 - **Out-of-plane discontinuity irregularity**
 - **Weak story irregularity**
 - **Torsional strength irregularity**

Limitations on Linear Static Procedure

Not Allowed if

- Building $T > 3.5 \times T_s$
- Horizontal dimension ratio between stories > 1.4
- Torsional stiffness irregularity
- Vertical stiffness irregularity
- Non-orthogonal lateral-force-resisting system

Limitations on Nonlinear Static Procedure

Not Allowed if

- R exceeds R_{max}
- Higher mode effects are significant

Acceptance Criteria

- **Primary and secondary components**
- **Deformation-controlled actions vs. Force-controlled actions**

Thanks!