Ongoing Activities for Future Updates of the ACI Standard 369.1-17

369 Committee Chair:	Wassim Ghannoum
369-0A: General Provisions, Chair:	Insung Kim
369-0C: Frames, Chair:	Adolfo Matamoros
369-0D: Walls, Chair:	Garrett Hagen
369-0E: Diaphragms and Foundations, Chair:	Arne Halterman
369-0F: Retrofit, Chair:	Sergio Breňa

ACI Fall Convention
Las Vegas, NV, October 2018

ACI 369.1-17

- Born of an MOU between ACI and ASCE/SEI
- ACI committee 369 now updates the concrete provisions of ASCE/SEI 41
- Published under ACI 369.1 Standard
- Both Standards coordinated and material same
- ACI 369.1 is on 3 year cycle
- ASCE/SEI 41 is on a 6 year cycle
- ACI 369.1-20 will have substantial updates
- Standards will merge again in 2023

ACI 369.1-17

An ACI Standard

Standard Requirements for Seismic Evaluation and Retrofit of Existing Concrete Buildings (ACI 369.1-17) and Commentary

Reported by ACI Committee 369

ACI 369.1-17

Metric version available
Next edition ACI 369.1-20

American Concrete Institute
Always advancing

ACI Committee 369

- ACI 369 “Seismic Repair and Rehabilitation”
- Expanded after publication of Standard
  - One Main committee and five sub-committees
  - Main committee: 23 voting member (balanced), 9 consulting members, 49 associate members
  - 369-0A: General Provisions, 11 voting members
  - 369-0C: Frames, 7 voting members
  - 369-0D: Walls, 8 voting members
  - 369-0E: Diaphragms and Foundations, 2 voting members
  - 369-0F: Retrofit, 9 voting members

FEMA Support for ACI 369/ASCE 41

- FEMA providing funding through ATC Project 140 to help ASC/SEI 41 and ACI 369 update provisions of their standards
- High priority topics currently in progress
  - Linear procedures
  - Nonlinear procedures
  - Tier 1-2 procedures
  - ***Concrete structural wall provisions***
  - Masonry provisions
  - Foundation modeling

But ACI 369 tackling many more items for the 2020 edition

ACI 369-A

Seismic Repair and Rehabilitation: General Provisions and Materials

Subcommittee Chair: Insung Kim

October 2018

Membership

- **Membership: 11 members:**

  Alex Chu, Arif Ozkan, Saeed Fathali, Hector Guerrero, Brian Kehoe, Conrad Paulson, Halil Sezen, Jose Pincheira, Adolfo Matamoros, Thomas Mander, Insung Kim

- ACI 369R Chapters 1, 2 and 3
  - 1. Scope
  - 2. Material Properties and Condition Assessment
    - 2.1 General
    - 2.2 Properties of In-Place Materials and Components
    - 2.3 Condition Assessment
    - 2.4 Knowledge Factor
  - 3. General Assumptions and Requirements
    - 3.1 Modeling and Design
    - 3.2 Strength and Deformability
    - 3.3 Flexural and Axial Load
    - 3.4 Shear and Torsion
    - 3.5 Development and Splices of Reinforcement
    - 3.6 Connection to Existing Concrete
    - 3.7 Retrofit Measures

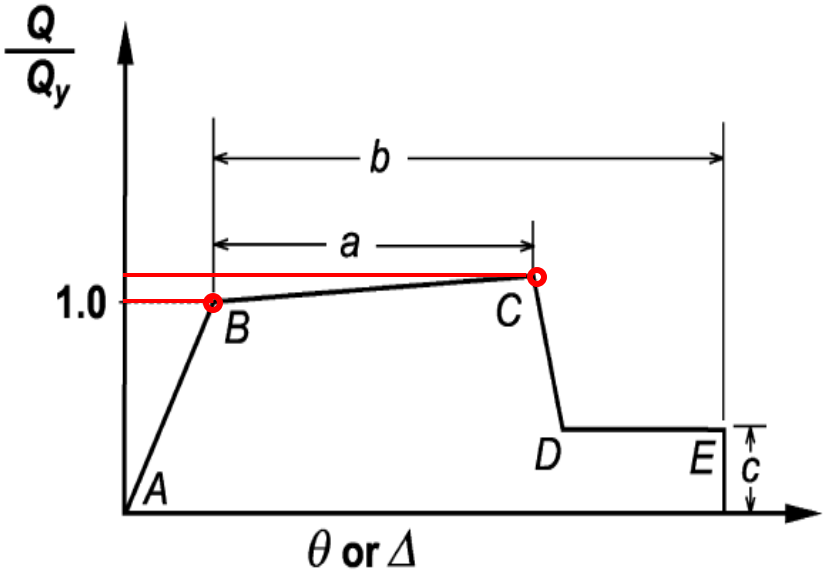
Tasks

- **Anchor** testing and Strength: liaison with ACI 355 TG6 **–Kehoe**
- Clarification of Lower bound and Expected **Material Strengths** **- Paulson/ Mander/Matamoros**
- **Effective Stiffness**: (Table 5) **– Matamoros / Kim**
- Improvement of usability for **Nonlinear Dynamic Procedure** (3.1.2.2)- **Guerrero / Fathali**
- **Fiber modeling** and Strain limits and measurement (3.3.1**) - Okzan / Chu**
- **Shear Friction** - **Kim / Chu**

Lower bound and Expected strengths Mander/Matamoros/Paulson

Table 10-1. Factors to Translate Lower-Bound Material Properties to Expected Strength Material Properties

Material Property	Factor
Concrete compressive strength	1.50
Reinforcing steel tensile and yield strength	1.25
Connector steel yield strength	1.50



$$f_{s,limit\ state} = f_{y,nominal} * SIF * DIF$$

SIF = static increase factor

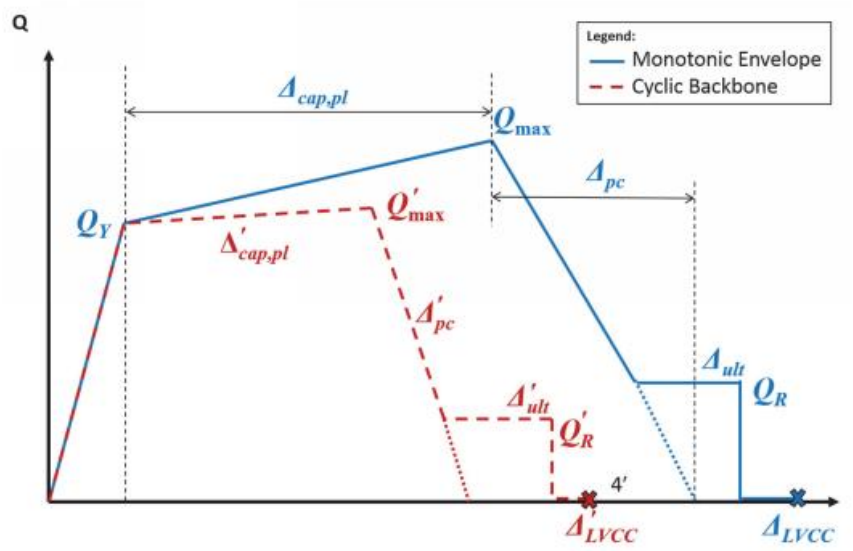
Function of the level of straining. Includes strain hardening effect.

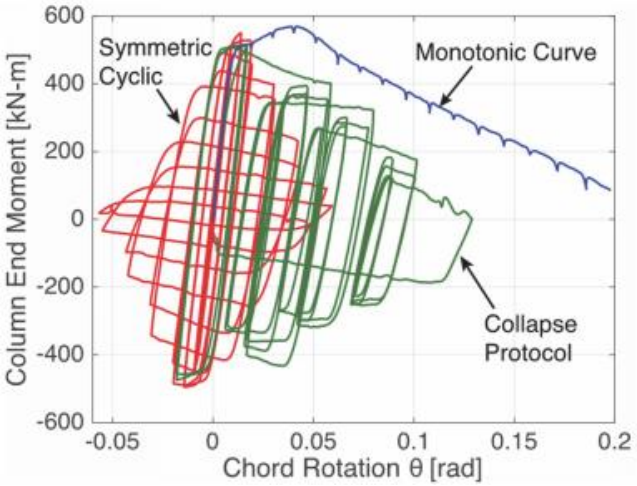
DIF = dynamic increase factor

Function of strain rate. Seismic strain rates are reported to range from 0.0001 /sec to 0.1 /sec

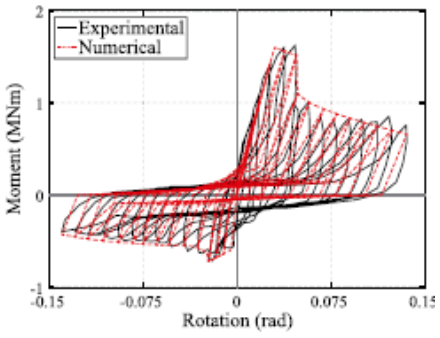
Both factors are dependent on reinforcing type and grade

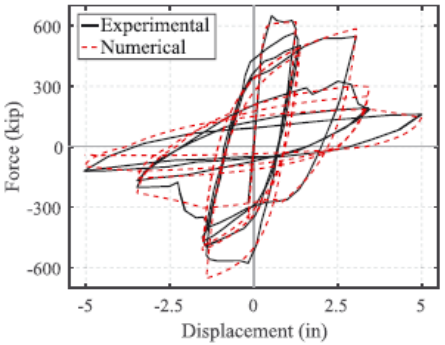
Nonlinear Dynamic Procedure
Guerrero / Fathali

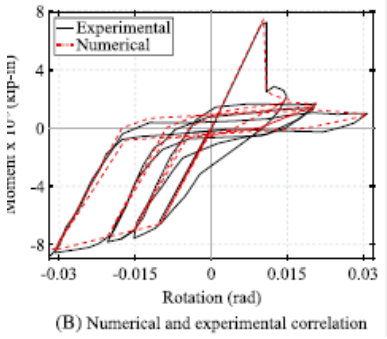




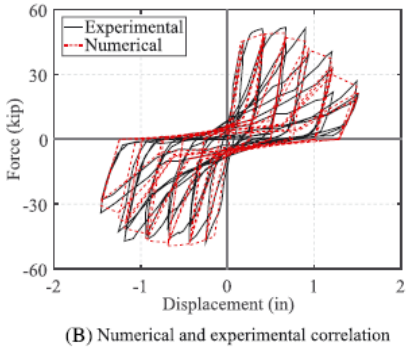
NIST GCR 17-917-45 (ATC 114)







(B) Numerical and experimental correlation



(B) Numerical and experimental correlation

Thanh. N. Do Filip. C. Filippou

ACI 369-C

Seismic Repair and Rehabilitation: Moment Resisting Frames

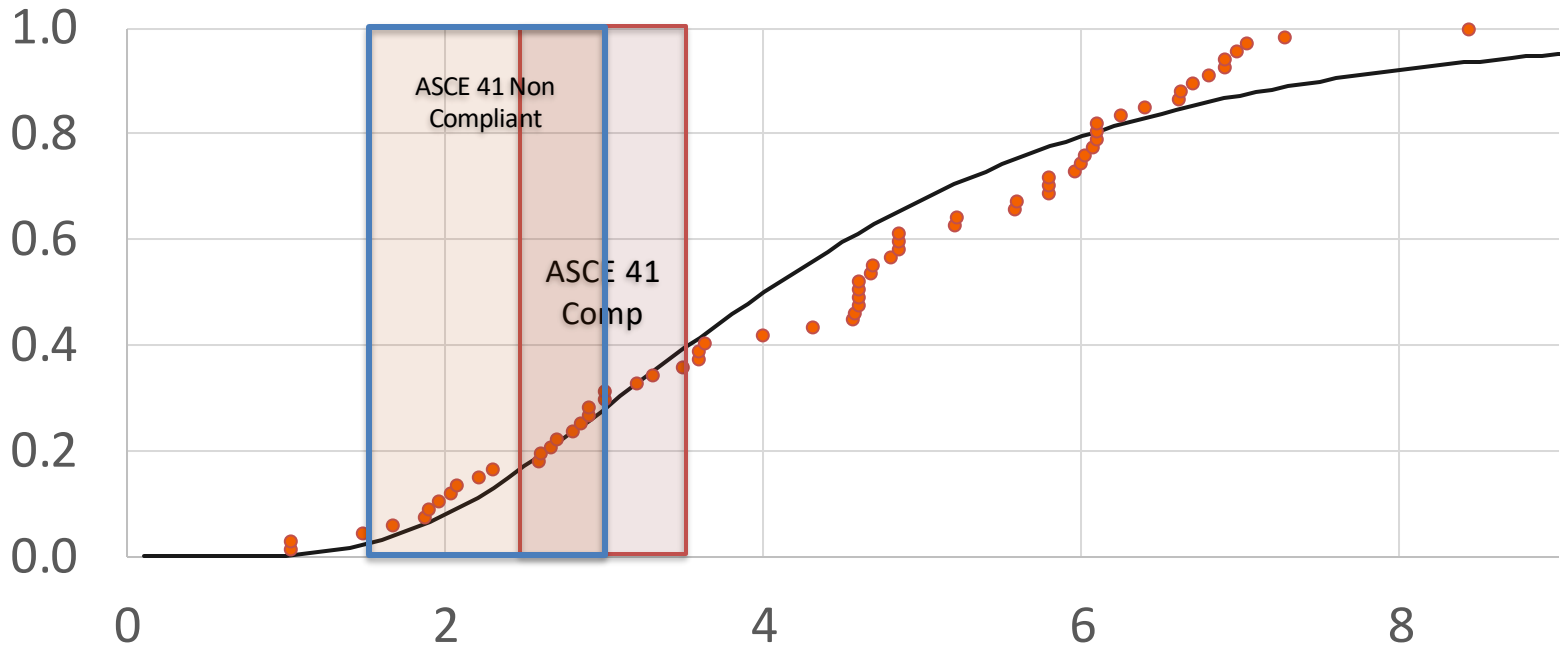
Subcommittee Chair: Adolfo Matamoros

October 2018

ACI 369-C Moment Resisting Frames

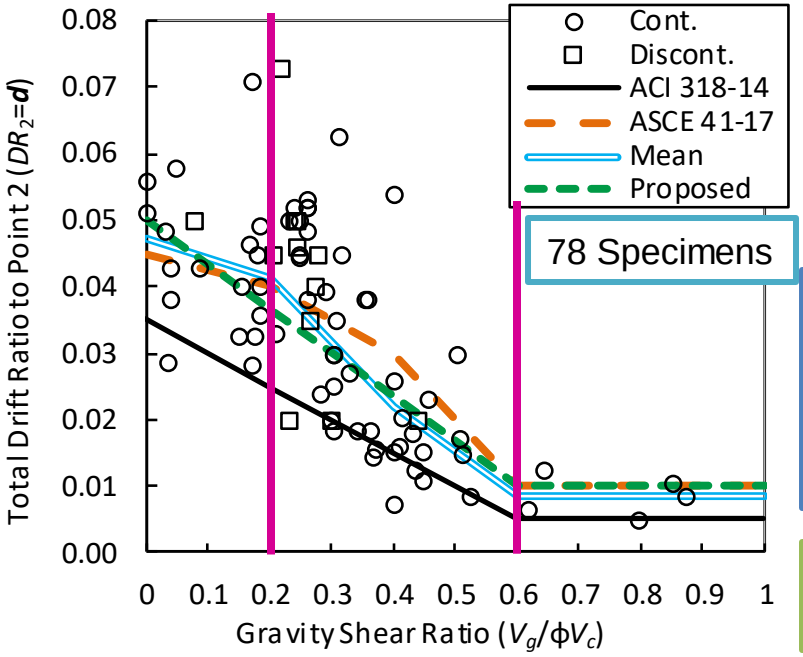
- Section 4.2.2.2 and 4.2.2.3 Nonlinear Modeling Parameters for Beams (Adolfo)
- Section 4.4 Slab-Column connections (Mary Beth and Yan).
- Section 4.2.3.2 Joint strength and modeling parameters and acceptance criteria (Wael Hassan).
- Fiber models (Mehrdad Sasani)
- Sections 4.2.4.2 and 4.4.4 Acceptance Criteria (Adolfo, Mehrdad, Mary Beth), coordinate with General Provisions
- Section 4.2 Linear Elastic Methods (drift demands and *m* factors).

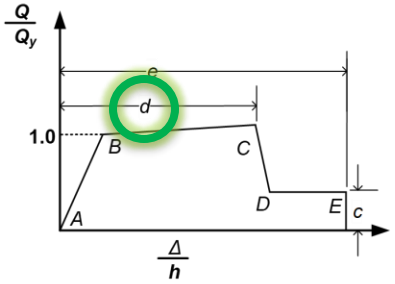
Section 4.2.2.2 and 4.2.2.3 Nonlinear Modeling Parameters for Beams (example parameters *a*, *e*)



Total Drift Ratio to Point 2 (DR_2=d)

RC Specimens with continuity reinf.





With continuity bars:

- The proposed d values are approximate mean values
- ASCE 41 tends to overestimate the mean for VR = 0.2-0.6

$d = 0.050 - (1/15)VR \quad (0 \le VR < 0.6)$

$d = 0.010 \quad (0.6 \le VR \le 1)$

Section 4.2.3.2 Joint strength and modeling parameters and acceptance criteria

- Research shows that current provisions are very conservative in some instances and unconservative in others.
- Committee will ballot in the near future a proposal for calculating joint strength.
- Later in the code cycle work will focus on
  - development of new modeling parameters and acceptance criteria for joints
  - review of provisions for elastic models.
  - recommendations for modeling of joints in nonlinear models, both in instances where joints are experience inelastic deformations and in cases where the joints have adequate shear strength so the modeling can be simplified.

ACI 369-D

Seismic Repair and Rehabilitation: Concrete Structural Wall and Coupling Beams Subcommittee

Subcommittee Chair: Garrett Hagen

Presented by: Wassim M. Ghannoum

October 2018

Wall Updates: Background

- Currently an ATC project focused on ASCE 41 updates
- Working group specifically focused on Wall Modeling Parameters and Acceptance Criteria

Wall Updates: Background

- Wall provisions have not been updated for a very long time – coarse and inconsistently accurate
- Concern that MP and AC are too conservative, particularly for flexure dominated walls
- Inconsistencies at interface between shear and flexure dominated walls
- Opportunity with a 1000 wall-test database

Wall Updates: Background

- Limited modeling guidance for walls
  - Disconnect between profession using fiber models and ACI369/ASCE41 not giving much info about fiber models
  - No cyclic guidance
  - No guidance on inadequate lap splices
  - Improper/incomplete guidance on single curtain walls
  - No guidance on non-rectangular shapes

Coupling Beam Updates: Background

- Similar to Walls, Coupling Beams have not been updated since FEMA 273
- Similar concern that coupling beam parameters in ASCE 41 are too conservative, especially for LS/CP
  - Question of whether Collapse is a concern for Coupling Beams under Gravity Loads
- No guidance for diagonally reinforced coupling beams
- Concern that current assumptions for stiffness are too high
- Question of how to treat axial restraint from slab and coupled walls

Objectives for Walls and Coupling Beams

- Revise framework how MP and AC are provided
- Provide standard language and guidance on modeling full response
  - including cyclic behavior
  - Including lumped-plasticity and fiber models
- Update and add to nonlinear MP and AC
  - Deformation limits
  - Strength equations
  - Cyclic parameters
  - Splice/anchorage provisions
  - Sliding at base
- Update linear AC

ACI 369-E

Seismic Repair and Rehabilitation: Diaphragms & Foundations

Subcommittee Chair: Arne Halterman

October 2018

ACI 369E
Diaphragms & Foundations

Chapter 12 - Cast-in-Place Diaphragms
Chapter 13 - Precast Diaphragms
Chapter 14 - Concrete Foundations

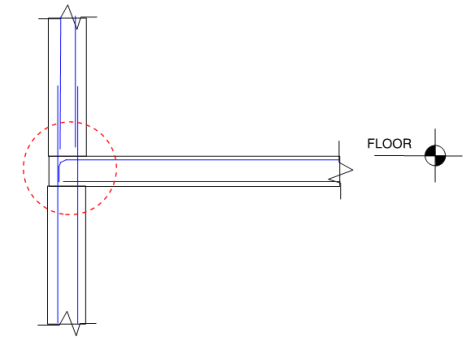
369E (RUNT OF THE LITTER)

October 2018

Holmes Structures

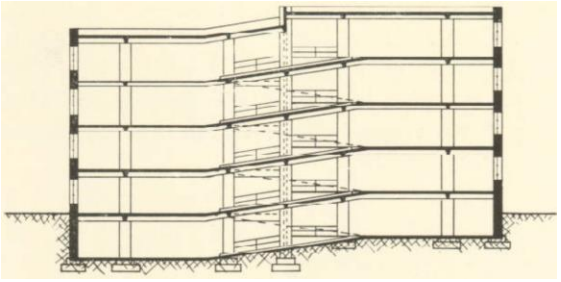
ACI 369E – Diaphragm Summary

Chapter 12 – Cast-in-place Concrete Diaphragms
Chapter 13 – Precast Concrete Diaphragms



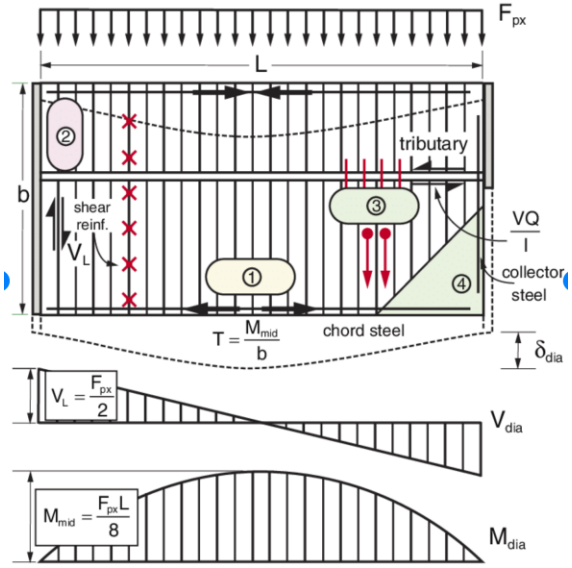
TYPICAL WALL-TO-SLAB CONNECTION DETAIL

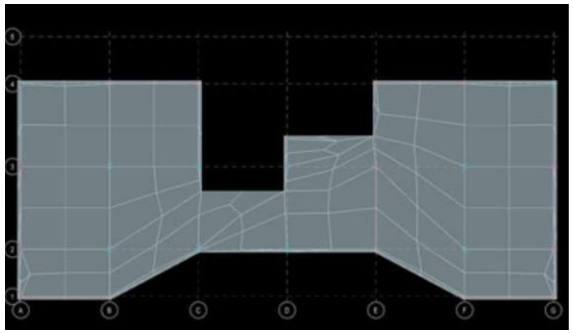
- Identifying the typical problems in diaphragms
  - Slab-to-Wall Interface: Shear friction analysis issue
    - Coordinate with 369A and 369D
  - Precast Concrete Diaphragms problems with frame elongation
    - Not typically a west-coast US problem to date, except for parking garages
    - Significant efforts in New Zealand to address these problems
    - Subcommittee will reference appropriate documents
  - Ramps/Stairs
    - Subcommittee will add commentary language only

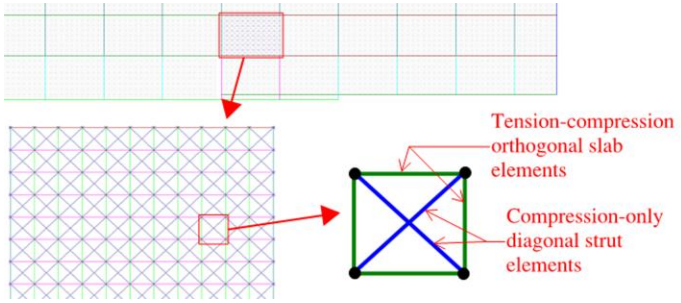


ACI 369E - Diaphragm Modeling

- Chapter 12 Analysis Method language is currently being updated to permit different analysis methods for diaphragms to be consistent with what is done in practice (i.e., beam model, finite elements, strut and tie)







SIMPLE BEAM MODEL

FINITE ELEMENT MODEL

STRUT AND TIE MODEL

ACI 369E – Chapter 14 Concrete Foundations Summary

- Revising the modeling language
- Updating language to permit deformation of foundation elements

14.3—Evaluation of Existing Condition

foundation displacements for the selected performance level shall be as prescribed in Chapter 8 of ASCE 41 or as established with project-specific data. All components of existing foundation systems and all new material, components, or components required for retrofit shall be evaluated as force-controlled actions. However, the capacity of the foundation components need not exceed 1.25 times the capacity of the supported vertical structural component or element (column or wall).

ACI 369-F

Seismic Repair and Rehabilitation: Retrofit

Subcommittee Chair: Sergio Breña

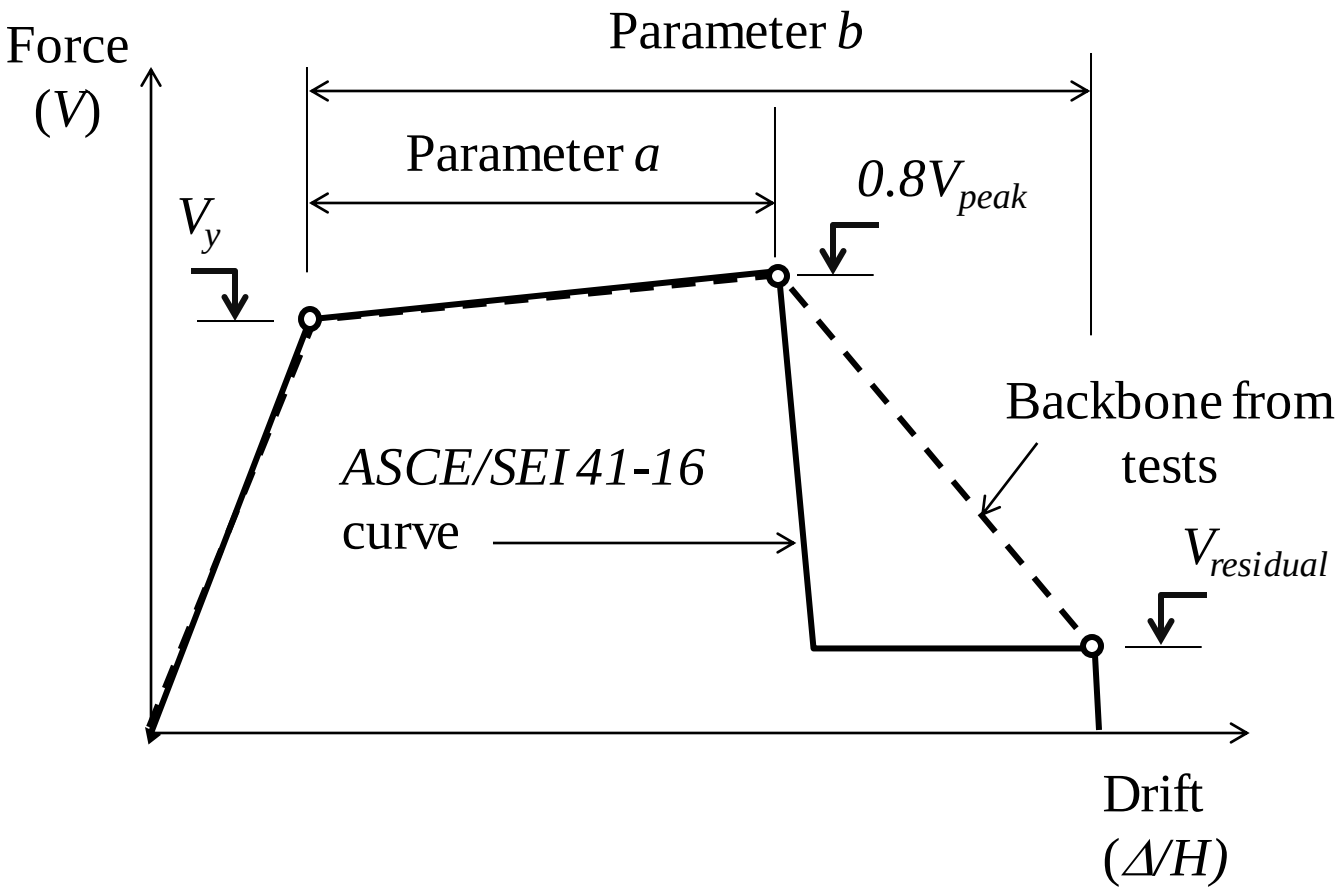
Members: Sergio Alcocer, Alvaro Celestino, Saeed Fathali, Matias Hube, Brian Kehoe, Insung Kim, Hayder Rasheed, Nancy L. Varney

October 2018

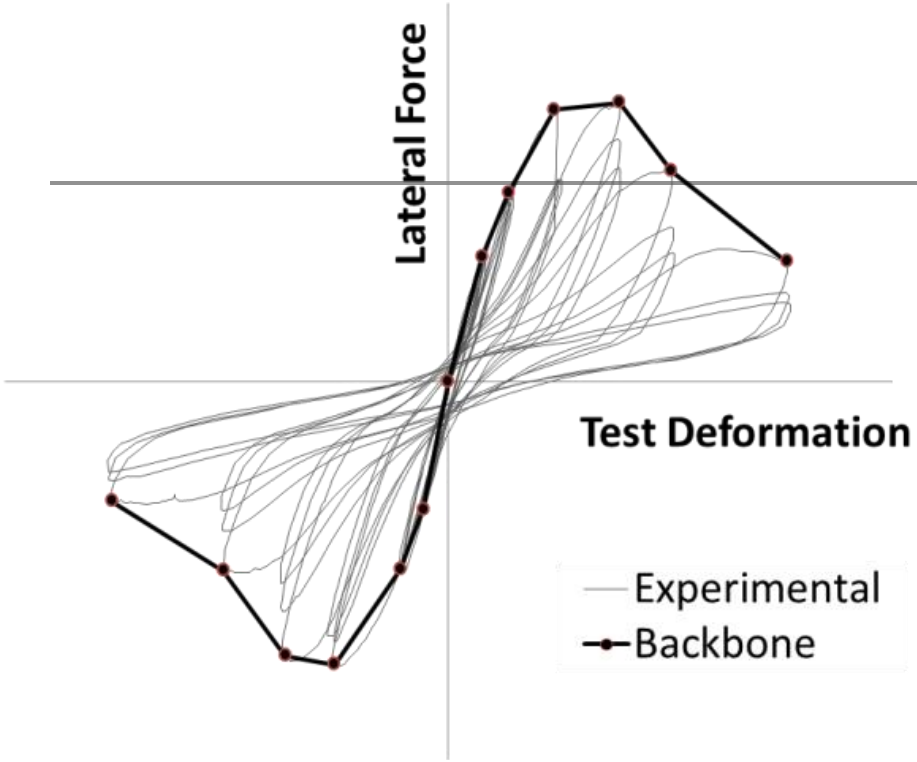
ACI 369-F Ongoing Activities

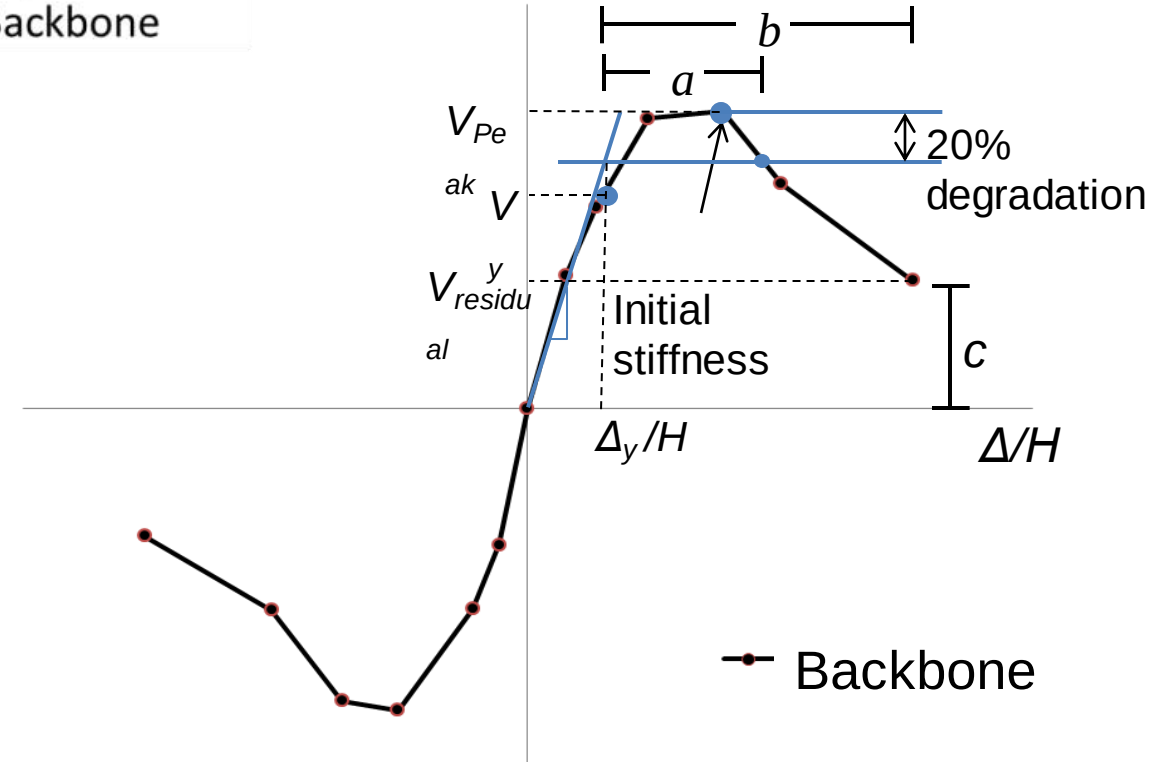
- Add content to the ACI 369.1-17 Standard to include jacketed columns as a retrofitting method
  - Discuss properties of new materials used for jacketing
  - Working with an existing database of jacketed columns to propose modeling parameters
  - Provide recommendations on methods to use to determine flexural, shear, axial strength of jacketed columns
  - Determine reasonable acceptance criteria for jacketed columns

ASCE/SEI 41 Backbone

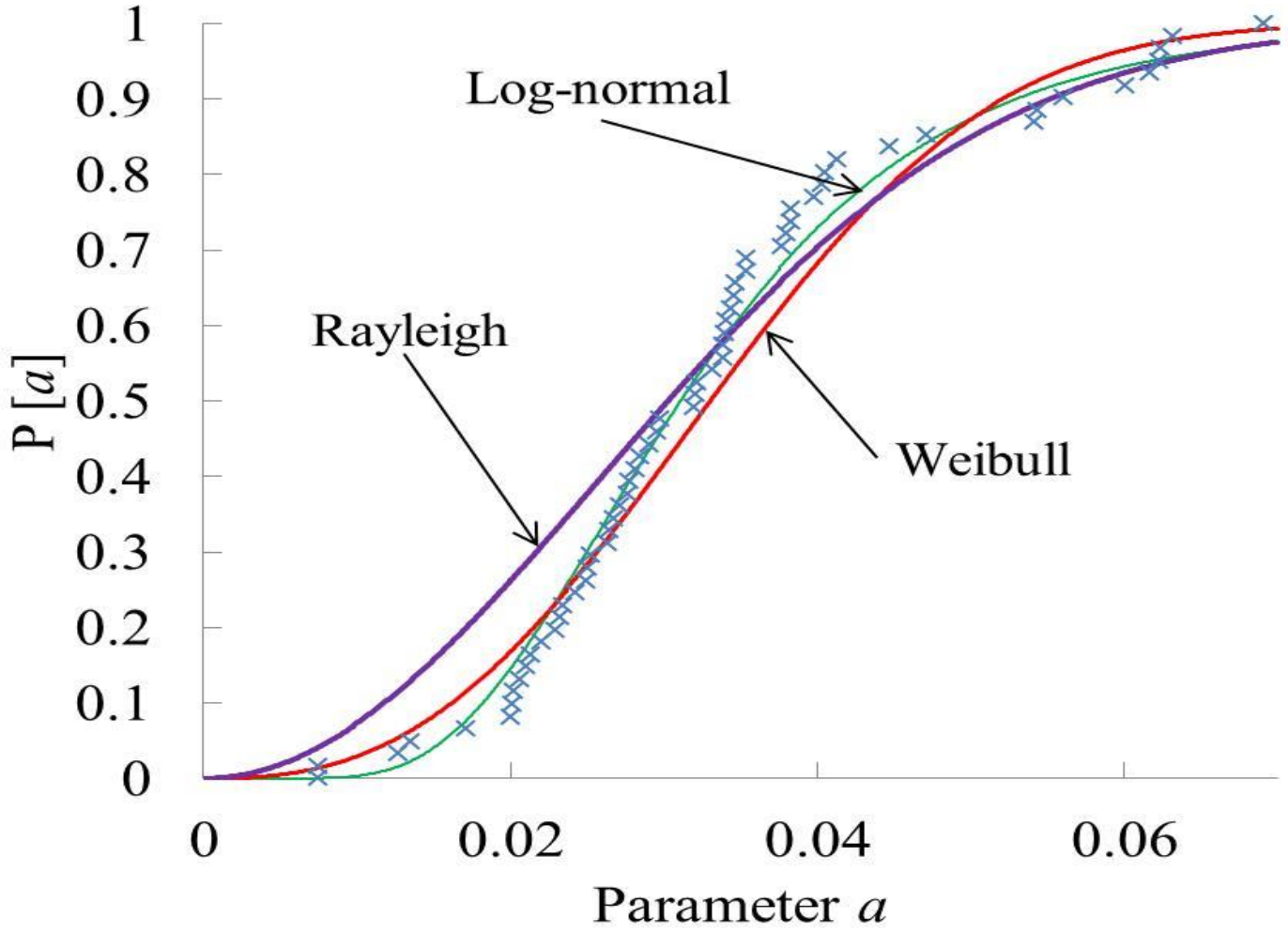


Data Extraction





FRP-Jacketed Rectangular Columns (sample)



Modeling Parameters for Jacketed Columns

Section Parameters			Modeling parameters		
			Plastic rotations angle, radians		Residual Strength ratio
Jacketing Material	Section Shape	$\frac{P}{A_g f'_c}$	a	b	c
FRP	Circular	≤ 0.1	0.049	0.060	0.2
		≥ 0.6	0.010	0.010	0.0
	Rectangular	≤ 0.1	0.034	0.060	0.2
		≥ 0.6	0.010	0.010	0.0
Steel	Circular	≤ 0.1	0.043	0.060	0.2
		≥ 0.6	0.010	0.010	0.0
	Rectangular	≤ 0.1	0.040	0.060	0.2
		≥ 0.6	0.010	0.010	0.0