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Design of Facade Attachments
Session L3: Lateral Drifts and Facade Attachments
May 23, 2019

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Course Description

Lateral Drifts and Facade Attachments
May 23, 2019

When buildings sway under wind and seismic loads, the facade systems must accommodate inter-story drifts between the building's floor levels. Finding ways to accommodate these drifts through the height of the building, particularly at corners and at the ground story, can be challenging. In this session, we will consider ways to detail facade attachments to accommodate a building's lateral drifts.

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Learning Objectives

- List the basic design strategies for accommodating the in-plane relative movement in a facade system that arises from building lateral drift.
- Explain the facade jointing challenges at building corners and how they can be detailed.
- Identify relevant code provisions for the design of facade systems for wind and seismic drift and their underlying performance objectives.
- Describe how the concepts of "mean recurrence interval" and "probability of exceedance" can be used to establish design criteria for building facades.

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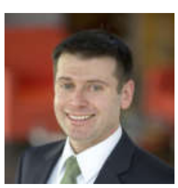
Design of Facade Attachments

Session L3: Lateral Drifts and Facade Attachments
May 23, 2019



Alec Zimmer, PE
Senior Project Manager
Simpson Gumpertz & Heger Inc.
Waltham, MA

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Syllabus for Night School Sessions

- Session R1
- Session L1
- Session L2
- Session L3
  - Accommodating Lateral Drifts
  - In-Plane Movements
  - Out-of-Plane Movements
  - Building Corners

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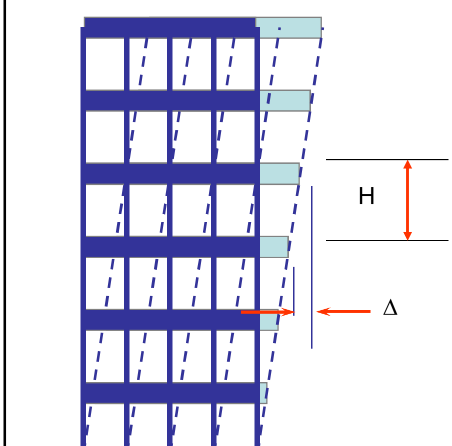
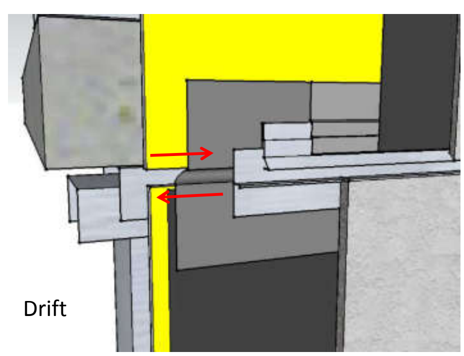
Dealing with Drift

Dealing with Drift





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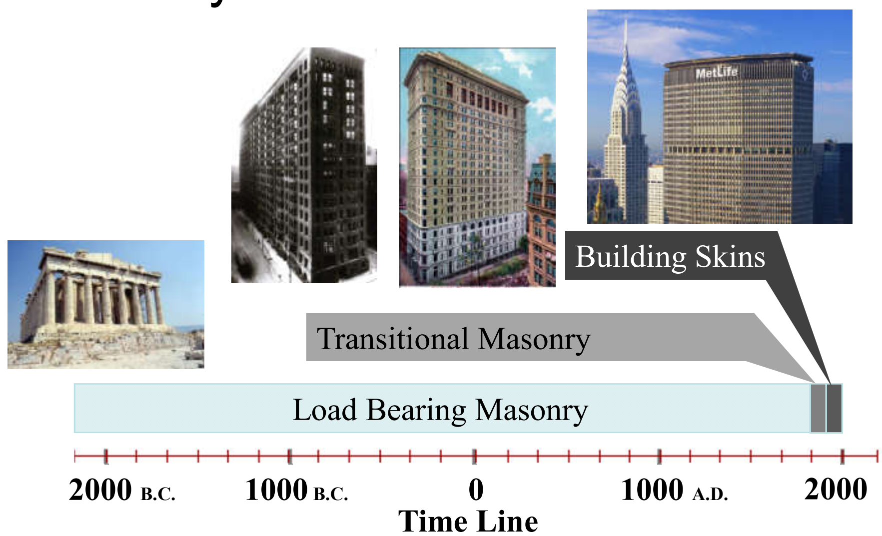
Dealing with Drift

History of Facade Construction



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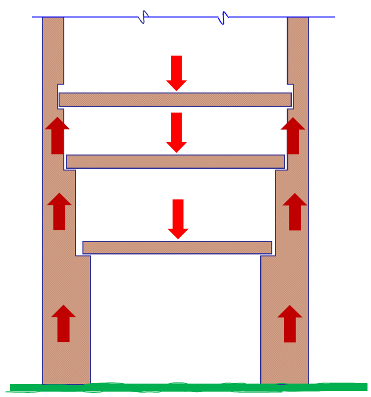
Dealing with Drift

Load Bearing Walls


Monadnock Block



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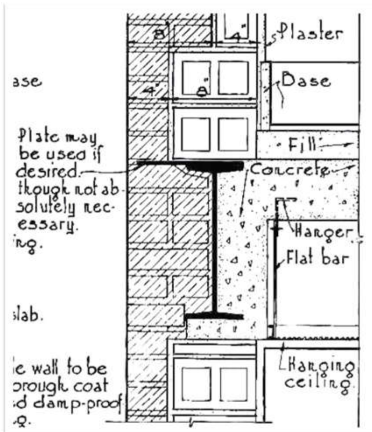
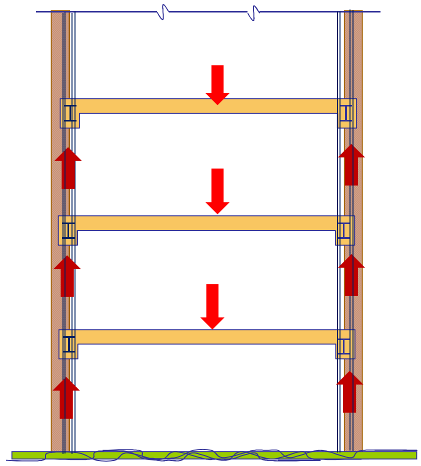
Dealing with Drift

Transitional Buildings





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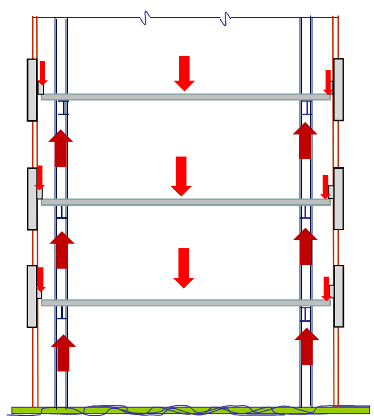
Dealing with Drift

Modern Non-Structural Wall Buildings (Skinned)



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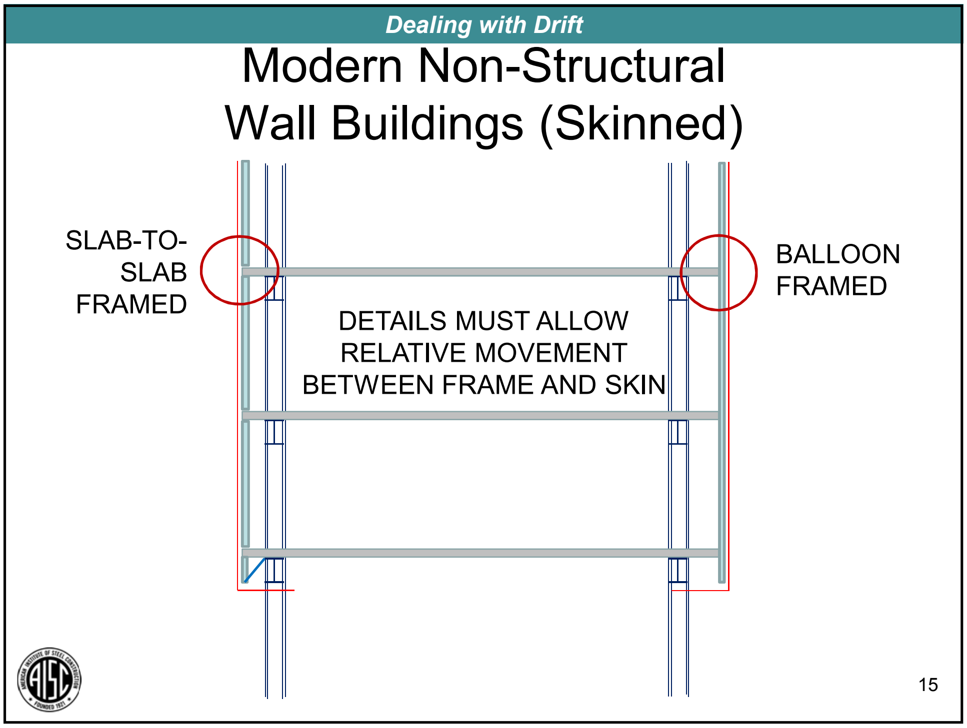
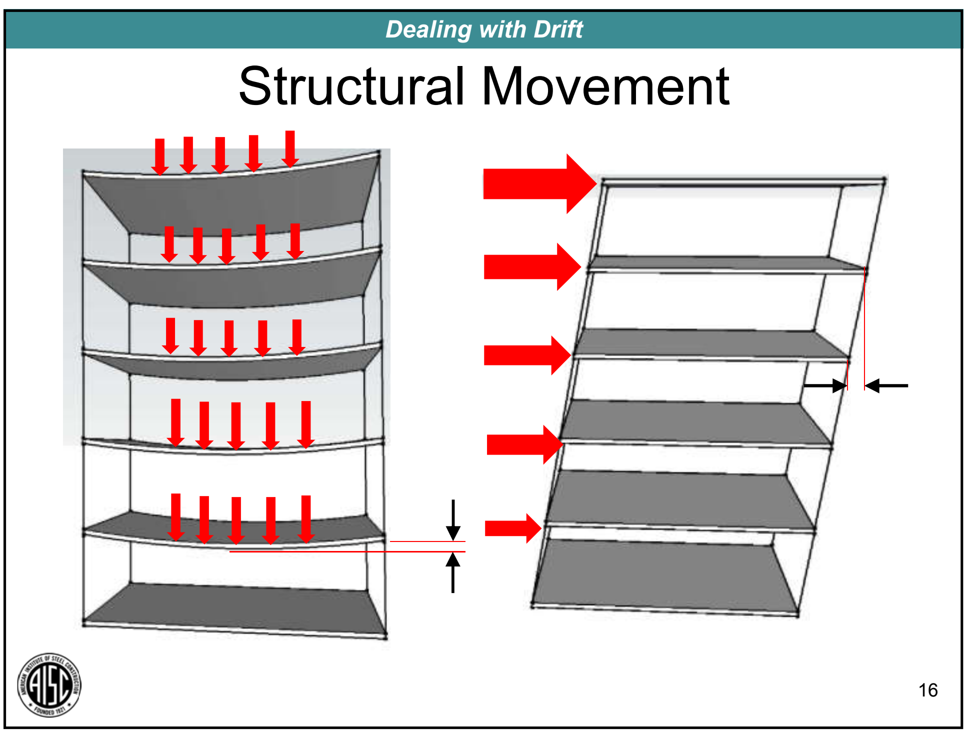

Dealing with Drift
Modern Non-Structural Wall Buildings (Skinned)
SLAB-TO-SLAB FRAMED
BALLOON FRAMED
DETAILS MUST ALLOW RELATIVE MOVEMENT BETWEEN FRAME AND SKIN
15


Dealing with Drift
Structural Movement
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Dealing with Drift

Why it Matters…

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Accommodating Vertical Movement

Accommodating Vertical Movement

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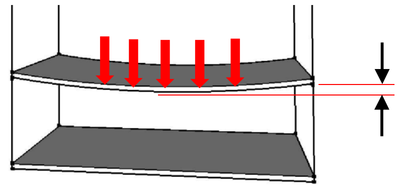
Accommodating Vertical Movement

Floor and Roof Deflections
Live, Snow, and Rain Loads



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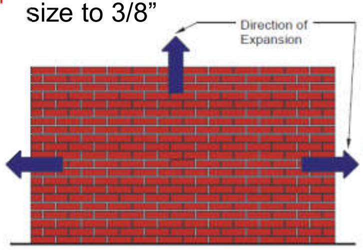
Accommodating Vertical Movement

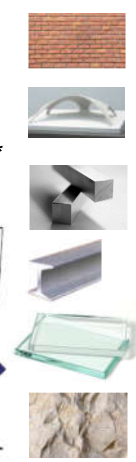
Thermal and Moisture Movements

$M = \Delta T * L * \alpha$

- M: Thermal movement
- ΔT: Max Temperature Range
- L: Length
- α: Coefficient of Linear Thermal Expansion

<u>Moisture example:</u>
A **1/2"** joint within a brick wall spaced @ 20'-0" O.C. will expand by 1/8" (0.05% * 20'-0"), reducing the joint size to 3/8"





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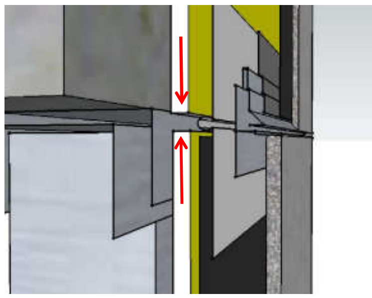
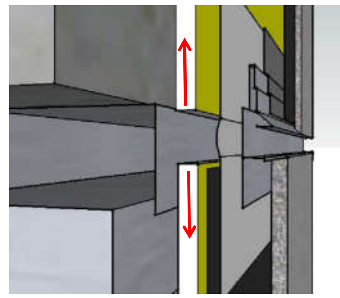
Accommodating Vertical Movement

Movement in Horizontal Joints



Compression



Expansion

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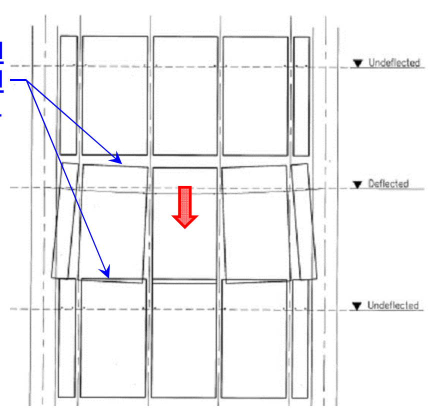
Accommodating Vertical Movement

Movement in Horizontal Joints

Effect on **horizontal** joint due to **vertical** movement.



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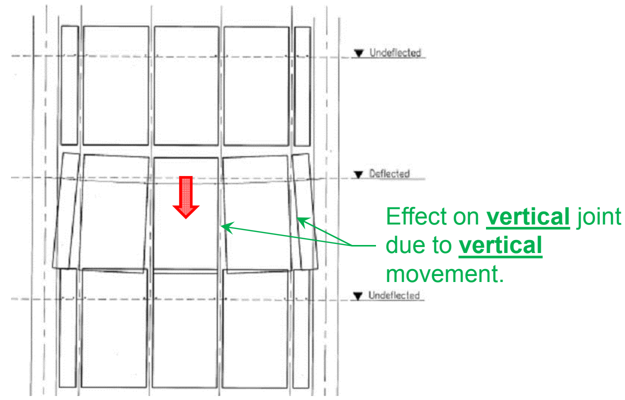
Accommodating Vertical Movement

Movement in Vertical Joints



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Accommodating Vertical Movement

Transitions in Facade Support

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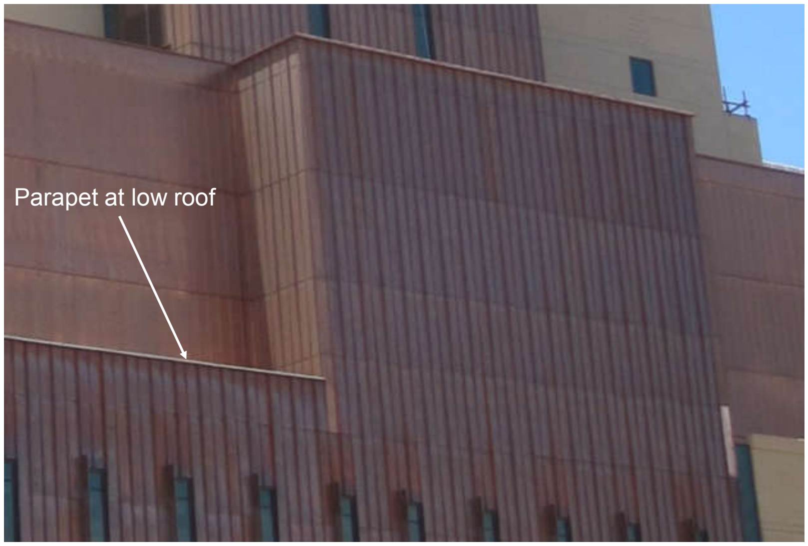
Accommodating Vertical Movement

Transitions in Facade Support



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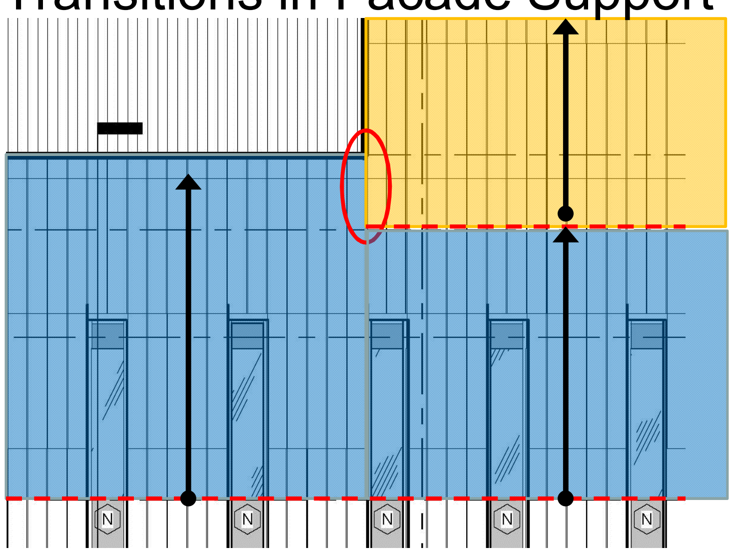
Accommodating Vertical Movement

Transitions in Facade Support



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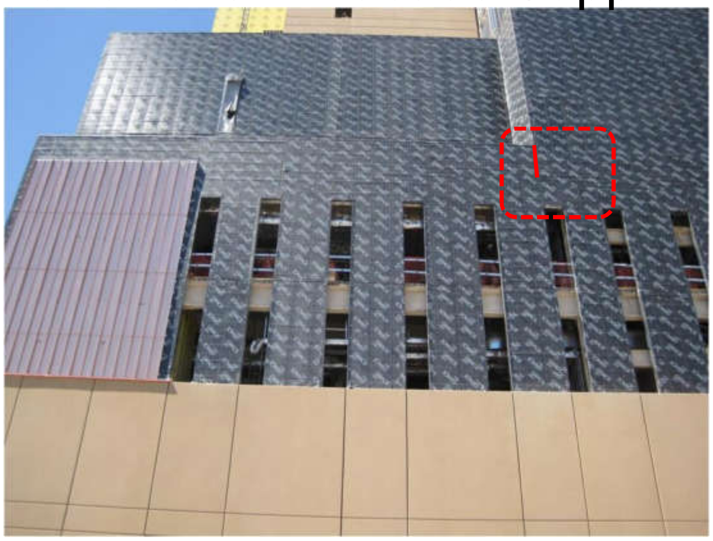
Accommodating Vertical Movement

Transitions in Facade Support



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Accommodating Vertical Movement

Transitions in Facade Support

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Accommodating Lateral Drift

Accommodating Lateral Drift

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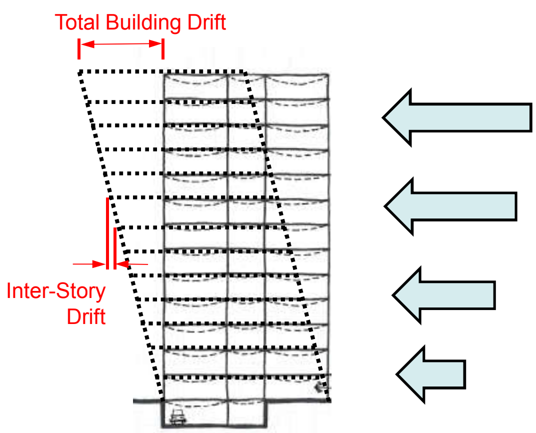
Accommodating Lateral Drift

Inter-Story Drift

- The most common sources of horizontal building movement are **wind loads** and **seismic loads**



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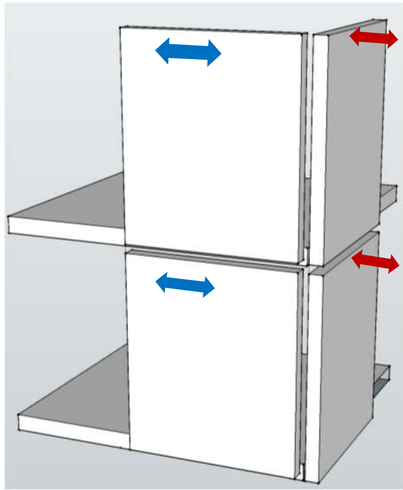
Accommodating Lateral Drift

In-Plane and Out-of-Plane Movements



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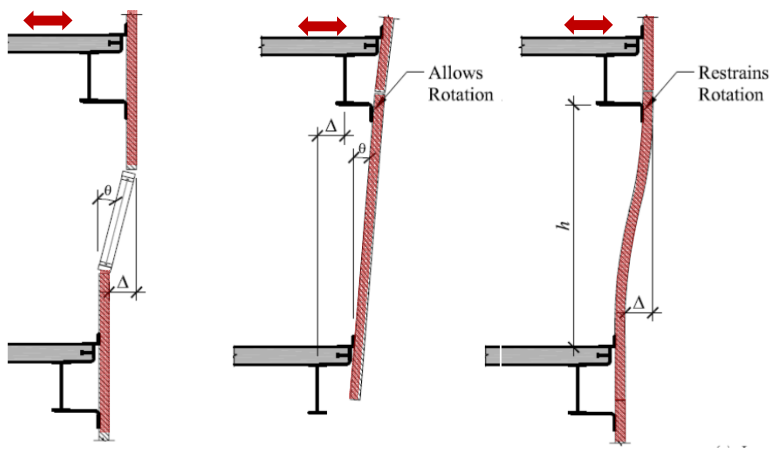
Accommodating Lateral Drift

Out-of-Plane Movement from Drift



Rigid Body Translation **Rigid Body Rotation** **Distortion, Curvature**

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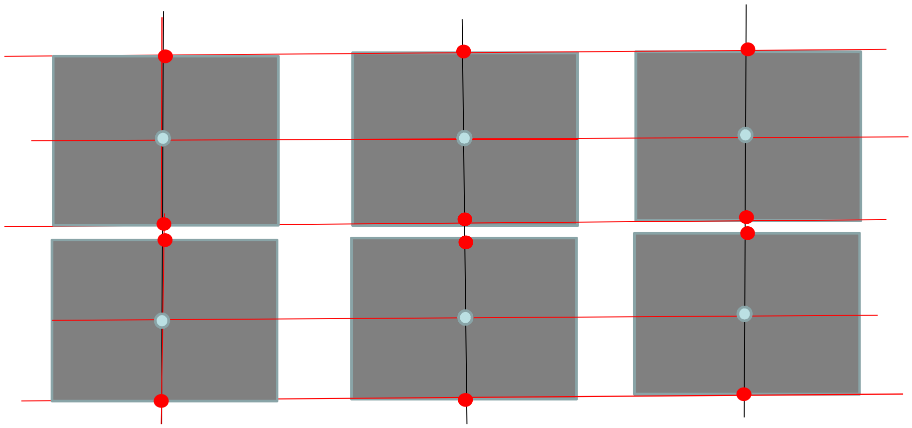
Accommodating Lateral Drift

Accommodating In-Plane Drift



Rigid Body Translation **Rigid Body Rotation** **Distortion, Racking**

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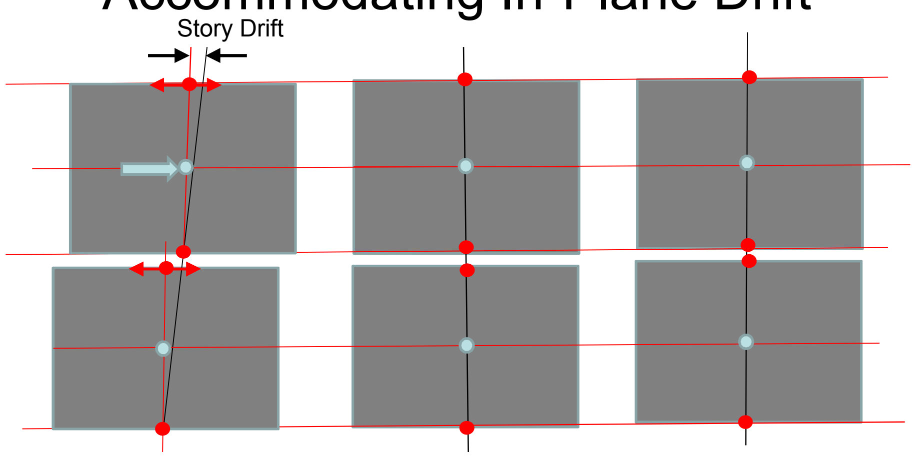
Accommodating Lateral Drift

Accommodating In-Plane Drift



Rigid Body Translation **Rigid Body Rotation** **Distortion, Racking**

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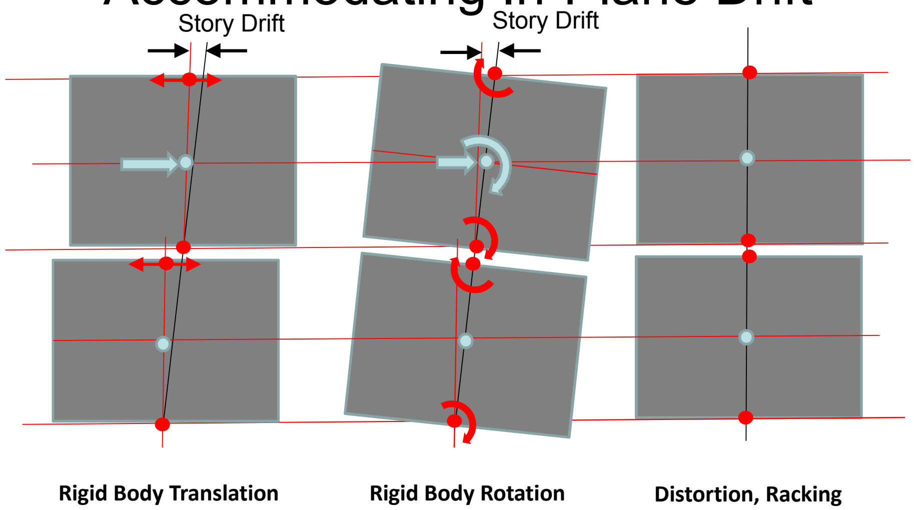
Accommodating Lateral Drift

Accommodating In-Plane Drift



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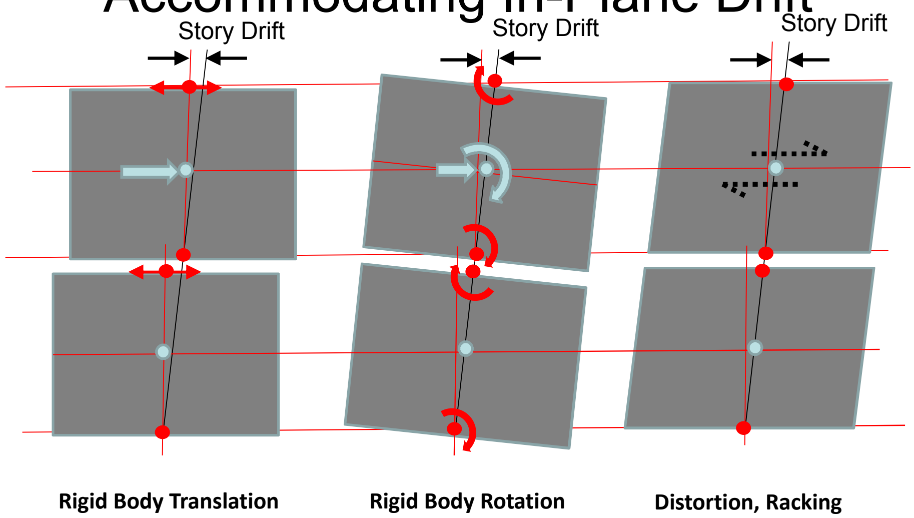
Accommodating Lateral Drift

Accommodating In-Plane Drift



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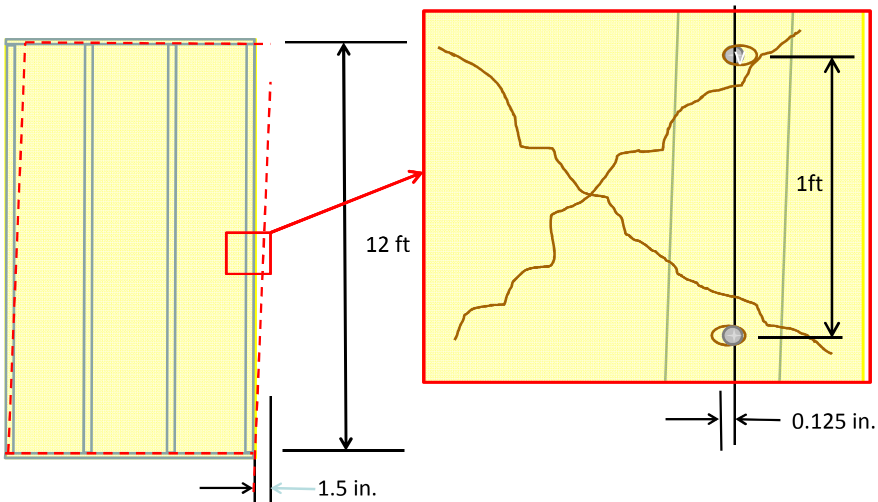
Accommodating Lateral Drift

Racking Metal Stud Backup - Does it Matter?



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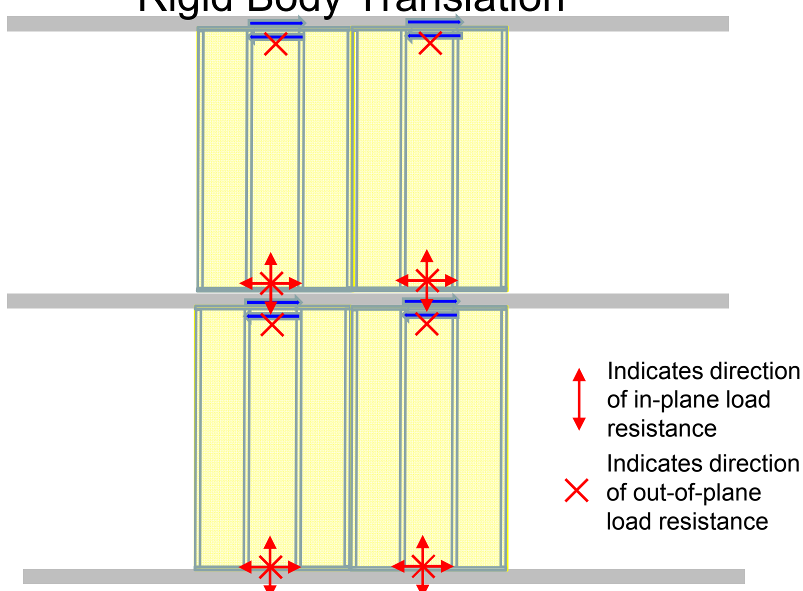
Accommodating Lateral Drift

Rigid Body Translation



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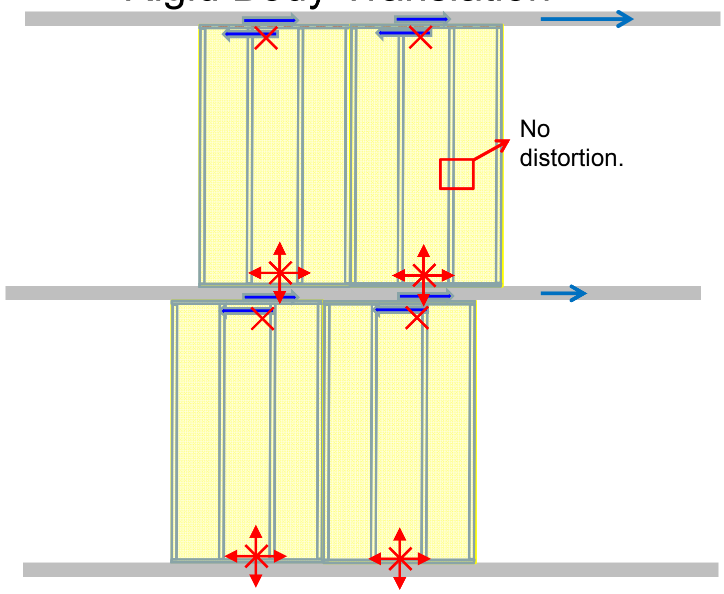
Accommodating Lateral Drift

Rigid Body Translation



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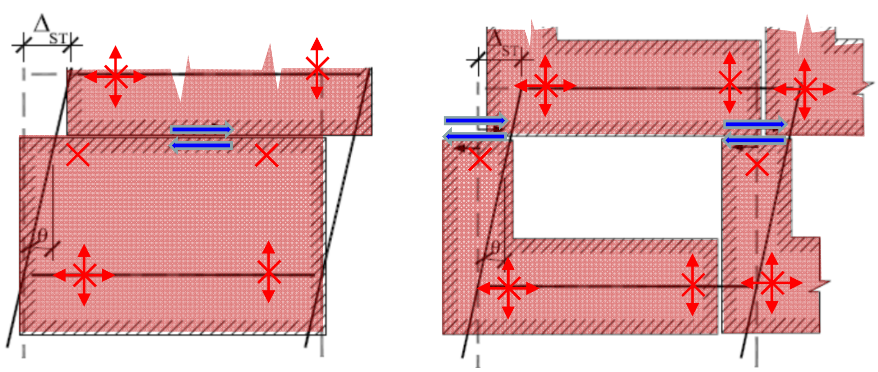
Accommodating Lateral Drift

Rigid Body Translation Connections



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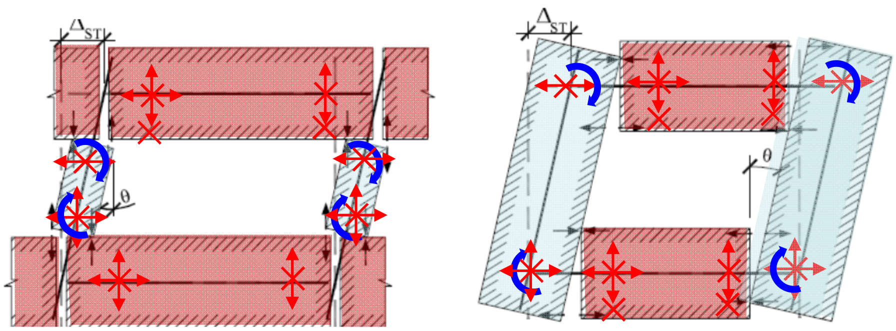
Accommodating Lateral Drift

Rigid Body Rotation Mixed with Translation



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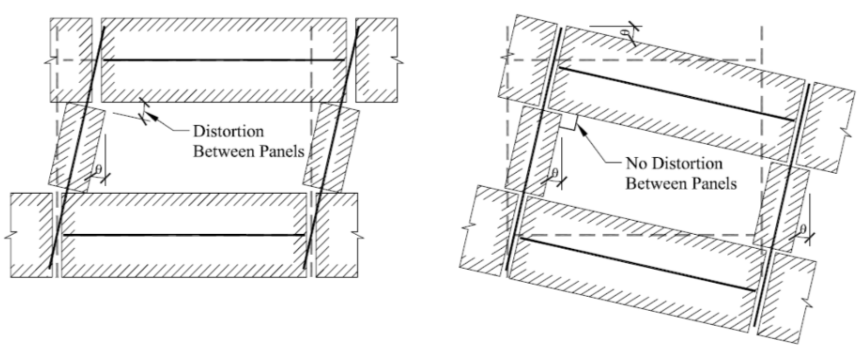
Accommodating Lateral Drift

Shear and Flexural Deformations



(a) Frame Shear Deformation Movement on Joints

(b) Frame Flexural Deformation Less Movement at Joints

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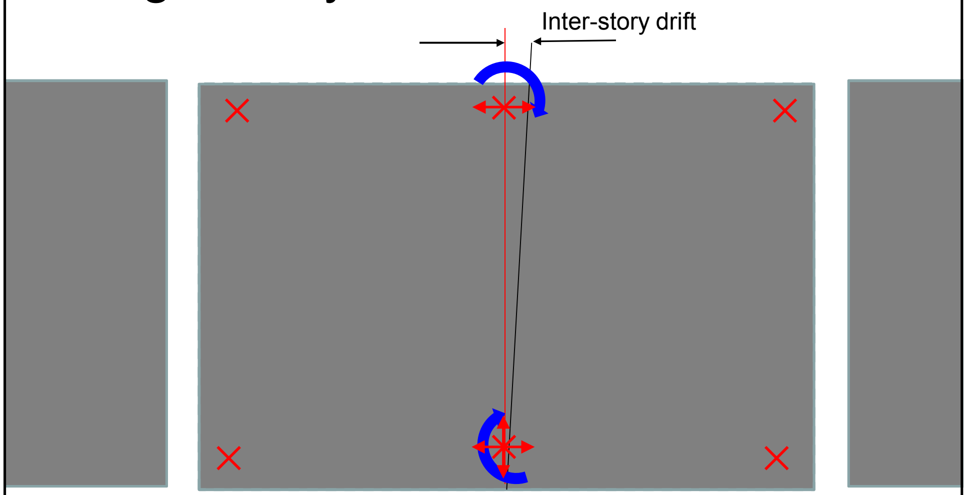
Accommodating Lateral Drift

Rigid Body Rotation Connections



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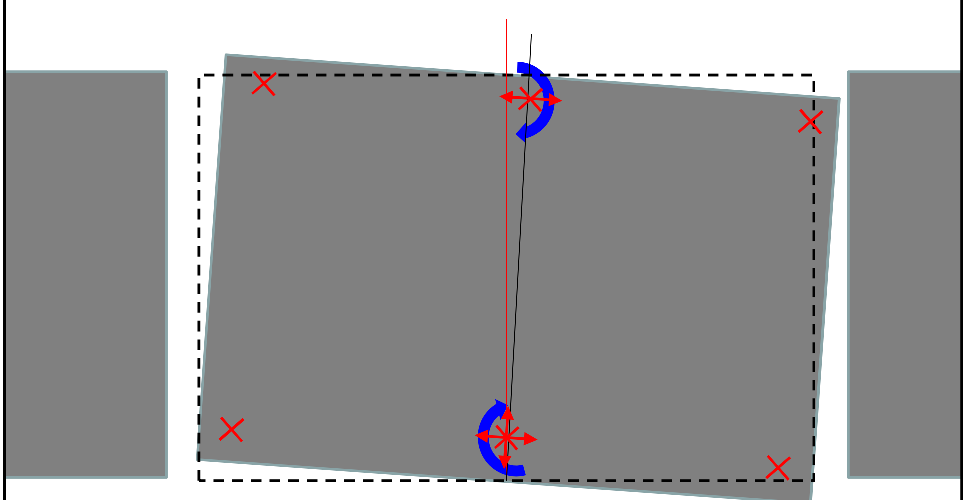
Accommodating Lateral Drift

Rigid Body Rotation Connections



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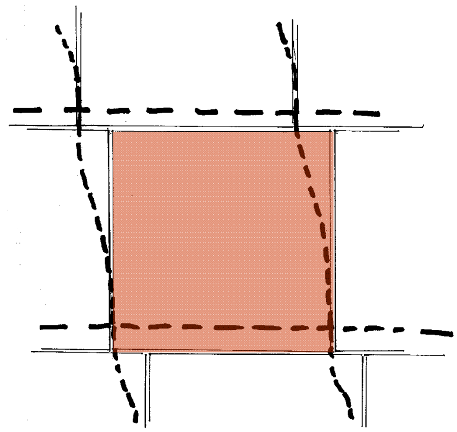
Accommodating Lateral Drift

In-Plane Movements



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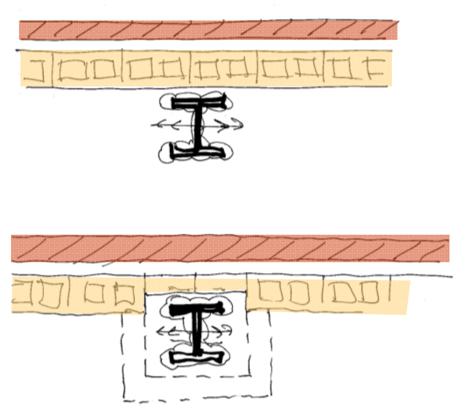
Accommodating Lateral Drift

In-Plane Movements



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Accommodating Lateral Drift

In-Plane Movements

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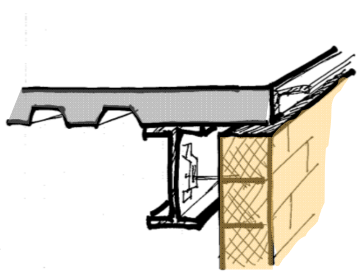
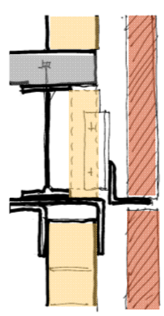
Accommodating Lateral Drift

Top of Wall Connections



CMU Backup
Long Slab Overhang
Angle at Slab



CMU Backup
Short Slab Overhang
Hung Angle

Metal Stud Backup
Long Slab Overhang
Hung Angle

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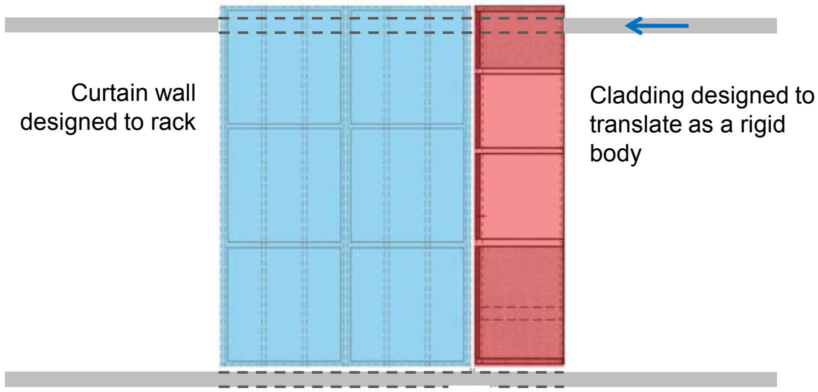
Accommodating Lateral Drift

Lateral Drift – Mixed Systems



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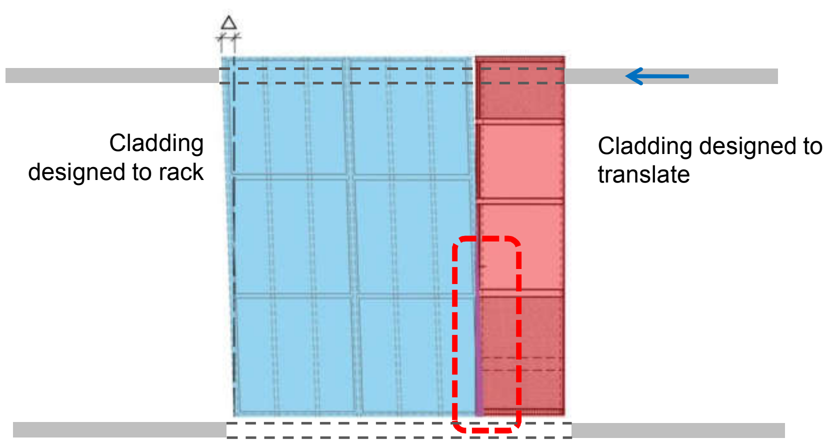
Accommodating Lateral Drift

Lateral Drift – Mixed Systems



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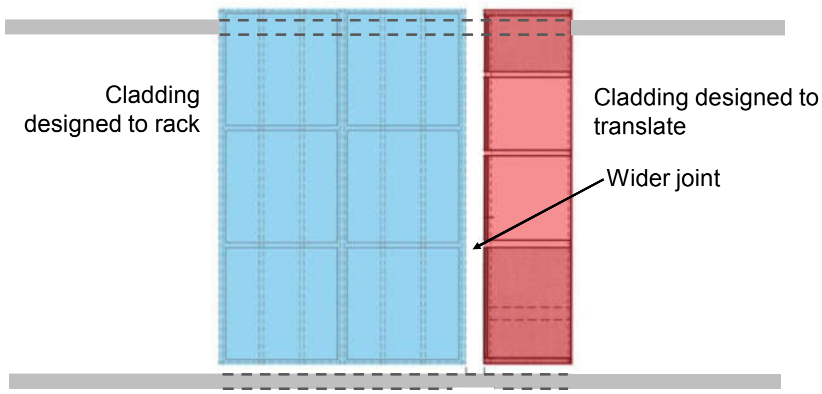
Accommodating Lateral Drift

Lateral Drift – Mixed Systems



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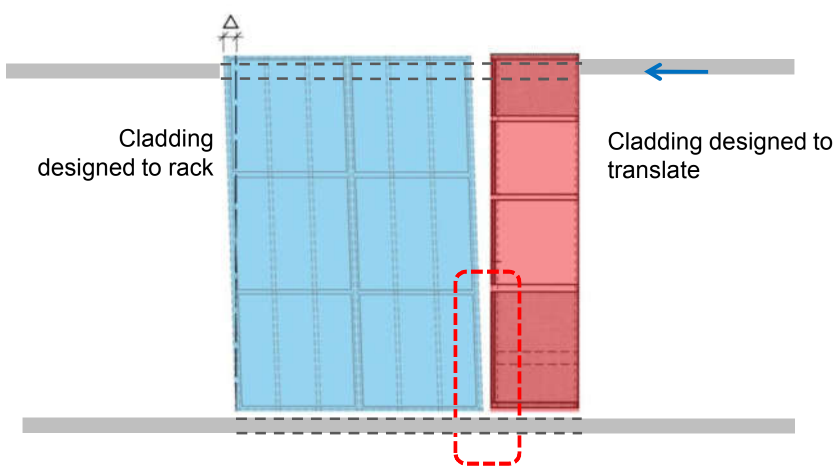
Accommodating Lateral Drift

Lateral Drift – Mixed Systems



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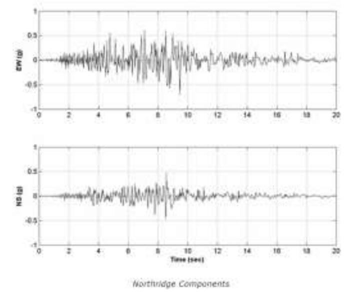
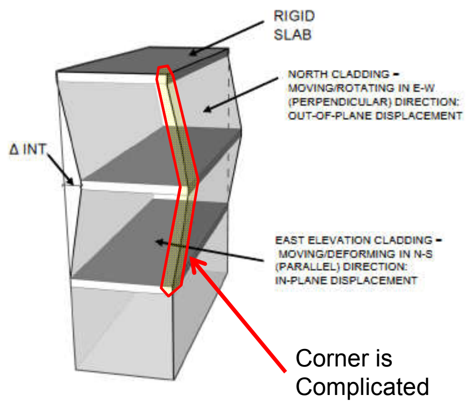
Accommodating Lateral Drift

Corners are Complicated





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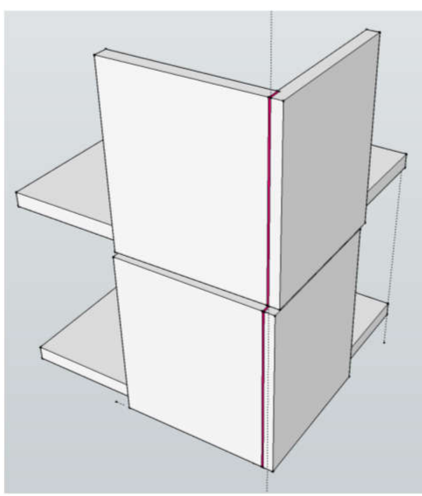
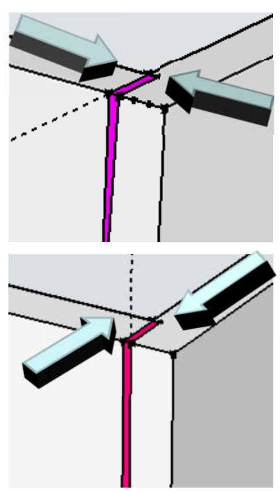
Accommodating Lateral Drift

Corners are Complicated





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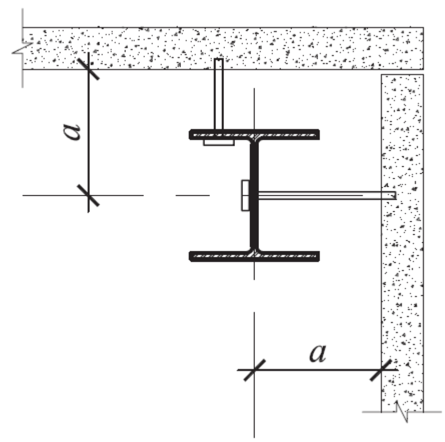
Accommodating Lateral Drift

Potential Interference at Corners



Plan View – Original Configuration

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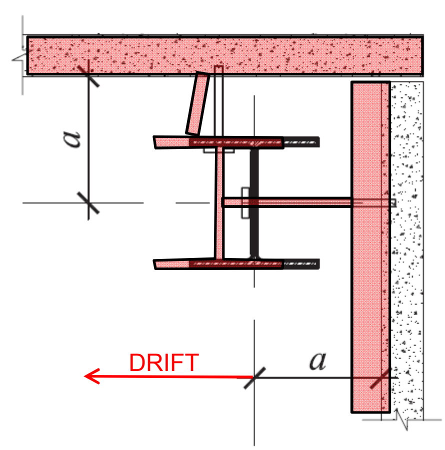
Accommodating Lateral Drift

Potential Interference at Corners



Plan View – Distortion in East-West Direction

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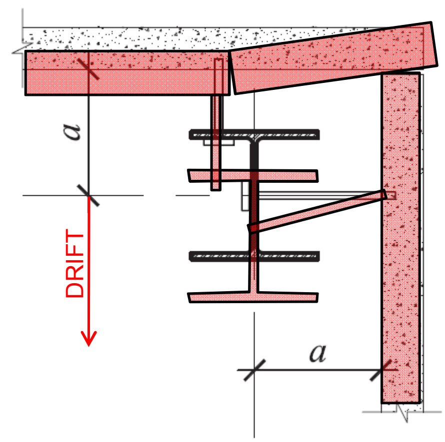
Accommodating Lateral Drift

Potential Interference at Corners



Plan View – Distortion in North-South Direction

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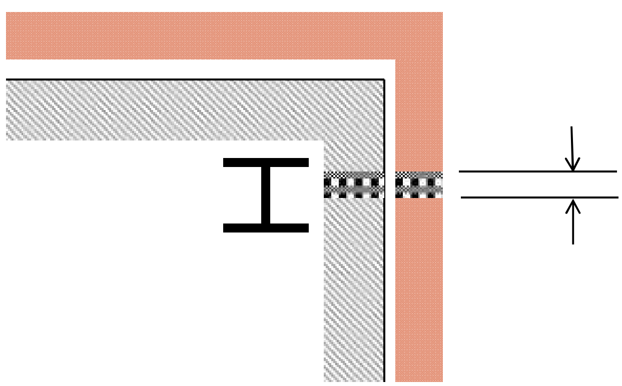
Accommodating Lateral Drift

Translating System Corner: Large Joint



Plan View – Original Configuration

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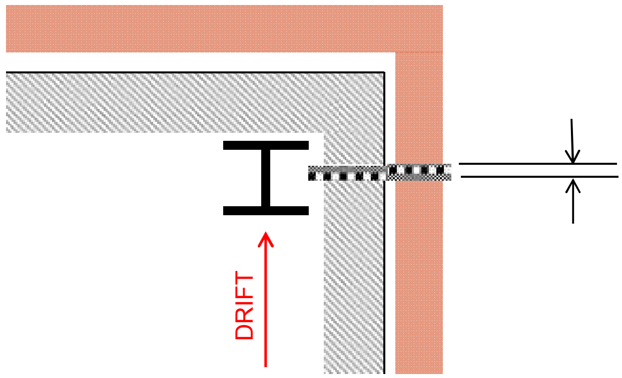
Accommodating Lateral Drift

Translating System Corner: Large Joint



Plan View – Distortion in North-South Direction

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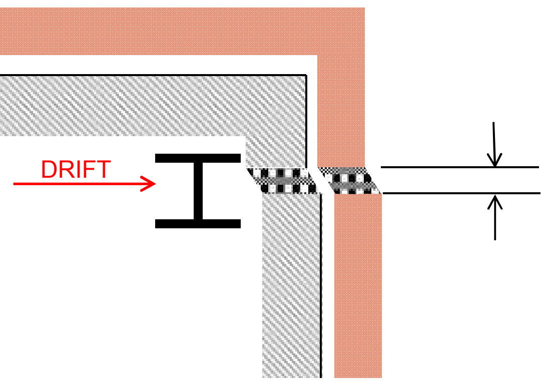
Accommodating Lateral Drift

Translating System Corner: Large Joint



Plan View – Original Configuration

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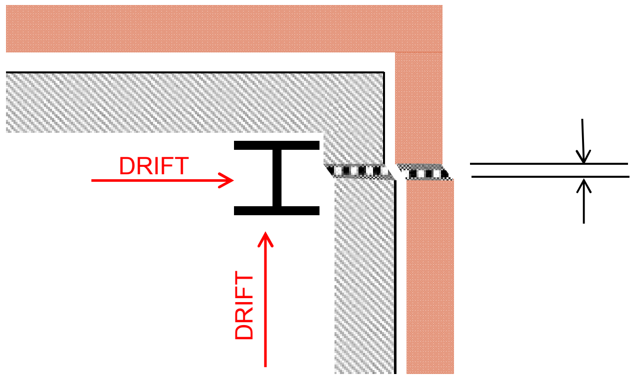
Accommodating Lateral Drift

Translating System Corner: Large Joint



Plan View – Distortion in Both Directions

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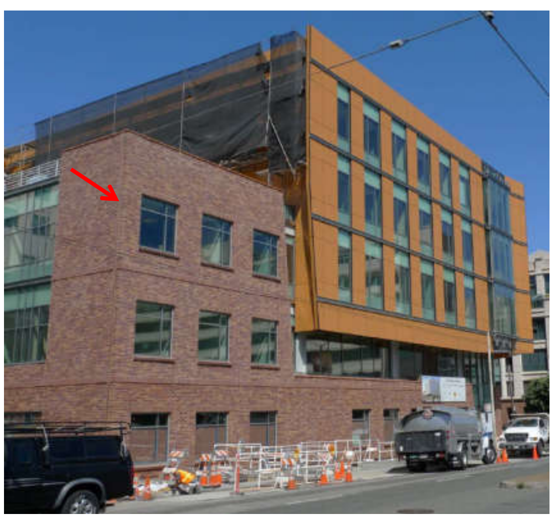
Accommodating Lateral Drift

Example: Wide Joint at Corner



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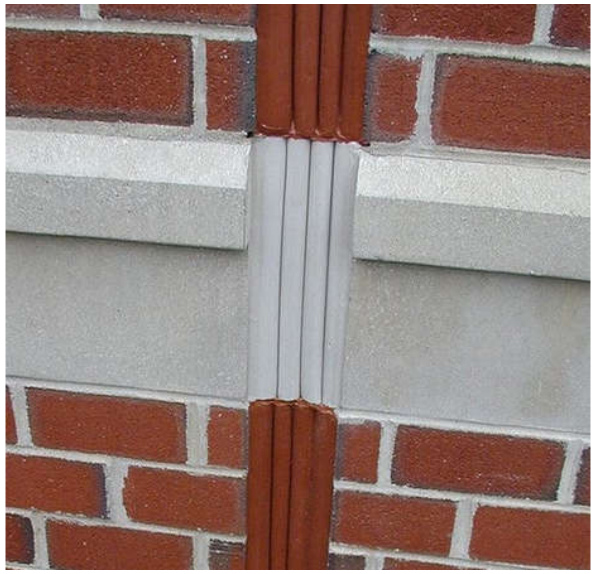
Accommodating Lateral Drift

Example: Wide Joint at Corner



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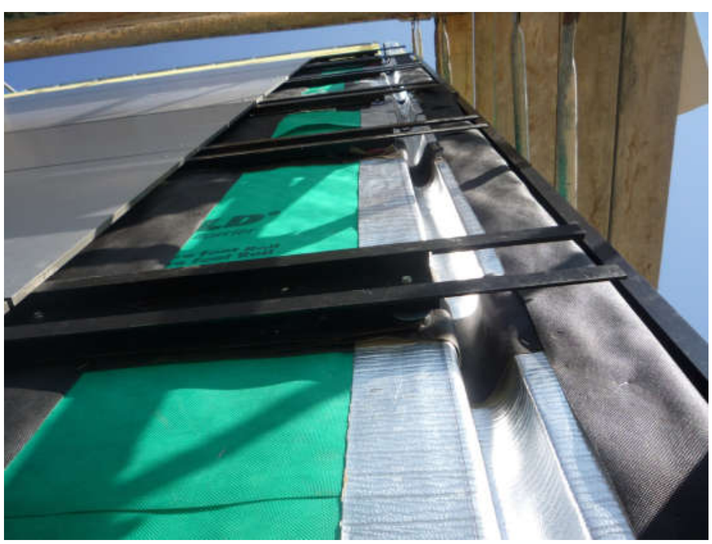
Accommodating Lateral Drift

Example: Hidden Joint at Corner



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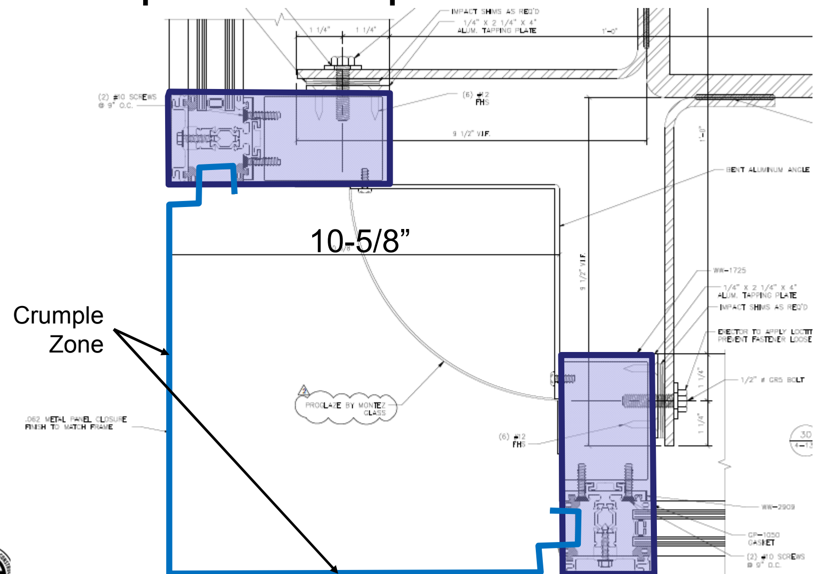
Accommodating Lateral Drift

Example: Crumple Zone at Corner



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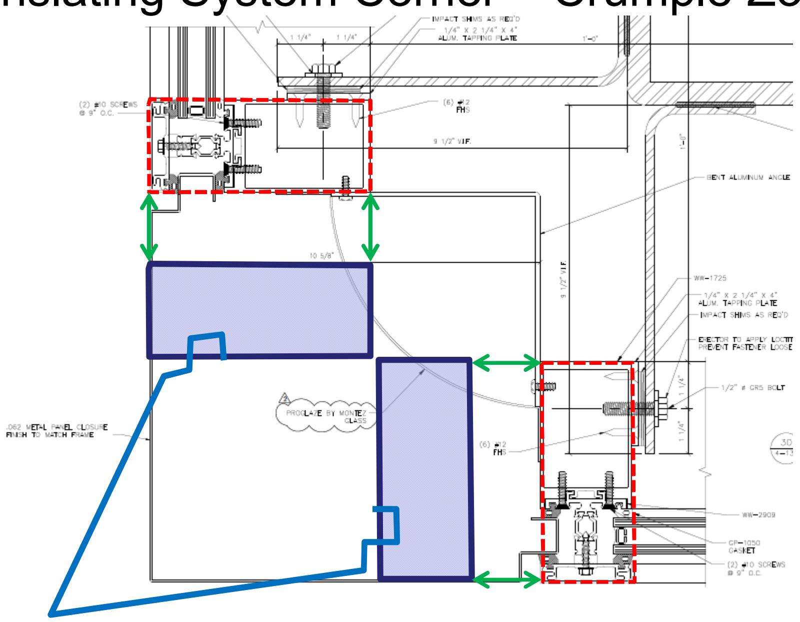
Accommodating Lateral Drift

Translating System Corner – Crumple Zone



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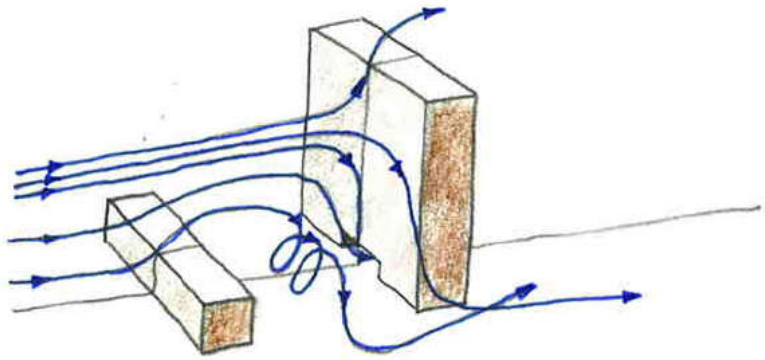
Lateral Forces

Wind and Seismic Forces



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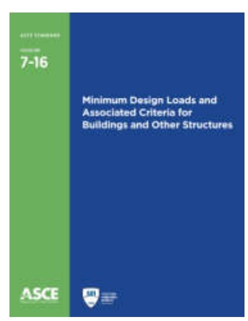
Lateral Forces

Demands - Wind

- Wind forces for main LFRS determines strength level drift
- Wind forces on components and cladding determine facade attachment forces



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Lateral Forces

Wind Load Demands

- **Out-of-Plane Forces – Components and Cladding**
  - Facade element strength
  - Facade attachments strength
- **Strength-Level Drift – Main LFRS**
  - Facade attachments must not fail due to displacement
  - Facade elements cannot become falling hazards
  - Connections must accommodate drift
- **Service Level Drift – not codified**
  - Performance of facade and joints

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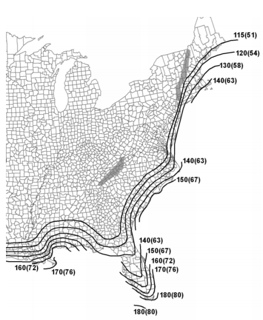
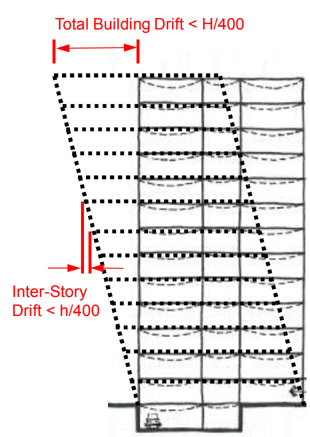
Lateral Forces

Wind Drift Design





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Lateral Forces

Design Wind Drift for Safety

- Code prescribed wind forces for safety:

Building Risk Category	MRI	Annual Probability of Exceedance
I	300 years	0.33%
II	750 years	0.14%
III	1700 years	0.06%
IV	1700 years	0.06%

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Lateral Forces

Serviceability Checks for Drift

- Serviceability checks may be for lower forces and drifts
- ASCE 7-16 Commentary suggests:
  $D + 0.5L + W_a$
- Example: Boston, Risk Category II:
  - 10 year MRI – W_a = 39% of W_{ult}
  - 25 year MRI – W_a = 50% of W_{ult}
  - 50 year MRI – W_a = 58% of W_{ult}
  - 100 year MRI – W_a = 69% of W_{ult}

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Lateral Forces

(Out-of-Plane) Wind Deflections
IBC 2015 Table 1604.3

TABLE 1604.3
DEFLECTION LIMITS[a, b, c, h, i]

CONSTRUCTION	L	S or W^f	$D + L^{d,g}$
Roof members:[e]			
Supporting plaster or stucco ceiling	$l/360$	$l/360$	$l/240$
Supporting nonplaster ceiling	$l/240$	$l/240$	$l/180$
Not supporting ceiling	$l/180$	$l/180$	$l/120$
Floor members	$l/360$	—	$l/240$
Exterior walls:			
With plaster or stucco finishes	—	$l/360$	—
With other brittle finishes	—	$l/240$	—
With flexible finishes	—	$l/120$	—
Interior partitions:[b]			
With plaster or stucco finishes	$l/360$	—	—
With other brittle finishes	$l/240$	—	—
With flexible finishes	$l/120$	—	—
Farm buildings	—	—	$l/180$
Greenhouses	—	—	$l/120$

Exterior Walls:
With plaster or stucco finishes ------ *l/360*
With other brittle finishes--------------*l/240*
With flexible finishes ------------------*l/120*

Footnote f:
The wind load is permitted to be taken as 0.42 times the "component and cladding" loads for the purpose of determining deflection limits herein.

Where members support glass in accordance with Section 2403 using the deflection limit therein, the wind load shall be no less than 0.6 times the "component and cladding" loads for the purpose of determining deflection.

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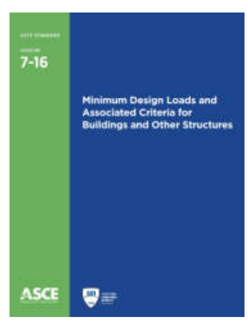
Lateral Forces

Demands - Seismic

- Seismic forces for main LFRS determines strength level drift
- Seismic forces on architectural components determine facade attachment forces



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Lateral Forces

Seismic Load Demands

- **Out-of-plane forces *and* in-plane forces – Chapter 13, Architectural Components**
  - Facade element strength
  - Facade attachment strength
- **Strength level drift – Chapter 12, main LFRS**
  - Facade attachments must not fail
  - Facade elements cannot become falling hazards
  - Connections must accommodate drift
- **Service level drift – not codified**
  - Performance of facade and joints

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Lateral Forces

Chapter 13, Seismic Loads

$$F_p = \frac{0.4 a_p S_{DS} W_p}{\left(\frac{R_p}{I_p}\right)}\left(1 + 2\frac{z}{h}\right)$$

Table 13.5-1 Coefficients for Architectural Components

Architectural Component	a_p[a]	R_p	Ω_0[b]
Exterior nonstructural wall elements and connections[b]			
Wall element	1	2½	NA
Body of wall panel connections	1	2½	NA
Fasteners of the connecting system	1¼	1	1
Veneer			
Limited deformability elements and attachments	1	2½	2
Low-deformability elements and attachments	1	1½	2

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Lateral Forces

Seismic Displacements for Exterior Walls

13.3.2 Seismic Relative Displacements. The effects of seismic relative displacements shall be considered in combination with displacements caused by other loads as appropriate. Seismic relative displacements, D_{pI}, shall be determined in accordance with Eq. (13.3-6):

$$D_{pI} = D_p I_e \qquad (13.3\text{-}6)$$

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Lateral Forces

Attachment Design

13.5.3 Exterior Nonstructural Wall Elements and Connections. Exterior nonstructural wall panels or elements that are attached to or enclose the structure shall be designed to accommodate the seismic relative displacements defined in Section 13.3.2 and movements due to temperature changes. Such elements shall be supported by means of positive and direct structural supports or by mechanical connections and fasteners in accordance with the following requirements:

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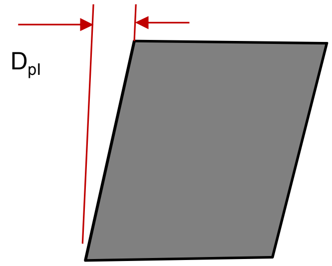
Lateral Forces

Attachment Design

1. Connections and panel joints shall allow for the story drift caused by relative seismic displacements (D_{pI}) determined in Section 13.3.2, or 0.5 in. (13 mm), whichever is greater.



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Lateral Forces

Attachment Design

2. Connections accommodating story drift through sliding mechanisms or bending of threaded steel rods shall satisfy the following:
   a. Threaded rods or bolts shall be fabricated of low-carbon or stainless steel. Where cold-worked carbon steel threaded rods are used, the rods as fabricated shall meet or exceed the reduction of area, elongation, and tensile strength requirements of ASTM F1554, Grade 36. Grade 55 rods shall also be permitted provided that they meet the requirements of Supplement 1; and

Ductility

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Lateral Forces

Attachment Design

b. Where threaded rods connecting the panel to the supports are used in connections using slotted or oversize holes, the rods shall have length to diameter ratios of 4 or less, where the length is the clear distance between the nuts or threaded plates. The slots or oversized holes shall be proportioned to accommodate the full in-plane design story drift in each direction, the nuts shall be installed finger-tight, and a positive means to prevent the nut from backing off shall be used; and

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Lateral Forces

Attachment Design

c. Connections that accommodate story drift by bending of threaded rods shall satisfy Eq. (13.5-1):

$$(L/d)/D_{pI} \geq 6.0[1/\text{in.}] \qquad (13.5\text{-}1)$$

where:

L = clear length of rod between nuts or threaded plates [in. (mm)];
d = rod diameter [in. (mm)]; and
D_{pI} = relative seismic displacement that the connection must be designed to accommodate [in. (mm)].

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Lateral Forces

Attachment Design

3. The connecting member itself shall have sufficient ductility and rotation capacity to preclude fracture of the concrete or brittle failures at or near welds.

Table 13.5-1 Coefficients for Architectural Components

Architectural Component	a_p[a]	R_p	Ω_0[b]
Exterior nonstructural wall elements and connections[b]			
Wall element	1	2½	NA
Body of wall panel connections	1	2½	NA
Fasteners of the connecting system	1¼	1	1
Veneer			
Limited deformability elements and attachments	1	2½	2
Low-deformability elements and attachments	1	1½	2

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Lateral Forces

Attachment Design

13.5.9 Glass in Glazed Curtain Walls, Glazed Storefronts, and Glazed Partitions

13.5.9.1 General. Glass in glazed curtain walls, glazed storefronts, and glazed partitions shall meet the relative displacement requirement of Eq. (13.5-2):

$$\Delta_{\text{fallout}} \geq 1.25 D_{pI} \qquad (13.5\text{-}2)$$

or 0.5 in. (13 mm), whichever is greater, where:

Δ_{fallout} = the relative seismic displacement (drift) at which glass fallout from the curtain wall, storefront wall, or partition occurs (Section 13.5.9.2);

By testing AAMA 501.6

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Lateral Forces

Exceptions for Fallout Provision

- Glass with sufficient glass-to-frame clearances to accommodate seismic displacement;
- Fully tempered monolithic glass less than 10 feet above walking surfaces; and
- Single thickness laminated glass that is fully captured and wet glazed.

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Lateral Forces

Attachment Design

EXCEPTIONS:

1. Glass with sufficient clearances from its frame such that physical contact between the glass and frame does not occur at the design drift, as demonstrated by Eq. (13.5-3), need not comply with this requirement:

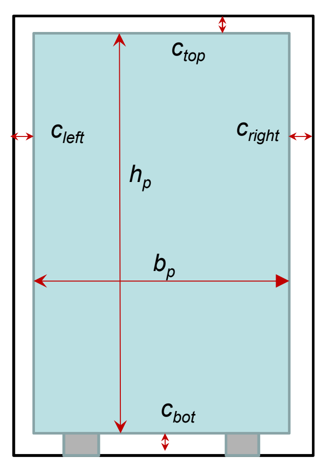
$$D_{\text{clear}} \geq 1.25 D_{pI} \quad (13.5\text{-}3)$$

where D_{clear} = relative horizontal (drift) displacement, measured over the height of the glass panel under consideration, which causes initial glass-to-frame contact. For rectangular glass panels within a rectangular wall frame,

$$D_{\text{clear}} = 2c_1\left(1 + \frac{h_p c_2}{b_p c_1}\right)$$

where

h_p = the height of the rectangular glass panel;
b_p = the width of the rectangular glass panel;
c_1 = the average of the clearances (gaps) on both sides between the vertical glass edges and the frame; and
c_2 = the average of the clearances (gaps) at the top and bottom between the horizontal glass edges and the frame.



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Lateral Forces

Limit States for Design

- Code prescribed wind forces for safety:

Building Risk Category	MRI	Annual Probability of Exceedance
I	300 years	0.33%
II	750 years	0.14%
III	1700 years	0.06%
IV	1700 years	0.06%

- Seismic forces are based on 1,200 to 1,300 year MRI in lower and moderate seismic zones, 375 to 800 year MRI in high seismic zones

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Lateral Forces

Seismic Drift

Table 12.12-1 Allowable Story Drift, Δ_a[a,b]

Structure	Risk Category I or II	Risk Category III	Risk Category IV
Structures, other than masonry shear wall structures, 4 stories or less above the base as defined in Section 11.2, with interior walls, partitions, ceilings, and exterior wall systems that have been designed to accommodate the story drifts.	$0.025h_{sx}$[c]	$0.020h_{sx}$	$0.015h_{sx}$
Masonry cantilever shear wall structures[d]	$0.010h_{sx}$	$0.010h_{sx}$	$0.010h_{sx}$
Other masonry shear wall structures	$0.007h_{sx}$	$0.007h_{sx}$	$0.007h_{sx}$
All other structures	$0.020h_{sx}$	$0.015h_{sx}$	$0.010h_{sx}$

[a] h_{sx} is the story height below Level x.
[b] For seismic force-resisting systems comprised solely of moment frames in Seismic Design Categories D, E, and F, the allowable story drift shall comply with the requirements of Section 12.12.1.1.

h/50 h/67 h/100

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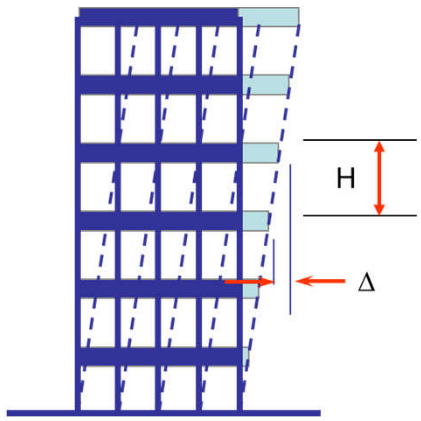
Performance Based Design and Performance Levels

Performance Based Seismic Design
How Much Drift?



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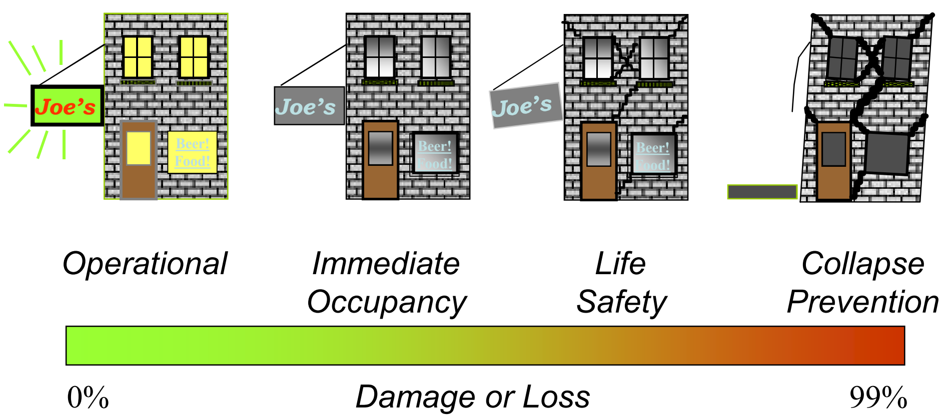
Performance Based Design and Performance Levels

Performance Levels



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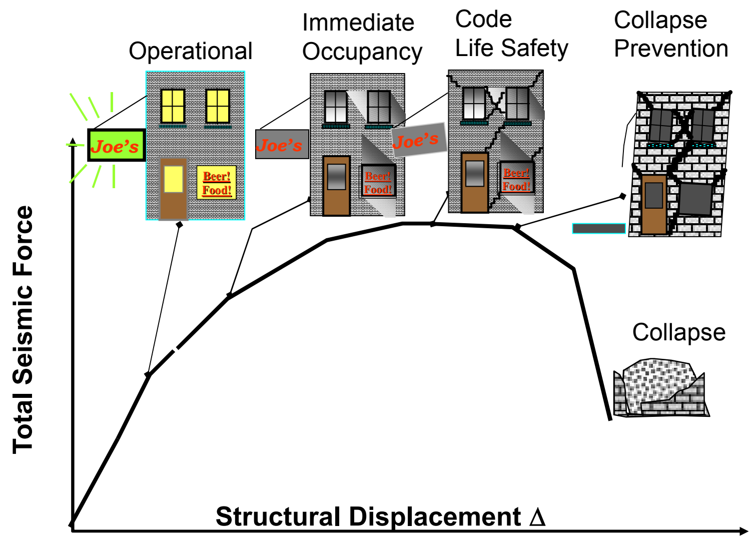
Performance Based Design and Performance Levels

Drift & Performance Levels



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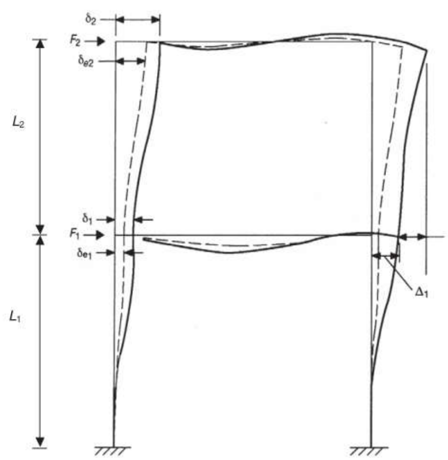
Performance Based Design and Performance Levels

Code Design Story Drift



Story Level 2

F_2 = strength-level design earthquake force

δ_{e2} = elastic displacement computed under strength-level design earthquake forces

δ_2 = $C_d\,\delta_{e2}/I_E$ = amplified displacement

Δ_2 = $(\delta_{e2} - \delta_{e1})\,C_d/I_E \le \Delta_a$ (Table 12.12-1)

Story Level 1

F_1 = strength-level design earthquake force

δ_{e1} = elastic displacement computed under strength-level design earthquake forces

δ_1 = $C_d\,\delta_{e1}/I_E$ = amplified displacement

Δ_1 = $\delta_1 \le \Delta_a$ (Table 12.12-1)

Δ_i = Story Drift

Δ_i/L_i = Story Drift Ratio

δ_2 = Total Displacement

FIGURE 12.8-2 Story Drift Determination

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Performance Based Design and Performance Levels

Code Design Story Drift

The deflection at level x (δ_x) (in. or mm) used to compute the design story drift, Δ, shall be determined in accordance with the following equation:

$$\delta_x = \frac{C_d \delta_{xe}}{I_e} \qquad (12.8\text{-}15)$$

where

C_d = the deflection amplification factor in Table 12.2-1

δ_{xe} = the deflection at the location required by this section determined by an elastic analysis

I_e = the importance factor determined in accordance with Section 11.5.1

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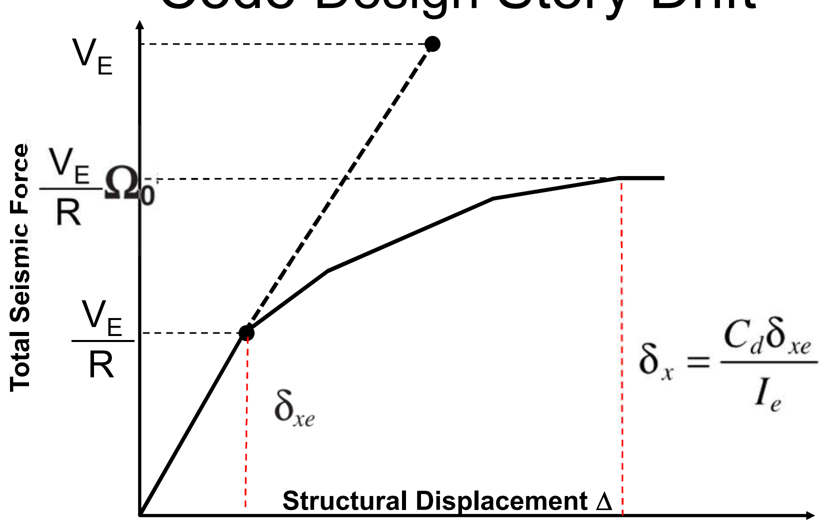
Performance Based Design and Performance Levels

Code Design Story Drift



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Performance Based Design and Performance Levels

Seismic Performance Objectives

Hazard Level and Performance Goal	Ground Motion & Return Period	Prescriptive Requirements
Risk-targeted Maximum Considered Earthquake (MCE_R) **Goal: Collapse Prevention**	Most severe earthquake considered by ASCE 7. The ground motion intensity depends on geographic location. Return period of event is >1000 years except at deterministic caps.	Building must have acceptably low probability of collapse in an MCE. CODE IMPLIED
Design Level Earthquake (DLE): **Goal: Life Safety**	2/3 of MCE ground motion intensity; return period ~400 to 1000 years, location dependent	Building must have a margin of safety against collapse and cladding components must not fall from building after a DE.
Service Level Earthquake (SLE): **Goal: Property Protection**	The term may be used in performance-based seismic design and throughout the cladding industry; however, the ground motion and return period for SLE are not codified.	Not codified/defined.

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Performance Based Design and Performance Levels

Seismic Performance Objectives

Hazard Level and Performance Goal	Ground Motion & Return Period	Prescriptive Requirements
Risk-targeted Maximum Considered Earthquake (MCE_R) **Goal: Collapse Prevention**	Most severe earthquake considered by ASCE 7. The ground motion intensity depends on geographic location. Return period of event is >1000 years except at deterministic caps.	Building must have acceptably low probability of collapse in an MCE.
Design Level Earthquake (DLE): **Goal: Life Safety**	2/3 of MCE ground motion intensity; return period ~400 to 1000 years, location dependent CODE REQUIRED	Building must have a margin of safety against collapse and cladding components must not fall from building after a DE.
Service Level Earthquake (SLE): **Goal: Property Protection**	The term may be used in performance-based seismic design and throughout the cladding industry; however, the ground motion and return period for SLE are not codified.	Not codified/defined.

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Performance Based Design and Performance Levels

Seismic Performance Objectives

Hazard Level and Performance Goal	Ground Motion & Return Period	Prescriptive Requirements
Risk-targeted Maximum Considered Earthquake (MCE_R) **Goal: Collapse Prevention**	Most severe earthquake considered by ASCE 7. The ground motion intensity depends on geographic location. Return period of event is >1000 years except at deterministic caps.	Building must have acceptably low probability of collapse in an MCE.
Design Level Earthquake (DLE): **Goal: Life Safety**	2/3 of MCE ground motion intensity; return period ~400 to 1000 years, location dependent	Building must have a margin of safety against collapse and cladding components must not fall from building after a DE.
Service Level Earthquake (SLE): **Goal: Property Protection**	The term may be used in performance-based seismic design and throughout the cladding industry; however, the ground motion and return period for SLE are not codified.	Not codified/defined. NOT CODIFIED

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Performance Based Design and Performance Levels

Effects Enclosure Damage

Stucco Wall System w/o Drift Joints

Damage State	Description of Damage	Likely Drift Range
None	No damage.	0 – 0.2%
Slight	Sporadic cracking. Some tearing of sealant joints. No damage to water barrier.	0.1% – 0.5%
Moderate	Cracking through-out. Most sealant joints torn. Some windows cracked. Water barrier damaged.	0.4% – 1.2%
Extensive	Severe cracking throughout. Significant plaster loss. Many windows broken. Sheathing fasteners loose. Water barrier damaged over significant at many locations of large area.	0.8% – 2.5%
Complete	Window frames damaged, studs deformed, stud anchorage deformed.	2.0% – 4.0%

Increasing Drift

Aluminum Curtain Wall – Stick Built

Damage State	Description of Damage	Likely Drift Range
None	No damage.	0 – 1.4%
Slight	Gasket seal failure at vulnerable locations, not widespread.	1.0% – 2.0%
Moderate	Cracked glass and gasket seal failure throughout significant area.	1.5% – 3.0%
Extensive	Cracked glass and gasket seal failure throughout. Significant glass fallout. Some deformed frames. Deformed anchorage.	2.5% – 3.5%
Complete	Nearly all panels either cracked or fallout. Most gasket seal failure. Significant deformed frames. Many deformed anchors requiring replacement.	3.0% – 5.0%

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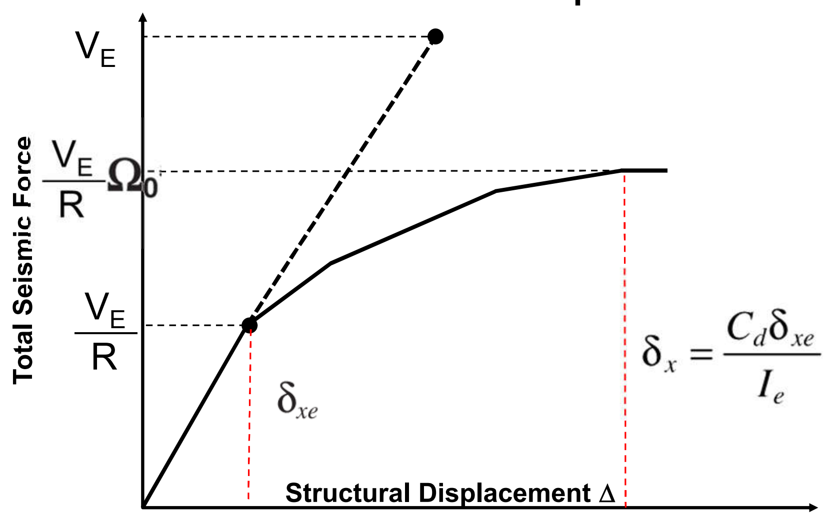
Performance Based Design and Performance Levels

"Elastic" Earthquake



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Performance Based Design and Performance Levels

MRI and Probability of Exceedance

Probability of Exceedance in Given Period

MRI	Years			
	10	**25**	**50**	**100**
500	2%	5%	10%	18%
225	4%	11%	20%	36%
100	10%	22%	39%	63%
72	13%	29%	50%	75%
50	18%	39%	63%	86%

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Performance Based Design and Performance Levels

Seismic Performance Objectives

Project Example

Performance Objective	Hazard Designation	Drift Δ (inches)
Collapse Prevention (Building will likely remain standing)	MCE	(usually not calculated)
Life Safety Moderate structural damage but no collapse; cladding must not fall from building; meet ASCE 7 requirements.	2/3 MCE	2.5 % = L/40 = 3-5/8” (12 ft story example)
Serviceability Structure to remain essentially elastic; no damage to exterior cladding components; building enclosure remains effective for water and air infiltration.	SLE Defined by owner 100 year return period 39% /50 year	0.5% = L/200 = 3/4” (12 ft story example)

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Performance Based Design and Performance Levels

Performance Based Design Objectives

Recent Project Example

Hazard Level		Target Performance Level of Exterior Wall Nonstructural Elements and Attachments	Target Performance Level of Enclosure Air and Water Barriers
EQ Probability of Exceedance	Mean Return Period (Years)		
2/3 MCE ~10%/50yr	Code Level (> 474)	Code provisions met. Falling hazards mitigated. Significant repair and/or replacement required.	No special provisions met. Repairs required especially at drift joints. Replacement of barriers may be required as part of cladding repair/replacement.
20%/50yr	225	Modest repair expected. Minor damage to cladding components. Repair required for aesthetics and performance, not safety.	Some repairs required where membranes bridge drift joints, terminations, and transitions. Modest cladding removal needed to repair membrane.
50%/50yr	72	Little to no repair is expected. Connections designed to be elastic. No visible damage to cladding.	Air and water barriers remain effective. No appreciable loss of performance of the enclosure as whole.

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AISC | Questions?

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CEU / PDH Certificates

- You will receive an email on how to report attendance from: registration@aisc.org.
- Be on the lookout: Check your spam filter! Check your junk folder!
- Completely fill out online form. Don't forget to check the boxes next to each attendee's name!

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4-Session Registrants

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One certificate will be issued at the conclusion of the course.

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4-Session Registrants

Attendance and PDH Certificates

- For Session R1, you must pass the quiz to receive credit for the session.
- For Sessions L1 – L3, you have two options to receive credit for the session.
  - Option 1: Watch the live session. Credit for live attendance will be displayed on the Course Resources table within two days of the session.
  - Option 2: Watch the recording and pass the associated quiz.

Videos and Quizzes

- Session R1 video recording and quiz access has been available since you registered.
- For Sessions L1 – L3, find access by the end of the day, Friday, after the live air date. (An email will be sent from webinars@aisc.org.)
- All video recordings and quizzes are available until 8:00 a.m. ET on June 17.
- Quiz scores are displayed in the Course Resources table.

Distribution of Certificates

All certificates will be issued after the course is completed (the week of June 17). Only the registrant will receive a certificate for the course.

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4-Session Registrants

Course Resources

Find all your handouts, quizzes and quiz scores, recording access, and attendance information in one place!

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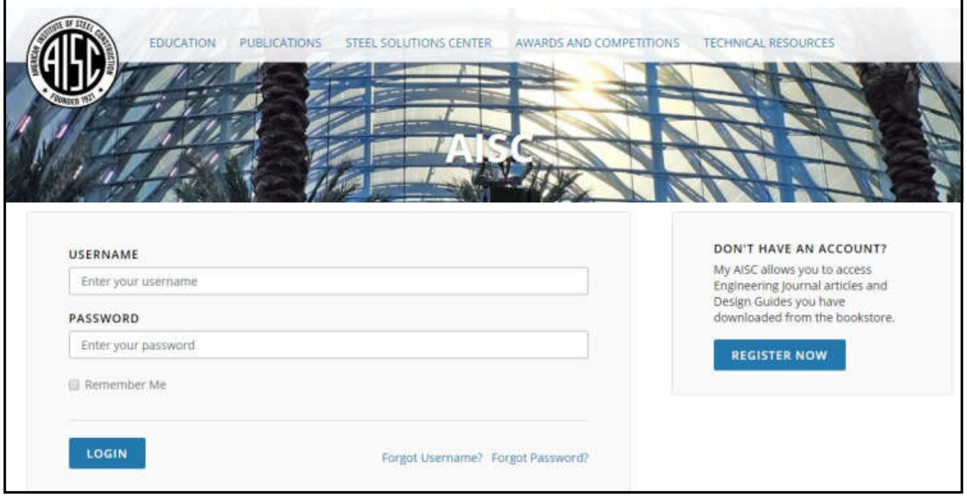
4-Session Registrants

Course Resources

Go to www.aisc.org and sign in.



4-Session Registrants

Course Resources

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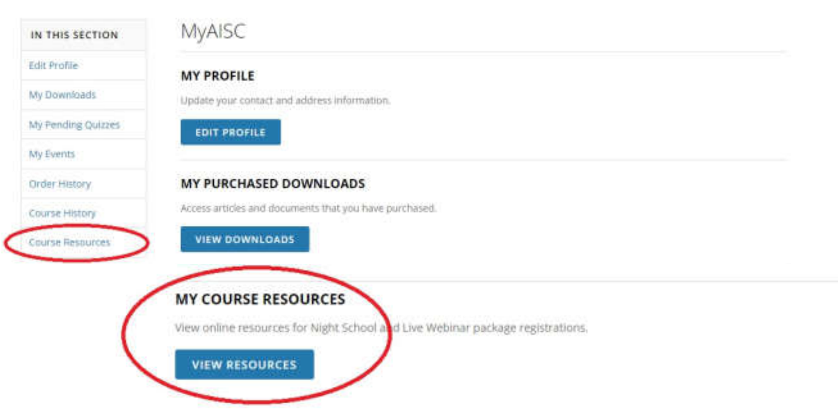
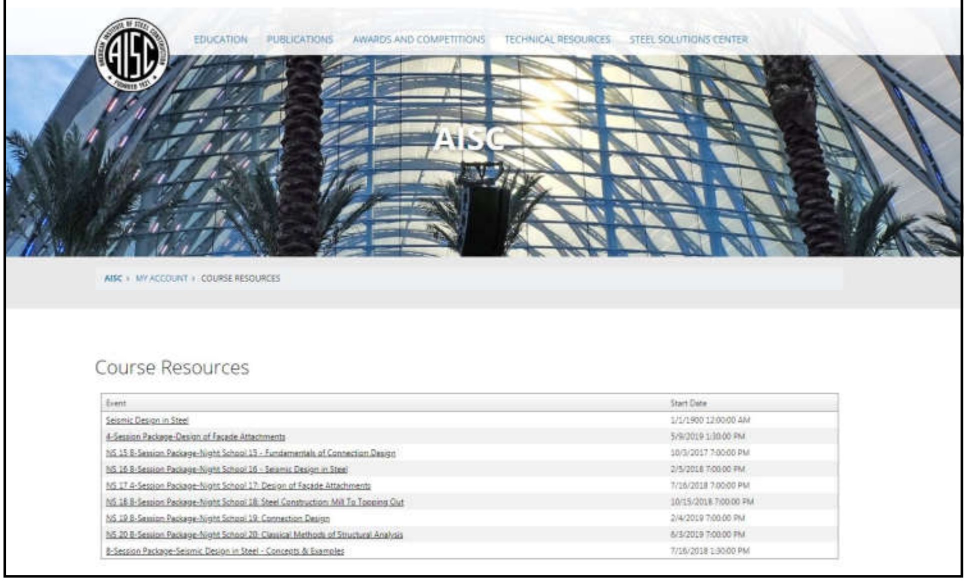


4-Session Registrants

Course Resources

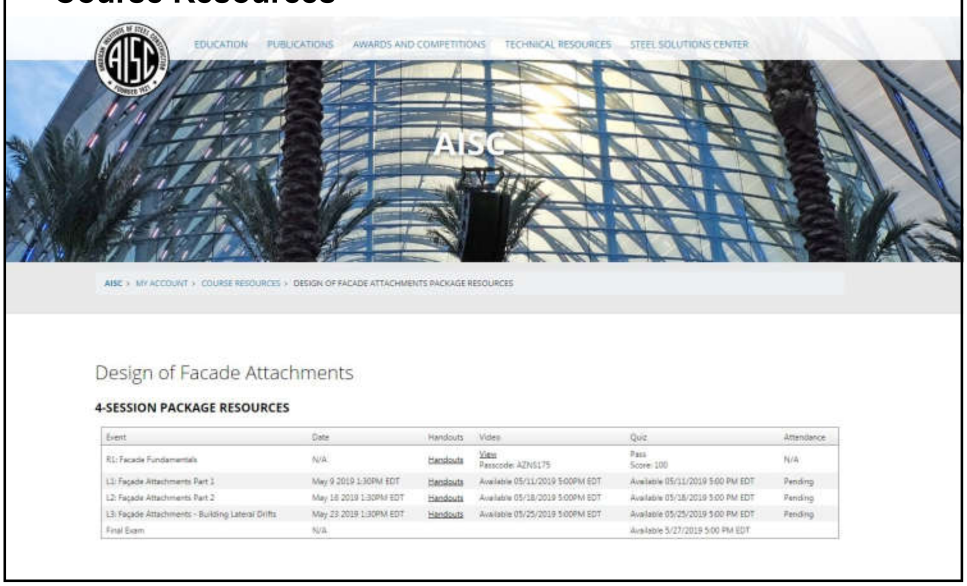


Course Resources

Event	Start Date
Seismic Design in Steel	1/1/1900 12:00:00 AM
4-Session Package-Design of Facade Attachments	5/9/2019 1:30:00 PM
NS 15 8-Session Package-Night School 15 - Fundamentals of Connection Design	10/3/2017 7:00:00 PM
NS 16 8-Session Package-Night School 16 - Seismic Design in Steel	2/5/2018 7:00:00 PM
NS 17 4-Session Package-Night School 17: Design of Façade Attachments	7/16/2018 7:00:00 PM
NS 18 8-Session Package-Night School 18: Steel Construction: Mill To Topping Out	10/15/2018 7:00:00 PM
NS 19 8-Session Package-Night School 19: Connection Design	2/4/2019 7:00:00 PM
NS 20 8-Session Package-Night School 20: Classical Methods of Structural Analysis	6/3/2019 7:00:00 PM
8-Session Package-Seismic Design in Steel - Concepts & Examples	7/16/2018 1:30:00 PM

4-Session Registrants

Course Resources



Design of Facade Attachments

4-SESSION PACKAGE RESOURCES

Event	Date	Handouts	Video	Quiz	Attendance
R1: Facade Fundamentals	N/A	Handouts	View Passcode: AZNS175	Pass Score: 100	N/A
L1: Façade Attachments Part 1	May 9 2019 1:30PM EDT	Handouts	Available 05/11/2019 5:00PM EDT	Available 05/11/2019 5:00 PM EDT	Pending
L2: Façade Attachments Part 2	May 16 2019 1:30PM EDT	Handouts	Available 05/18/2019 5:00PM EDT	Available 05/18/2019 5:00 PM EDT	Pending
L3: Façade Attachments - Building Lateral Drifts	May 23 2019 1:30PM EDT	Handouts	Available 05/25/2019 5:00PM EDT	Available 05/25/2019 5:00 PM EDT	Pending
Final Exam	N/A			Available 5/27/2019 5:00 PM EDT	

AISC | Thank you.

Smarter.
Stronger.
Steel.