There's always a solution in steel.

AISC Live Webinars

Thank you for joining our live webinar today.
We will begin shortly. Please standby.

Thank you.

Need Help?
Call ReadyTalk Support: 800.843.9166

structural STEEL

AISC Live Webinars

Today's audio will be broadcast through the internet. Alternatively, to hear the audio through the phone, dial 800.290.2715.

For additional support, please press *0 *and you will be connected to a live operator.*

There's always a solution in steel!

2

AISC Live Webinars

Today's live webinar will begin shortly.
Please standby.
As a reminder, all lines have been muted. Please type any questions or comments through the Chat feature on the left portion of your screen.

Today's audio will be broadcast through the internet. Alternatively, to hear the audio through the phone, dial 800.290.2715.

For additional support, please press *0 *and you will be connected to a live operator.*

There's always a solution in steel!

3

There's always a solution in steel.

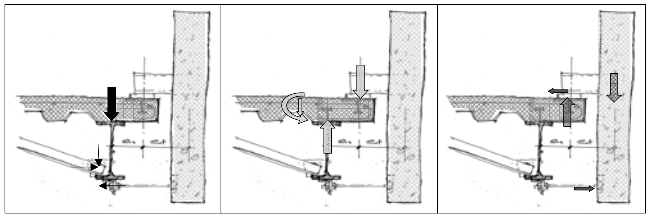
Façade Attachments to Steel-Framed Buildings

Presented by
James C. Parker, S.E., P.E.
Simpson Gumpertz & Heger Inc.

structural STEEL

Façade Attachments

to Steel-Framed Buildings



An **AISC** Webinar

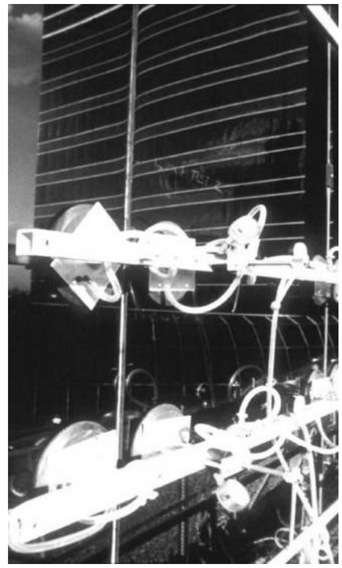
James C. Parker
Simpson Gumpertz & Heger Inc.

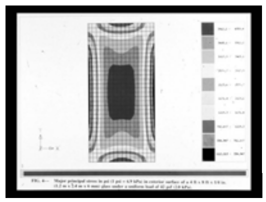
There's always a solution in steel!

5

There's always a solution in steel!

Field Testing





There's always a solution in steel!

7

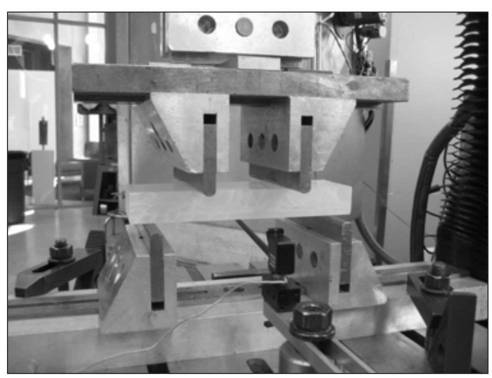
Lab Material Testing

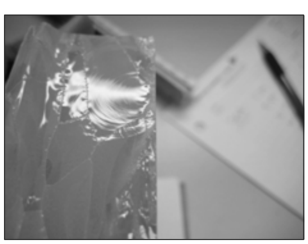
Methods

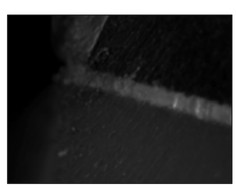
- ASTM C158- Strength of Glass by Flexure

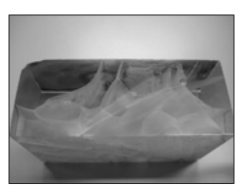
(Conditioned and Unconditioned)

- C666- Resistance to Rapid Freezing and Thawing
  (100 and 200 cycles)
- Moisture exposure including dye penetrant Resistance



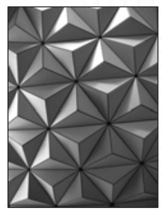


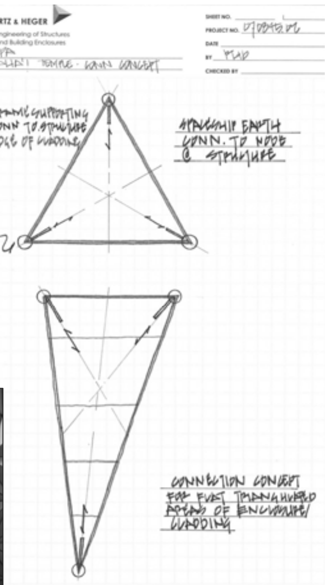




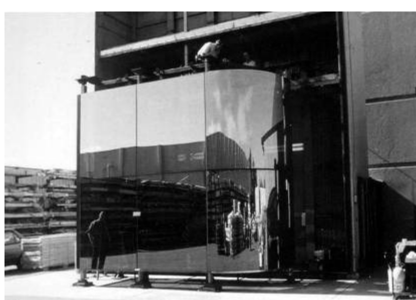
8

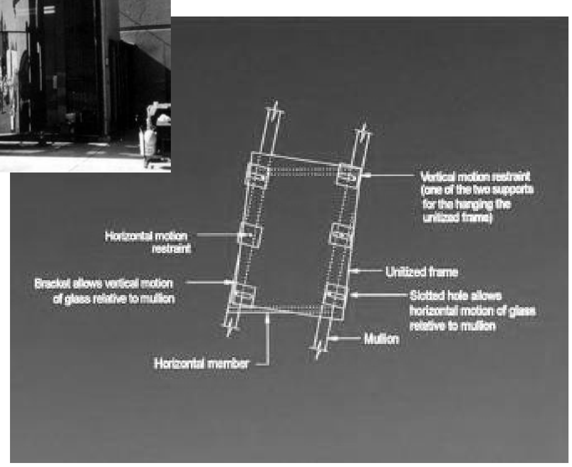
Concept to Allow Drift





9





There's always a solution in steel!

10

There's always a solution in steel!

11

There's always a solution in steel!

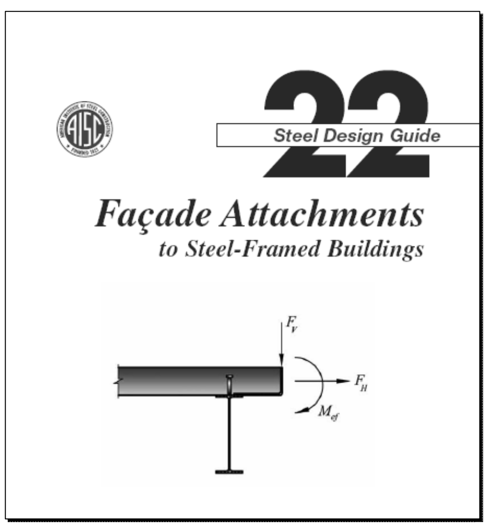
12

Enclosure Modernization

There's always a solution in steel!

13

AISC Design Guide 22



There's always a solution in steel!

14

Design Guide Objective

- To assist the practicing engineer in achieving slab edge and spandrel beam details for steel frames that are:
  - Structurally sound
  - Durable
  - Economical
  - Accommodating of façade requirements

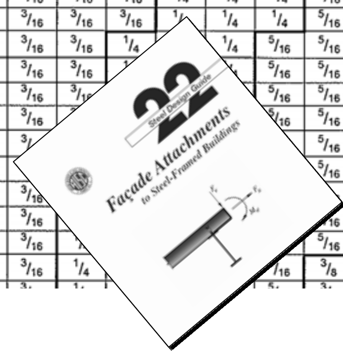
There's always a solution in steel!

15

Design Aids

Table 5.3.1 Minimum Thickness of Bent Plate (in.) Used as a Pour Stop for Normal Weight Concrete

Slab Thickness (in.)	Slab Overhang (in)														
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
4	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	1/4	1/4	1/4	5/16	5/16
4 1/4	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	1/4	1/4	1/4	5/16	5/16
4 1/2	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	1/4	1/4	1/4	5/16	5/16
4 3/4	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	[illegible]	1/4	1/4	5/16	5/16
5	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	1/4	[illegible]	1/4	5/16	5/16	5/16
5 1/4	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	[illegible]	[illegible]	[illegible]	5/16	5/16	5/16
5 1/2	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	[illegible]	[illegible]	[illegible]	[illegible]	5/16	5/16	5/16
5 3/4	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	[illegible]	[illegible]	[illegible]	[illegible]	5/16	5/16	5/16
6	3/16	3/16	3/16	3/16	3/16	3/16	3/16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5/16	3/8
6 1/4	3/16	3/16	3/16	3/16	3/16	3/16	3/16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5/16	3/8
6 1/2	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3/8
6 3/4	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3/8
7	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5/16	3/8
7 1/4	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	1/4	[illegible]	[illegible]	[illegible]	[illegible]	3/8	3/8



There's always a solution in steel!

16

Example Designs

Step 2: Consider Roll Beams at 9 ft on Center in Place of Kickers.

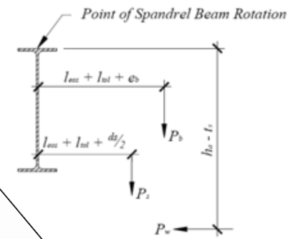
Without kickers to brace the bottom flange of the spandrel, torsion on the spandrel beam between the roll beams must be considered. Using the "Flexural Analogy," a relatively simple, conservative method is presented for calculating the additional vertical deflection of the roll beams due to twist of the spandrel. The hangers are located at the ⅓ points along the torsionally unbraced length. F… simplicity, neglect the rotation of the roll b… See Figures 7-21 and 7-22.

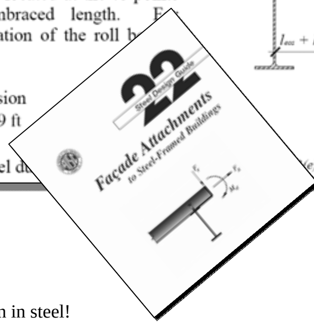
Spandrel beam span for torsion

$$L_T = 9 \text{ ft}$$

Torsion imposed on spandrel d…

In this calculation, the self-weight of the hangers, brackets, and shelf angles has been ignored.





(e) Torsional loads on spandrel beam.

There's always a solution in steel!

17

Example Designs

Lateral displacement of spandrel beam bottom flange at hanger location

$$\Delta_{bf} = \frac{5P_H L_T^3}{162EI_{bf}} = \frac{5(2.48 \text{ kips})(9 \text{ ft})^3(1{,}728 \text{ in.}^3/\text{ft}^3)}{162(29{,}000 \text{ ksi})(12.4 \text{ in.}^4)}$$

$$= 0.268 \text{ in.}$$

Equivalent rotation at top flange

$$\theta_{FA} = \sin^{-1}\left(\frac{\Delta_{bf}}{d}\right) = \sin^{-1}\left(\frac{0.268 \text{ in.}}{20.8 \text{ in.}}\right)$$

$$= 0.738°$$

Initial horizontal and vertical distances between center of top flange of spandrel rotation and bottom of the shelf angle

$$x_i = l_{eos} + l_{tol} + l_{ah} = 11 \text{ in.} + 2 \text{ in.} + 6 \text{ in.}$$
$$= 19.0 \text{ in.}$$
$$y_i = h_a - t_s = 4 \text{ ft}(12 \text{ in./ft}) - 6.25 \text{ in.}$$
$$= 41.8 \text{ in.}$$

For simplicity, conservatively assume that the bottom flange of the spandrel consists of a single span, simply supported at the roll beams. Use Steel Construction Manual Table 3-23, Case 9 with loads at the ⅓ points to calculate the deflection. In reality, the bottom flange is continuous, so the actual deflection would be somewhat less than that which is reported here

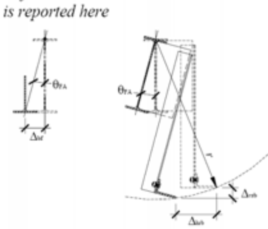


Fig. E7.3(g) Lateral translation of shelf angle.

There's always a solution in steel!

18

Today's Agenda

1. Fundamentals of Façade Performance
2. Design Criteria
3. Roles and Responsibilities
4. Tolerances
5. Slab Edges
6. Spandrel Beams
7. Masonry Veneer, and Other Wall Systems

There's always a solution in steel!

19

Three Key Take-Aways

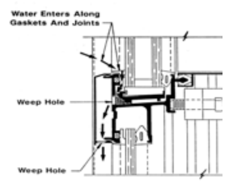
1. The design team needs to develop a strategy for façade attachment and the SER has a role in its development.
2. The current ASCE 7 and IBC have explicit criteria for façade attachments especially for seismic considerations.
3. The façade attachment strategy chosen by the team will affect the design of slab edges and spandrel beams.

There's always a solution in steel!

20

1

Fundamentals of Façade Performance



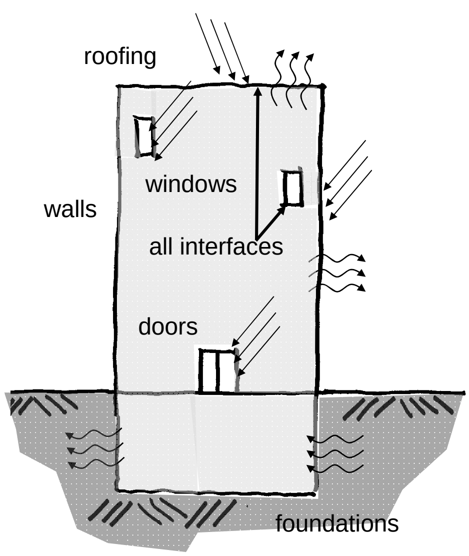
The building envelope encloses the building, controlling the transmission of air, water, heat, sound, and light both into and out of the building.

There's always a solution in steel!

21

1

The Façade and the Building Envelope

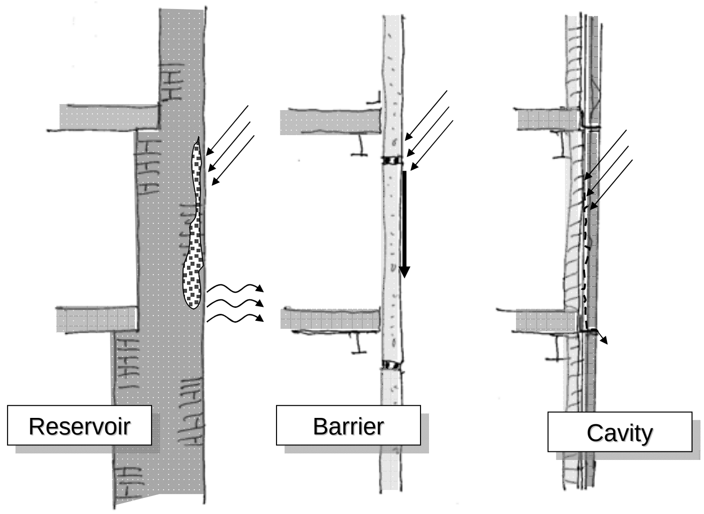


There's always a solution in steel!

22

1

Fundamentals of Façade Performance

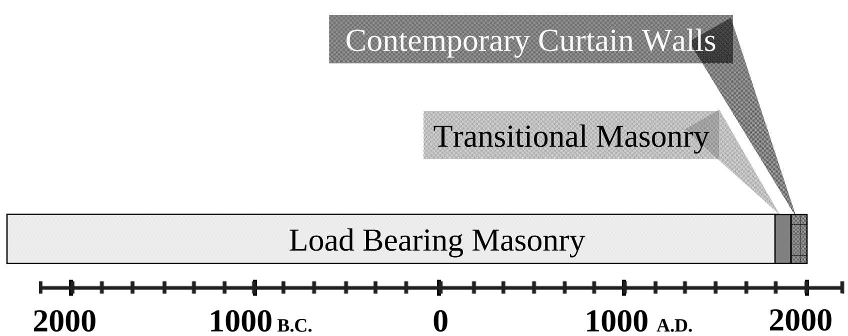


There's always a solution in steel!

23

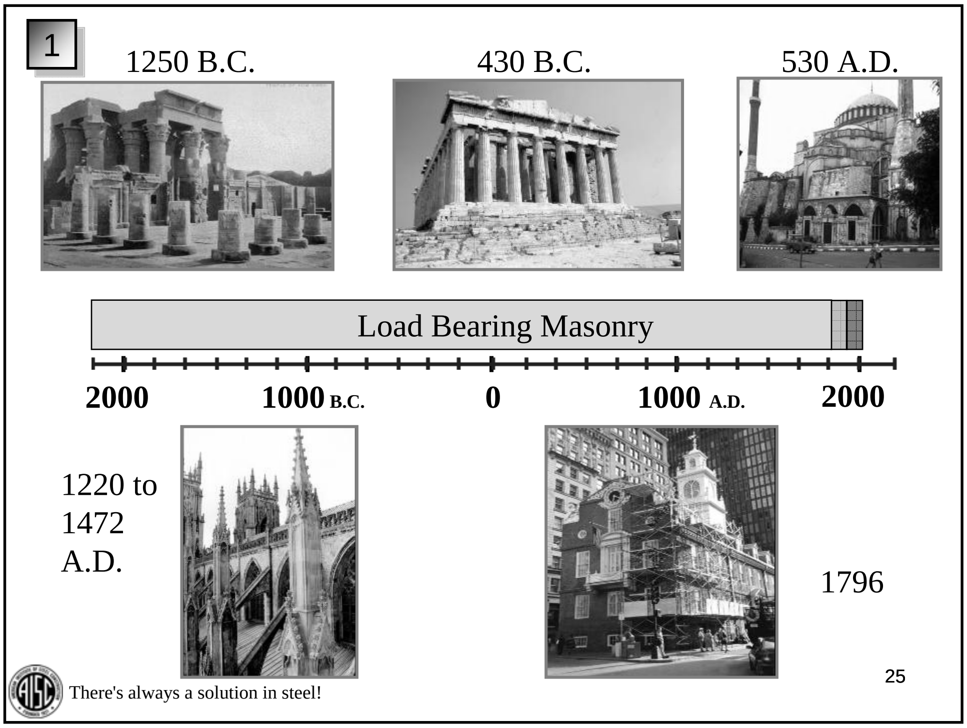
1

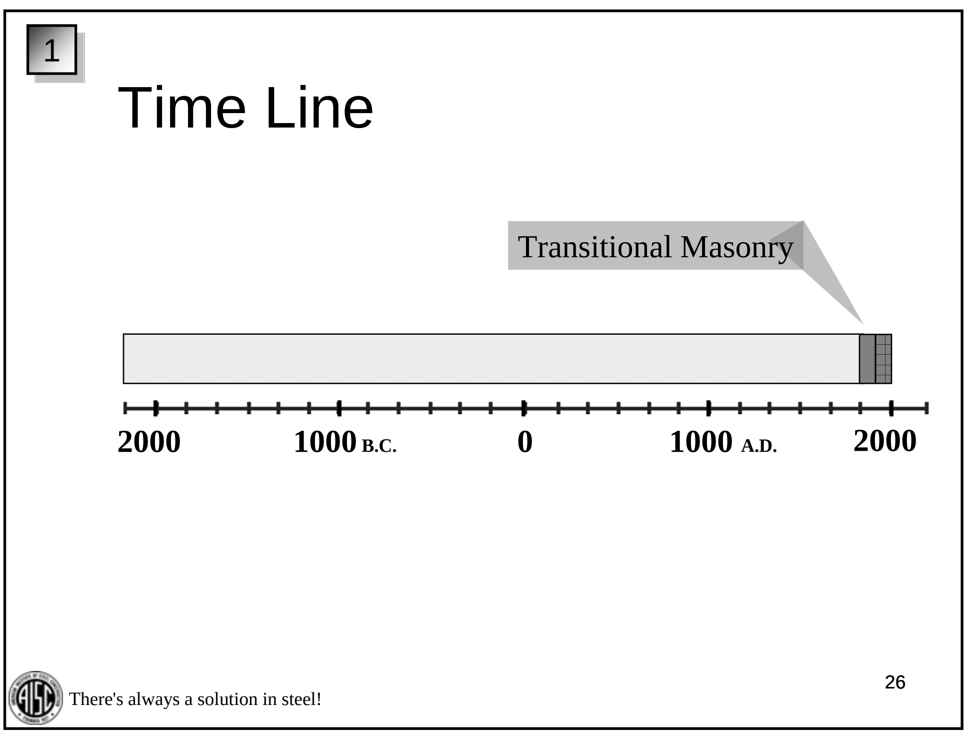
Time Line



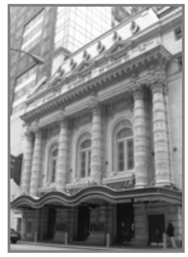
There's always a solution in steel!

24


1
1250 B.C.
430 B.C.
530 A.D.
Load Bearing Masonry
2000
1000 B.C.
0
1000 A.D.
2000
1220 to
1472
A.D.
1796
25
There's always a solution in steel!


1
Time Line
Transitional Masonry
2000
1000 B.C.
0
1000 A.D.
2000
26
There's always a solution in steel!

1



Transitional Masonry Buildings

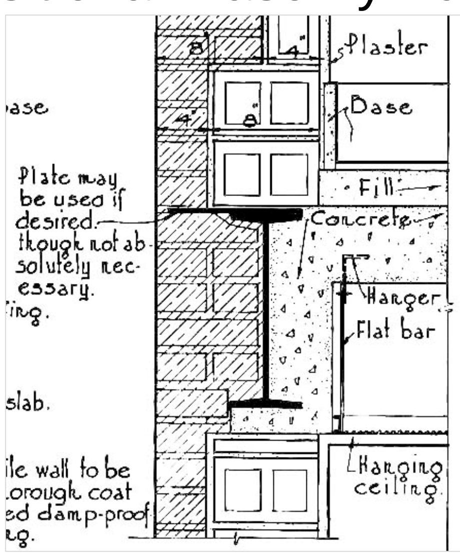
1890 1900 1910 1920 1930 1940 1950

There's always a solution in steel!

27

1

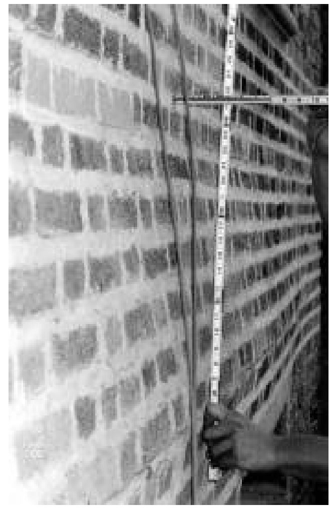
Transitional Masonry Buildings



There's always a solution in steel!

28

1



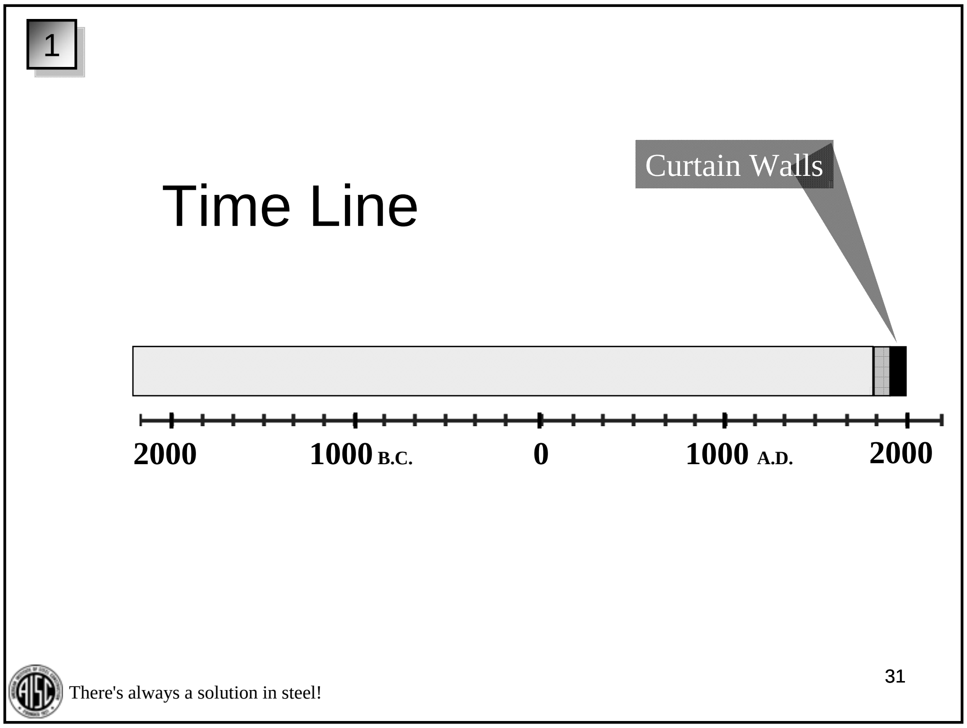
There's always a solution in steel!

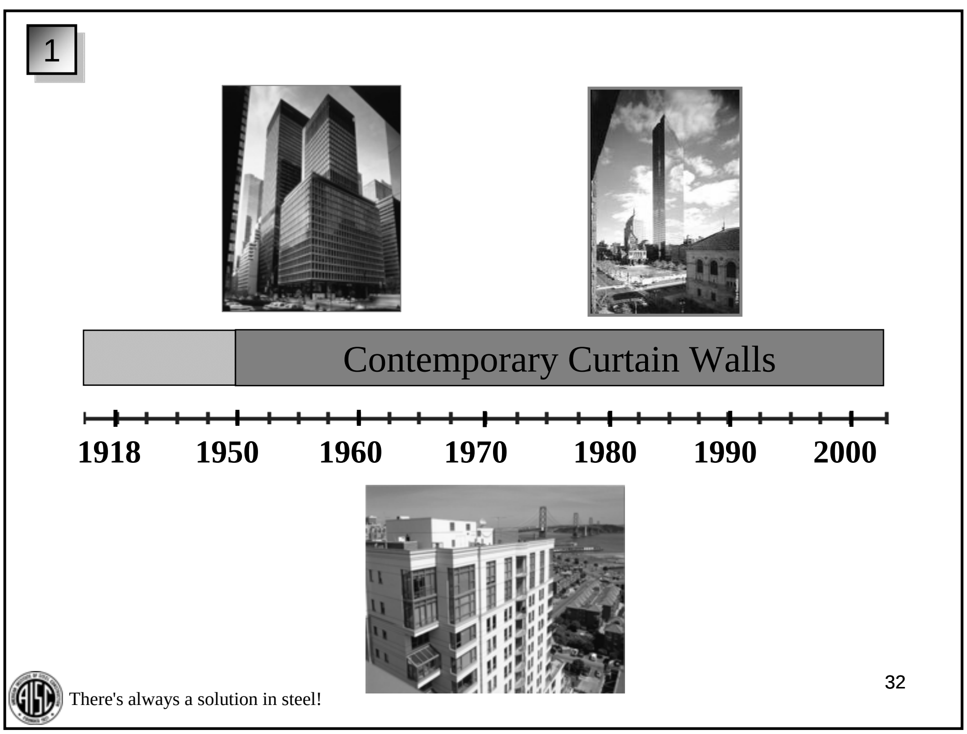
29

1

There's always a solution in steel!

30


1
Time Line
Curtain Walls
2000
1000 B.C.
0
1000 A.D.
2000
There's always a solution in steel!
31


1
Contemporary Curtain Walls
1918
1950
1960
1970
1980
1990
2000
There's always a solution in steel!
32

1

Contemporary Curtain Walls

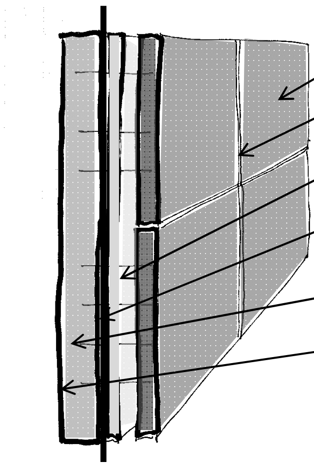
- “Skin” and Frame Detailed to Accommodate Differential Movement

There's always a solution in steel!

33

1

Functional Components of the Exterior Wall System



- Cladding
- Joints
- Insulation
- Water barriers and air barriers
- Structure
- Interior finishes

There's always a solution in steel!

34

1

Concepts for Control of Water Infiltration

- Barrier Walls
- Internal Drainage Planes
- Cavity Walls
- PE Rain Screens

There's always a solution in steel!

35

1

Problems Associated with Support and Anchorage

- Anchors or support clips interrupt the flashing or water barrier without proper repair.
- Anchors causing conditions of poor drainage.
- Anchors not stiff enough to prevent differential movement that tears barriers.
- Damage to barriers during erection and installation.
- Constructability issues, coordination of trade issues.

There's always a solution in steel!

36

2

General Design Criteria

Façade/Wall System Criteria

1. structural integrity;
2. provisions for movement; and
3. envelope performance.

There's always a solution in steel!

37

2

Primary Criteria for Attachment

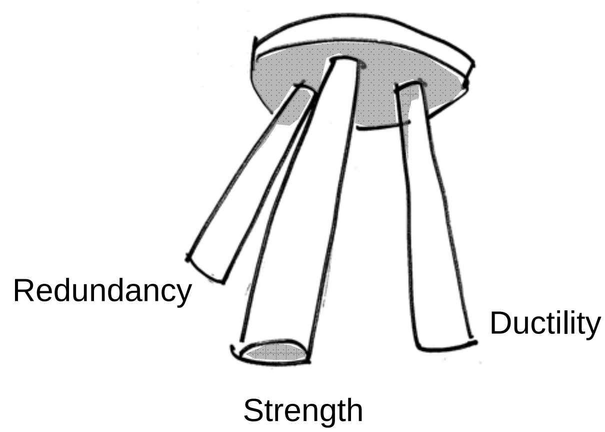
- Structural Integrity
- Accommodating Movement
- Durability
- Accounting for Tolerances and Clearances
- Constructability
- Economy

There's always a solution in steel!

38

2

Structural Integrity



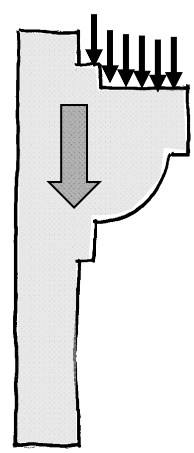
There's always a solution in steel!

39

2

Gravity Loads

- Façade dead load
  - Need to understand materials and system
- Façade live loads
  - Horizontal projections
- SER usually needs to estimate before wall is designed.
- Window washing activities.



There's always a solution in steel!

40

2

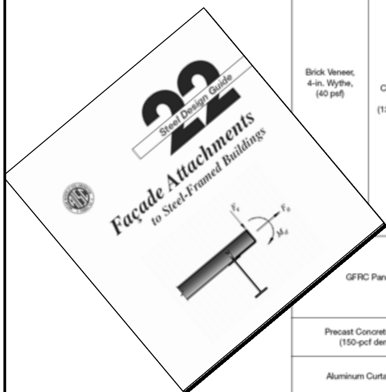


Table 2-1. Dead Loads for Façade Components and Systems

Component				Load	Common Design Assumption for System
Coverings		Bituthene Membrane		0.4 psf	5 psf
		Extruded Polystyrene, 2 in.		0.3 psf	
		Gypsum Sheathing, ⅝ in.		2.5 psf	
Brick Veneer, 4-in. Wythe, (40 psf)	6-in. or 8-in. Metal Stud Back-up	18 Gage	24-in. o.c.	1.1 psf	45–50 psf[1]
			16-in. o.c	1.7 psf	
	Concrete Block Back-up (130-pcf Density)	6-in. Wythe	No Grout	30 psf	75–85 psf[2]
			48-in. o.c. Grout Spacing	36 psf	
			40-in. o.c. Grout Spacing	37 psf	
			32-in. o.c. Grout Spacing	38 psf	
			24-in. o.c. Grout Spacing	41 psf	
			16-in. o.c. Grout Spacing	46 psf	
			Full Grout	62 psf	
		8-in. Wythe	No GProut	39 psf	85–100 psf[2]
			48-in. o.c. Grout Spacing	47 psf	
			40-in. o.c. Grout Spacing	48 psf	
			32-in. o.c. Grout Spacing	50 psf	
			24-in. o.c. Grout Spacing	54 psf	
			16-in. o.c. Grout Spacing	61 psf	
			Full Grout	83 psf	
		12-in. Wythe	No Grout	54 psf	105–130 psf[2]
			48-in. o.c. Grout Spacing	66 psf	
			40-in. o.c. Grout Spacing	69 psf	
			32-in. o.c. Grout Spacing	72 psf	
			24-in. o.c. Grout Spacing	78 psf	
			16-in. o.c. Grout Spacing	90 psf	
			Full Grout	127 psf	
GFRC Panels		120-pcf Density	½-in. Backing	5 psf	9–25 psf[3]
			⅝-in. Backing	6.3 psf	
			⅝-in. Exposed Aggregate Face	3.8 psf	
		140-pcf Density	½-in. Backing	5.8 psf	
			⅝-in. Backing	7.3 psf	
			⅝-in. Exposed Aggregate Face	4.4 psf	
Precast Concrete Panels (150-pcf density)		4-in. Panel		50 psf	55 psf[4]
		6-in. Panel		75 psf	80 psf[4]
		8-in. Panel		100 psf	105 psf[4]
Aluminum Curtain Walls		Curtain-wall Framing		3 plf	10 psf
		Storefront Framing		1.8 plf	
		Insulating glass, 1-in. Total Thickness[6]		6.8 psf	
Metal Insulated Panels		1¼-in. Panel		2 psf	10–15 psf[5]
		4-in. Panel		4 psf	
EIFS		Self Weight		1 psf	10 psf[5]

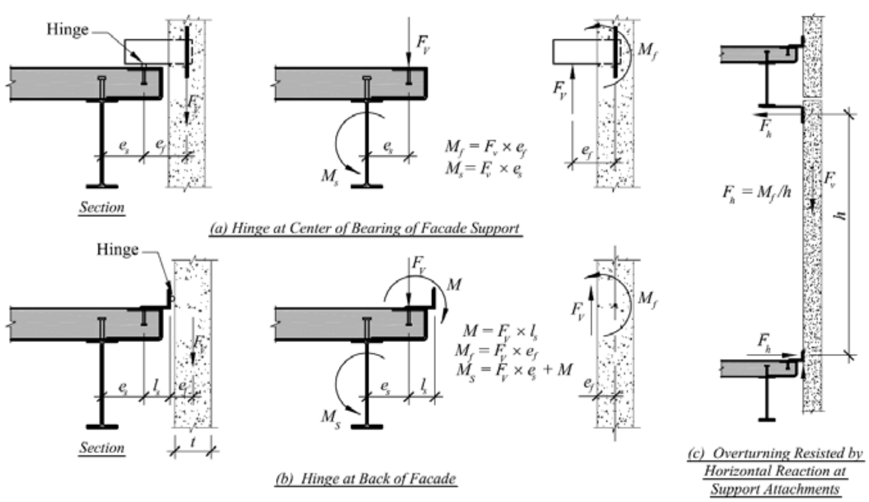
Notes:
1. Values include waterproofing, insulation, gypsum sheathing, and hardware.
2. Values are for solid walls; deduct for window and other openings.
3. Values include insulation, gypsum sheathing, metal studs, and hardware.
4. Values include insulation and hardware.
5. Values include gypsum sheathing, metal studs, and hardware.
6. 1-in. total thickness includes ¼-in. glass, ½-in. air space, and ¼-in. glass.

There's always a solution in steel!

41

2

Gravity Load Eccentricities

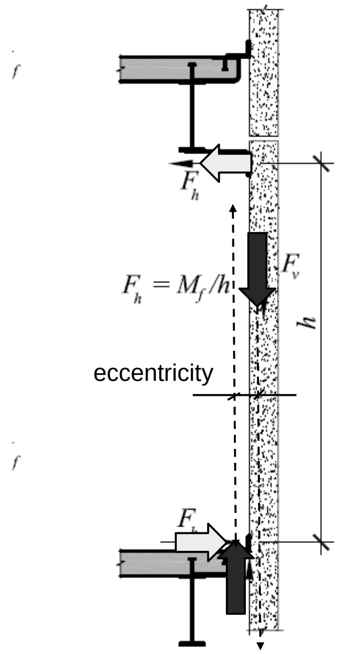


There's always a solution in steel!

42

2

Gravity Load Eccentricities

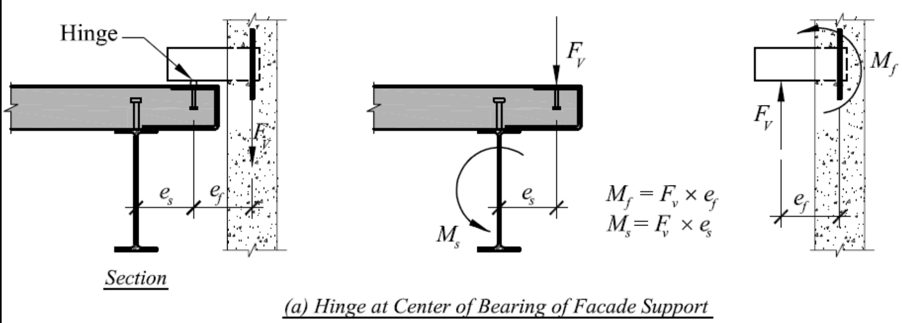


There's always a solution in steel!

43

2

Gravity Load Eccentricities

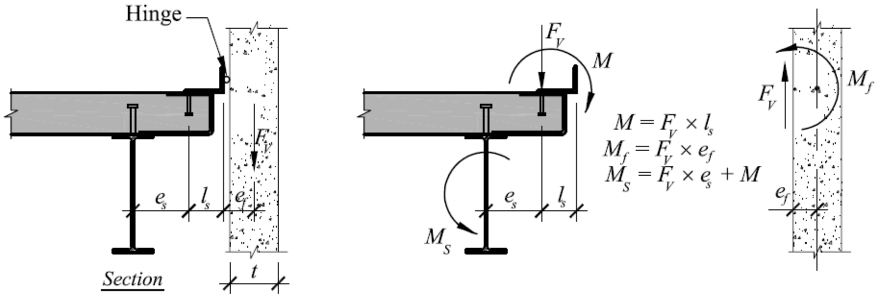


There's always a solution in steel!

44

2

Gravity Load Eccentricities



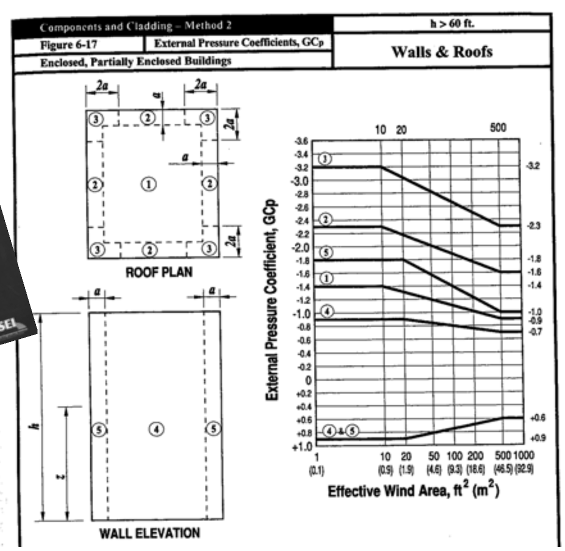
(b) Hinge at Back of Facade

There's always a solution in steel!

45

2

Wind Loads



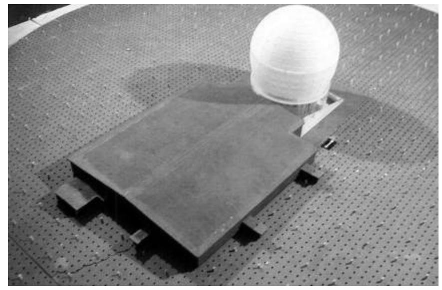
There's always a solution in steel!

46

2

Wind Loads

- Wind tunnel testing



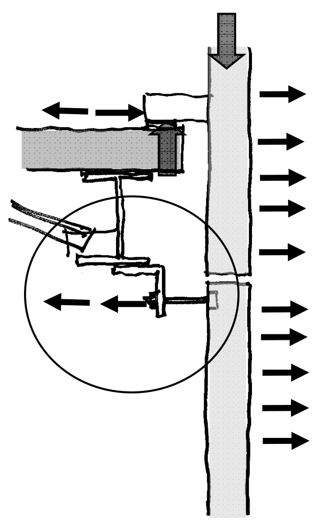
There's always a solution in steel!

47

2

Wind Loads

- Negative pressures combined with gravity eccentricities often control attachment design.



There's always a solution in steel!

48

2

Seismic Requirements

1. Seismic Forces
2. Relative Displacements
3. Ductility

There's always a solution in steel!

49

2

Seismic Loads

TABLE 13.2-1 APPLICABLE REQUIREMENTS FOR ARCHITECTURAL, MECHANICAL, AND ELECTRICAL COMPONENTS: SUPPORTS AND ATTACHMENTS

Nonstructural Element (i.e., Component, Support, Attachment)	General Design Requirements Section 13.2	Force and Displacement Requirements Section 13.3	Attachment Requirements Section 13.4	Architectural Component Requirements Section 13.5	Mechanical and Electrical Component Requirements Section 13.6
Architectural Components and Supports and Attachments for Architectural Components	X	X	X	X	
Mechanical and Electrical Components with $I_p > 1$	X	X	X		X
Supports and Attachments for Mechanical and Electrical Components	X	X	X		X

There's always a solution in steel!

50

2

Seismic Loads

13.2.7 Construction Documents. Where design of nonstructural components or their supports and attachments is required by Table 13.2-1, such design shall be shown in construction documents prepared by a registered design professional for use by the owner, building officials, contractors, and inspectors. Such documents shall include a quality assurance plan if required by Appendix 11A.

There's always a solution in steel!

51

2

Seismic Loads

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_p) shall be determined in accordance with the equations set forth in Sections 13.3.2.1 and 13.3.2.2.

There's always a solution in steel!

52

2

Seismic Loads

13.4.3 Installation Conditions. Determination of forces in attachments shall take into account the expected conditions of installation including eccentricities and prying effects.

13.4.4 Multiple Attachments. Determination of force distribution of multiple attachments at one location shall take into account the stiffness and ductility of the component, component supports, attachments, and structure and the ability to redistribute loads to other attachments in the group. Designs of anchorage in concrete in accordance with Appendix D of ACI 318 shall be considered to satisfy this requirement.

13.4.5 Power Actuated Fasteners. Power actuated fasteners shall not be used for tension load applications in Seismic Design Categories D, E, and F unless approved for such loading.

13.4.6 Friction Clips. Friction clips shall not be used for anchorage attachment.

There's always a solution in steel!

53

2

Seismic Loads

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:

There's always a solution in steel!

54

2

Seismic Loads

a. Connections and panel joints shall allow for the story drift caused by relative seismic displacements (D_p) determined in Section 13.3.2, or 0.5 in. (13 mm), whichever is greatest.

b. Connections to permit movement in the plane of the panel for story drift shall be sliding connections using slotted or oversize holes, connections that permit movement by bending of steel, or other connections that provide equivalent sliding or ductile capacity.

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

There's always a solution in steel!

55

2

Seismic Loads

d. All fasteners in the connecting system such as bolts, inserts, welds, and dowels and the body of the connectors shall be designed for the force (F_p) determined by Section 13.3.1 with values of R_p and a_p taken from Table 13.5-1 applied at the center of mass of the panel.

e. Where anchorage is achieved using flat straps embedded in concrete or masonry, such straps shall be attached to or hooked around reinforcing steel or otherwise terminated so as to effectively transfer forces to the reinforcing steel or to assure that pullout of anchorage is not the initial failure mechanism.

There's always a solution in steel!

56

2

Seismic Loads

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

	a_p[a]	R_p[b]
Exterior Nonstructural Wall Elements and Connections[b]		
Wall Element	1.0	2.5
Body of wall panel connections	1.0	2.5
Fasteners of the connecting system	1.25	1.0
Veneer		
Limited deformability elements and attachments	1.0	2.5
Low deformability elements and attachments	1.0	1.5

There's always a solution in steel!

57

2

Relative Seismic Displacement

13.3.2.1 Displacements within Structures. For two connection points on the same Structure A or the same structural system, one at a height h_x and the other at a height h_y, D_p shall be determined as

$$D_p = \delta_{xA} - \delta_{yA} \qquad (13.3\text{-}5)$$

Alternatively, D_p is permitted to be determined using modal procedures described in Section 12.9, using the difference in story deflections calculated for each mode and then combined using appropriate modal combination procedures. D_p is not required to be taken as greater than

$$D_p = \frac{(h_x - h_y)\,\Delta_{aA}}{h_{sx}} \qquad (13.3\text{-}6)$$

There's always a solution in steel!

58

2

Relative Seismic Displacement

The deflections of Level x at the center of the mass (δ_x) (in. or mm) shall be determined in accordance with the following equation:

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

where

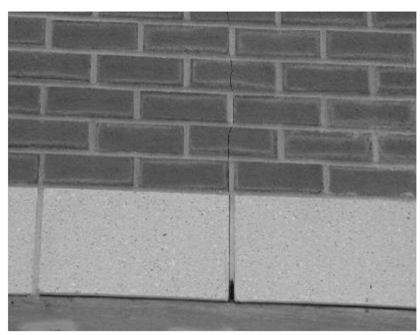
C_d = the deflection amplification factor in Table 12.2-1
δ_{xe} = the deflections determined by an elastic analysis
I = the importance factor determined in accordance with Section 11.5.1

There's always a solution in steel!
59

2

Accommodating Relative Movement

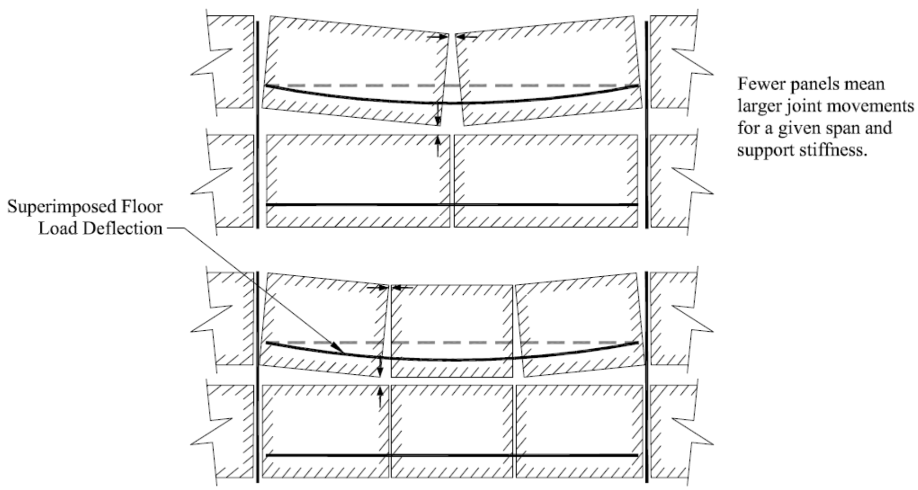
- Spandrel deflections,
- Spandrel rotations,
- Column shortening,
- Bracket deflections,
- Inter-story dirft,
- Façade thermal,
- Façade moisture,
- Façade deformation due to forces.



There's always a solution in steel!
60

2

Accommodating Relative Movement



There's always a solution in steel!

61

2

Accommodating Relative Movement

- Rules of thumb and code provisions for flexural stiffness control façade material cracking.
  - L/360; L/600; etc.

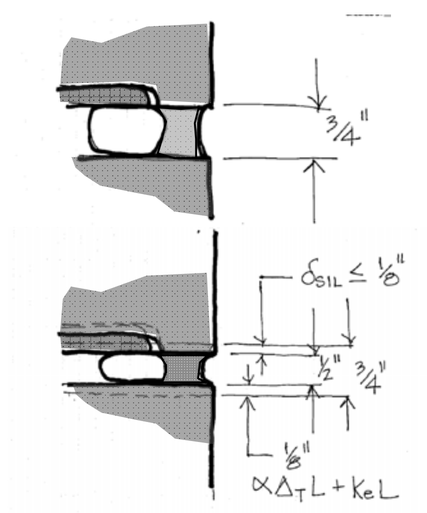
There's always a solution in steel!

62

2

Accommodating Relative Movement

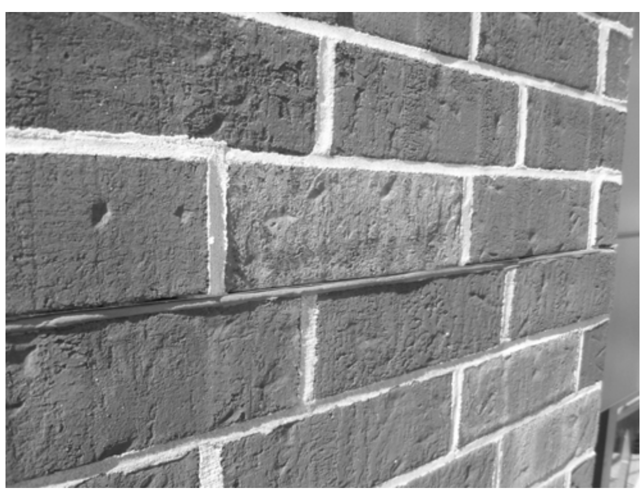
- Joint criteria may control – example:
  - Say ¾ inch joint; allowable movement of ¼ inch, M=.33
  - Say thermal and moisture is 1/8 inch; leaving 1/8 inch for structural movement.
  - Say design load movement from 50% LL; then 100% LL allowable movement = ¼ inch.
  - This is L/960 and L/1440 on 20 ft and 30 ft spans, respectively.



There's always a solution in steel!
63

2

Add slide of protruding sealant



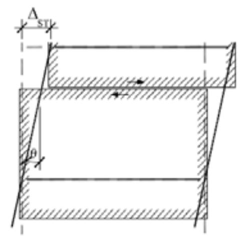
There's always a solution in steel!
64

2

Accommodating Relative Movement

Inter-story Drift from Lateral Loads

- Common drift limits:
  - Wind
    - H/400 (.0025H); or H/500 (.002H)
  - Seismic
    - .025 H (10 times wind!)
- For a 12 ft story height:
  - Wind – 0.36 inches (but not less than ½")
  - Seismic – 3.6 inches

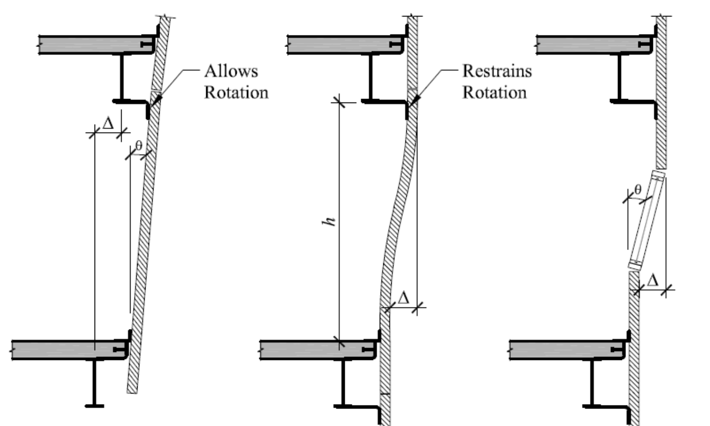


There's always a solution in steel!

65

2

Accommodating Relative Movement



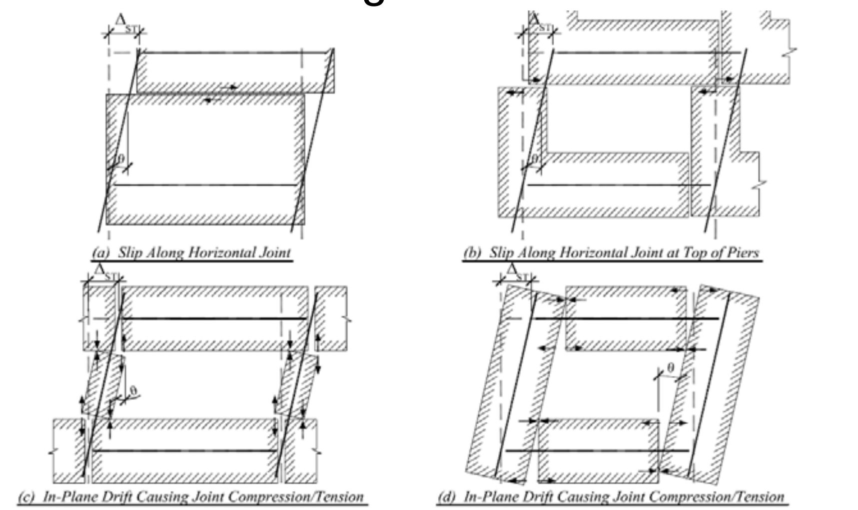
(a) Rotation at Attachments *(b) Flexure of Facade Element* *(c) Increased Rotations at Facade Sub-Element Such as a Window*

There's always a solution in steel!

66

2

Accommodating Relative Movement

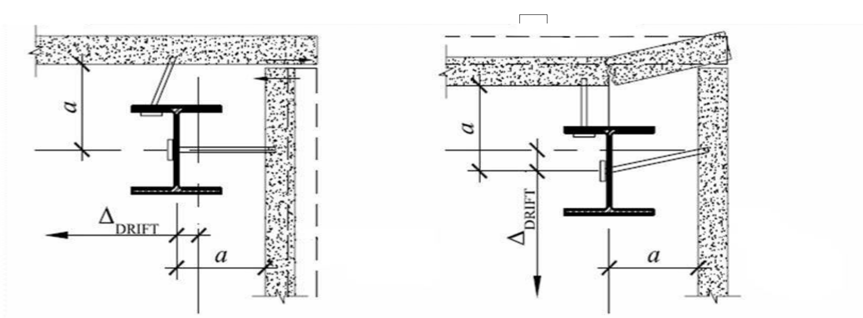


There's always a solution in steel!

67

2

Inter-Story Drift: Corners

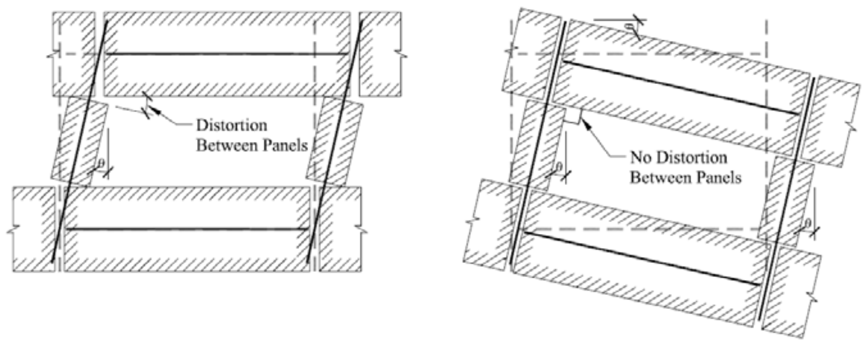


There's always a solution in steel!

68

2

Shear and Flexural Deformations



(a) Frame Shear Deformation Movement on Joints

(b) Frame Flexural Deformation Less Movement at Joints

2

Limit States

- Code prescribed forces for safety:
  - 50 yr. recurrence interval for wind
  - 475 yr. recurrence interval for seismic
  - Attachments must safely accommodate forces.
  - Joints must prevent hazardous damage; falling hazards.
- Serviceability checks may allow lower forces and drifts; for example joint sealant movements.

2

Tolerances and Clearances

- Tolerances:
  - Permissible amount of deviation from a specified criterion: dimension, shape, location.
- Clearances:
  - Space purposely provided between two parts to allow for movement, accommodate tolerances and provide access.

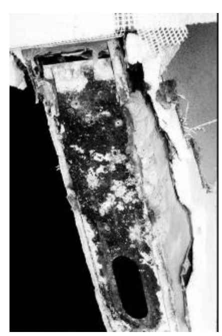
There's always a solution in steel!

71

2

Durability of the Attachment

- Attachments are usually hard to inspect.
- Consider what happens if the wall leaks.
- Consider how likely the wall is to leak over time.
- Special attention to thin steel parts or steel fasteners.



There's always a solution in steel!

72

2

Constructability and Economy

There's always a solution in steel!

73

2

Summary of Criteria

- For Attachments:
  - Structural Integrity
  - Accommodating Movement
  - Durability
  - Accounting for Tolerances and Clearances
  - Constructability and Economy

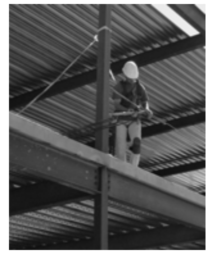
There's always a solution in steel!

74

3

Responsibilities for Façade Attachments for New Buildings





- Owner
- Architect
- SER
- SSE

- Fabricator, Erector
- CM, GC
- Façade Contractor(s)

There's always a solution in steel!

75

3

Responsibilities

- SER (Structural Engineer of Record)
  - For this presentation, we mean the design professional responsible for the structural design of the primary building structure.
- SSE (Specialty Structural Engineer)
  - For this presentation, we mean the design professional responsible for the structural design of the façade and/or façade attachments to the primary structure.

There's always a solution in steel!

76

3

Responsibility

- The design of the façade elements and their attachments are often NOT in the scope of the SER responsible for the primary building frame.
  - Yet the SER must understand the façade system and the ***strategy*** for attachment to design the primary structure.

There's always a solution in steel!

77

3

Responsibility

- The performance specified elements including attachments will often be designed by the SSE working for the contractor (but could part of the design team).
  - The SSE may not become involved until after the frame is designed, even fabricated, and even erected!

There's always a solution in steel!

78

3

SER

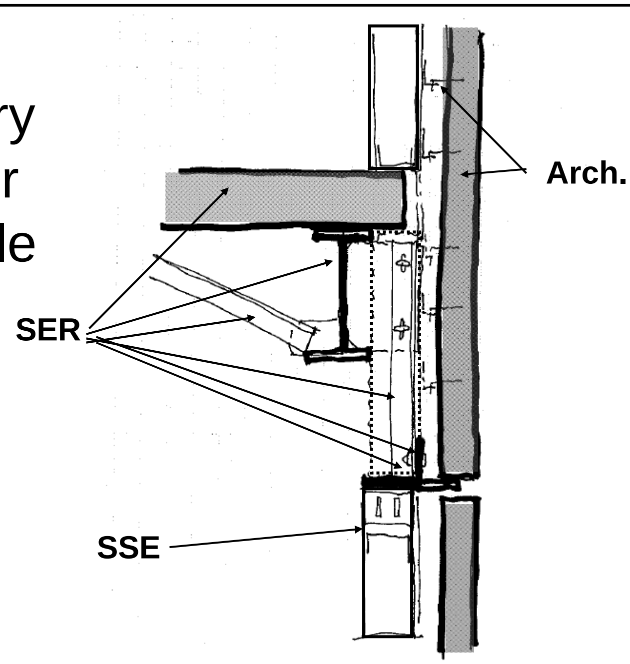
- Provides anticipated structural movements.
- Designs frame and slab edge consistent with attachment strategy.

There's always a solution in steel!

79

3

Masonry Veneer Example

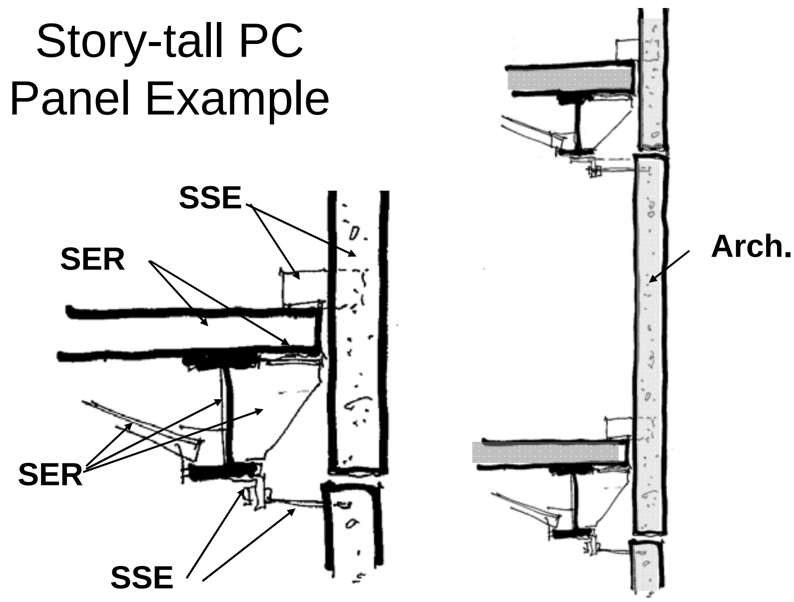


There's always a solution in steel!

80

3

Story-tall PC Panel Example

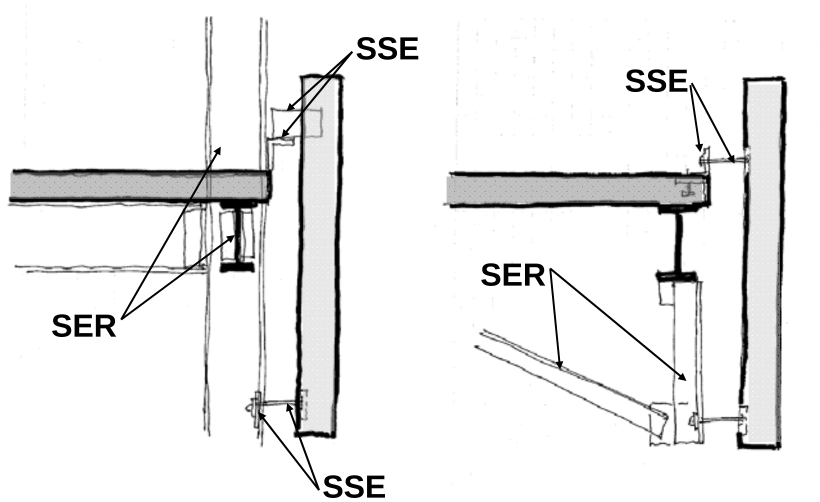


There's always a solution in steel!

81

3

Column Supported PC Spandrel Panel Example

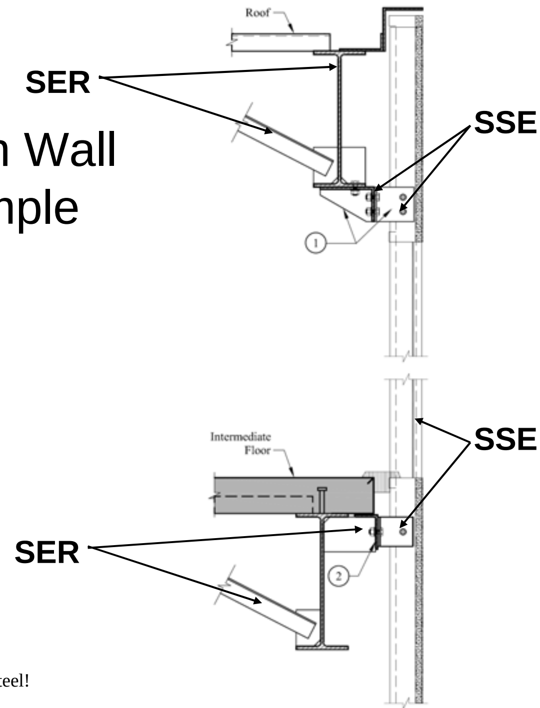


There's always a solution in steel!

82

3

Curtain Wall Example



There's always a solution in steel!

83

3

Summary

- Communicate!
- Façade attachments are difficult because every member of the design team has a significant role in the planning, designing and coordination.

There's always a solution in steel!

84

4

Accommodating Construction Tolerances and Clearances


University of Southern Indiana

Adjustability must be provided between the structural details and façade attachment details to achieve a façade erected within acceptable tolerances relative to the theoretical plane.

There's always a solution in steel!

85

4

Tolerances and Clearances

- Tolerances:
  - Permissible amount of deviation from a specified criterion: dimension, shape, location.
- Clearances:
  - Space purposely provided between two parts to allow for movement, accommodate tolerances and provide access.

There's always a solution in steel!

86

4

Types of Tolerances

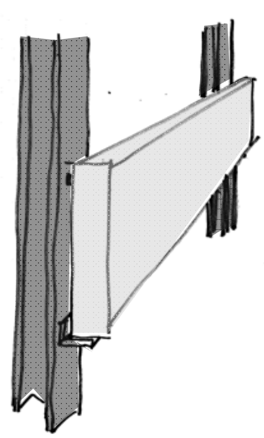
- Material Production Tolerances
- Fabrication and Assembly Tolerances
- Erection and Installation Tolerances
- Accumulated Tolerances

The AISC Design Guide includes summaries of major façade materials and components.

4

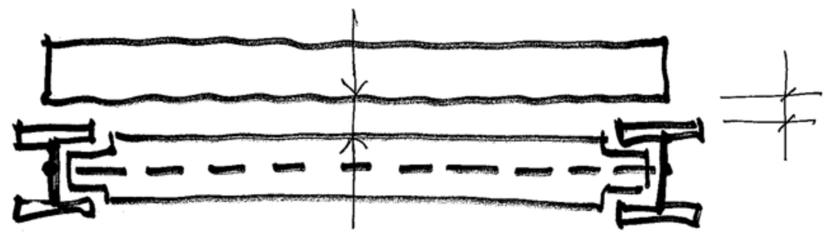
Accumulated Tolerances

- Case Study:
  - PC panel supported on columns at 10th story.
  - 40 ft. span.
  - Column plumbness:
    - -2 inches in; +1 inch out.
  - Steel beam sweep:
    - +/- ½ inch.
  - PC plan location at each end: +/- ½ inch.
  - PC bow: L/360 = +/- 1.33 inches.



4

Accumulated Tolerances



There's always a solution in steel!

89

4

Accumulated Tolerances

- Maximum change in planned gaps if using all tolerance maximums:
  - At columns:
    - Open: 2 +.5 = 2.5 inches
    - Close: 1+.5 = 1.5 inches
  - At mid span:
    - Open: 2 +.5 +.5 +1.33 = 4.33 inches
    - Close: 1 +.5 +.5 +1.33 = 3.33 inches

There's always a solution in steel!

90

4

Accumulated Tolerances

- Unlikely that all tolerances will vary to the maximum allowed and all occur in the same direction.
- However, no statistical data is usually available to the designer about the distribution of variation.

There's always a solution in steel!

91

4

Recommendations for Accumulated Tolerances

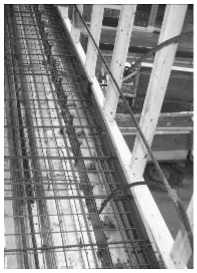
- Understand the sources of variability.
- Understand the consequence of exceeding the tolerance provisions in the details.
- Understand the costs associated with providing means to accommodate the variability.
- For each project, the team should develop a design criteria for addressing façade accumulated tolerances.

There's always a solution in steel!

92

5

Slab Edge Conditions



The slab edge detail is an important consideration when designing for façade attachments.

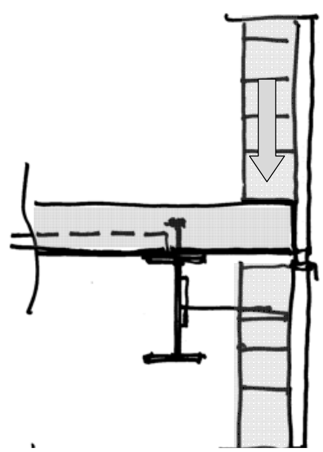
There's always a solution in steel!

93

5

Factors that Influence the Design

- Type, weight and location of façade
- Amount of slab overhang
- Slab or deck capacity
- Application of façade loads
- Similar conditions (or not)



There's always a solution in steel!

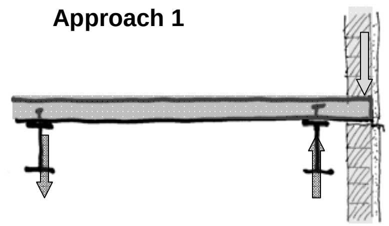
94

5

Two Fundamental Approaches

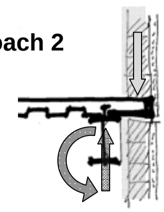
- The slab or deck cantilevers and picks up load.

Approach 1



- The designer does not count on the slab or deck to carry loads.

Approach 2

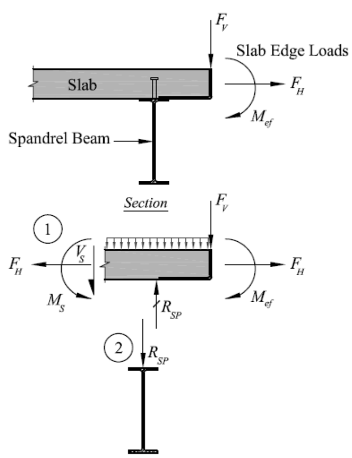


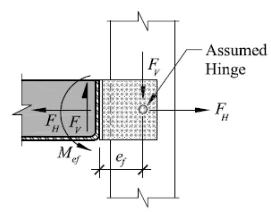
There's always a solution in steel!

95

5

Approach 1: Slab Cantilever Resolves Eccentricity





$M_{ef} = F_V \times e_f$

NOTES:

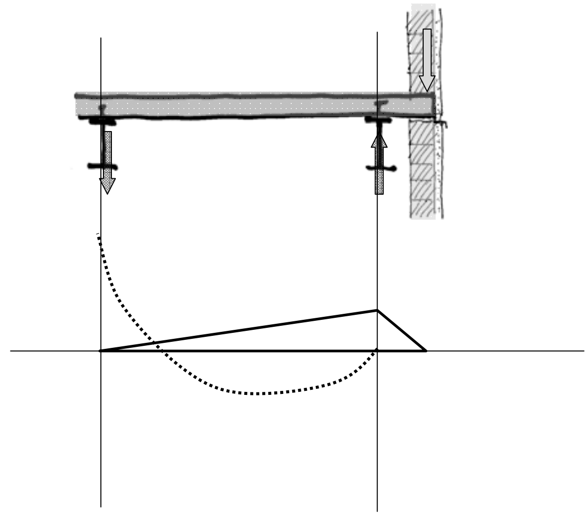
1. The slab is designed as a cantilever over the beam. The slab resists the wall anchor forces and delivers a vertical load to the spandrel.
2. The spandrel beam is designed for vertical reaction at beam, R_{SP}, no torsion.

There's always a solution in steel!

96

5

Design of Slab Overhang

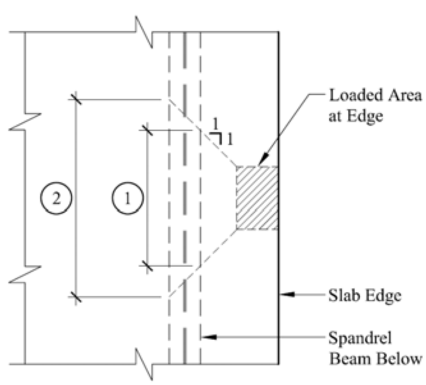


There's always a solution in steel!

97

5

Design of Slab Overhang



Plan at Slab Edge

There's always a solution in steel!

98

5

Design Aids in Design Guide

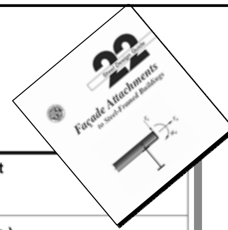


Table 5-4. Cantilevered Slab Flexural Strength, ϕM_n, kip-in. / ft
Concrete Compressive Strength f'_c = 3,000 psi
3-in. Composite Floor Deck Parallel to Spandrel Beam

Slab Reinforcement		Composite Floor Slab Total Thickness (in.)										
Bars	in.^{2}/ft	5	$5^1/_2$	6	$6^1/_4$(6)	$6^1/_2$	7	$7^3/_{16}$(8)	$7^1/_2$(7)	8	$8^1/_4$(9)	$8^1/_2$
#3@18(5)	0.07	2.92	4.89	6.86	7.8	8.83	10.8	11.5	12.8	14.7	15.7	16.7
#3@16(5)	0.08	3.28	5.52	7.76	8.9	10.0	12.2	13.1	14.5	16.7	17.8	19.0
#3@12	0.11	4.18	7.15	10.1	11.6	13.1	16.1	17.2	19.0	22.0	23.5	25.0
#4@18(5)	0.13	4.19	8.04	11.6	13.4	15.2	18.8	20.2	22.4	26.0	27.8	29.6

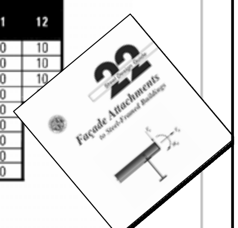
Table 5-8. Cantilevered Slab Flexural Strength, ϕM_n, kip-in. / ft
Concrete Compressive Strength f'_c = 3,000 psi
3-in. Composite Floor Deck Perpendicular to Spandrel Beam

Slab Reinforcement		Composite Floor Slab Total Thickness (in.)										
Bars	in.^{2}/ft	5	$5^1/_2$	6	$6^1/_4$(7)	$6^1/_2$	7	$7^3/_{16}$(9)	$7^1/_2$(8)	8	$8^1/_4$(10)	$8^1/_2$
#3@18(6)	0.07	14.5	16.5	18.5	19.5	20.5	22.4	23.2	24.4	26.4	27.4	28.4
#3@16(6)	0.08	16.4	18.6	20.8	22.0	23.1	25.3	26.2	27.6	29.8	30.9	32.0
#3@12	0.11	21.4	24.3	27.3	28.8	30.3	33.2	34.4	36.2	39.2	40.7	42.2
#4@18(6)	0.13	25.1	28.6	32.2	34.0	35.8	39.4	40.8	43.0	46.6	48.4	50.2

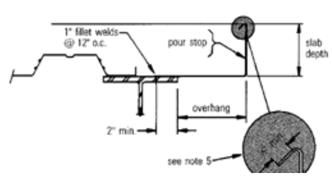
5

Table 5.1 Gage Metal Pour Stop
Selection Table for Normal Weight Concrete

SLAB DEPTH (INCHES)	OVERHANG (INCHES) / POUR STOP TYPES 0	1	2	3	4	5	6	7	8	9	10	11	12
4.00	20	20	20	20	18	18	16	14	12	12	12	10	10
4.25	20	20	20	18	18	16	16	14	12	12	12	10	10
4.50	20	20	20	18	18	16	16	14	12	12	12	10	10
4.75	20	20	18	18	16	16	14	14	12	12	10	10	
5.00	20	20	18	18	16	16	14	14	12	12	10	10	
5.25	20	18	18	16	16	14	14	12	12	12	10	10	
5.50	20	18	18	16	16	14	14	12	12	12	10	10	
5.75	20	18	16	16	14	14	12	12	12	12	10	10	
6.00	18	18	16	16	14	14	12	12	12	10	10	10	
6.25	18	18	16	14	14	12	12	12	12	10	10		
6.50	18	16	16	14	14	12	12	12	12	10	10		
6.75	18	16	14	14	14	12	12	12	10	10	10		
7.00	18	16	14	14	12	12	12	12	10	10	10		
7.25	16	16	14	14	12	12	12	10	10	10			
7.50	16	14	14	12	12	12	12	10	10	10			
7.75	16	14	14	12	12	12	10	10	10	10			
8.00	14	14	12	12	12	12	10	10	10				
8.25	14	14	12	12	12	10	10	10	10				
8.50	14	12	12	12	12	10	10	10					
8.75	14	12	12	12	12	10	10	10					
9.00	14	12	12	12	10	10	10						
9.25	12	12	12	12	10	10	10						
9.50	12	12	12	10	10	10							
9.75	12	12	12	10	10	10							
10.00	12	12	10	10	10	10							
10.25	12	12	10	10	10								
10.50	12	12	10	10	10								
10.75	12	10	10	10									
11.00	12	10	10	10									
11.25	12	10	10										
11.50	10	10	10										
11.75	10	10											
12.00	10	10											



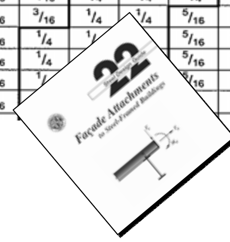
TYPES	DESIGN THICKNESS
20	0.0358
18	0.0474
16	0.0598
14	0.0747
12	0.1046
10	0.1345



5

Design Aids in Design Guide

Table 5.3.1 Minimum Thickness of Bent Plate (in.) Used as a Pour Stop for Normal Weight Concrete															
Slab Thickness (in.)	Slab Overhang (in)														
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
4	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	1/4	1/4	1/4	5/16	5/16
4 1/4	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	1/4	1/4	1/4	5/16	5/16
4 1/2	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	1/4	1/4	1/4	5/16	5/16
4 3/4	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	1/4	1/4	1/4	5/16	5/16
5	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	1/4	1/4	1/4	5/16	5/16	5/16
5 1/4	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	1/4	1/4	1/4	5/16	5/16	5/16
5 1/2	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	1/4	1/4	1/4	5/16	5/16	5/16
5 3/4	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	1/4	1/4	1/4	5/16	5/16	5/16
6	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	1/4	1/4	1/4	5/16	5/16	3/8
6 1/4	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	1/4	1/4	5/16	5/16	5/16	3/8
6 1/2	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	1/4	[illegible]	[illegible]	5/16	5/16	5/16	3/8
6 3/4	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	1/4	[illegible]	[illegible]	5/16	5/16	5/16	3/8
7	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	[illegible]	[illegible]	[illegible]	[illegible]	5/16	5/16	3/8
7 1/4	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	[illegible]	[illegible]	[illegible]	[illegible]	5/16	3/8	3/8

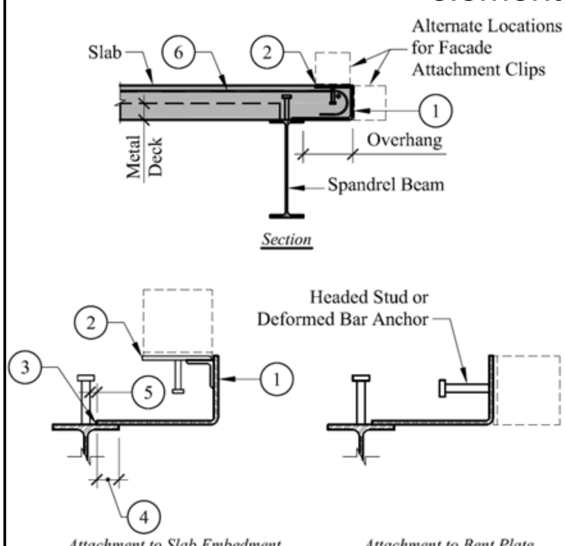


There's always a solution in steel!

101

5

Case 2 – Pour Stop Plus Means to Attach Façade elements



NOTES:

1. Design bent steel plate as pour stop. Commonly 3/16 inch min. and 1/2 inch max. thickness. Consider steel plate over light gage metal pour stop for large overhangs and/or embedment plates.
2. Example of embedment plate for facade attachment. Field weld or otherwise field anchor to steel closure plate. Design to transfer facade attachment loads to slab.
3. Shop weld pour stop to spandrel beam if tolerances are accomodated in the facade attachment details; otherwise field weld.
4. Overlap as necessary for weld design.
5. Maintain minimum clearance for headed studs.
6. Design slab to cantilever over spandrel and support loads from facade attachment.

102

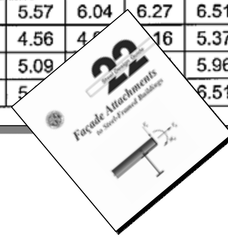
There's always a solution in steel!

5

Design Aids in Design Guide

Table 5.4.1
Headed Stud Tensile Capacities in 4,000 psi Normalweight Concrete Slab Edges, ϕN_n (kip)

Headed Stud Diameter (in.)	Embedment Depth (in.)	Slab Thickness (in.) 4	$4^1/_2$	5	$5^1/_2$	6	$6^1/_2$	7	$7^1/_4$	$7^1/_2$	$8^1/_4$
$^1/_2$	6	2.66	3.03	3.40	3.78	4.16	4.56	4.96	5.16	5.30	5.99
	8	3.01	3.41	3.82	4.24	4.66	5.09	5.30	5.74	5.30	6.64
	10	3.32	3.75	4.20	4.65	5.11	5.30	5.30	6.27	5.30	7.23
$^5/_8$	6	2.66	3.03	3.40	3.78	4.16	4.56	4.96	5.16	5.37	5.99
	8	3.01	3.41	3.82	4.24	4.66	5.09	5.52	5.74	5.96	6.64
	10	3.32	3.75	4.20	4.65	5.11	5.57	6.04	6.27	6.51	7.23
$^3/_4$	6	2.66	3.03	3.40	3.78	4.16	4.56	[illegible]	[illegible]	5.37	5.99
	8	3.01	3.41	3.82	4.24	4.66	5.09	[illegible]	[illegible]	5.96	6.64
	10	3.32	3.75	4.20	4.65	5.11	[illegible]	[illegible]	[illegible]	6.51	7.23



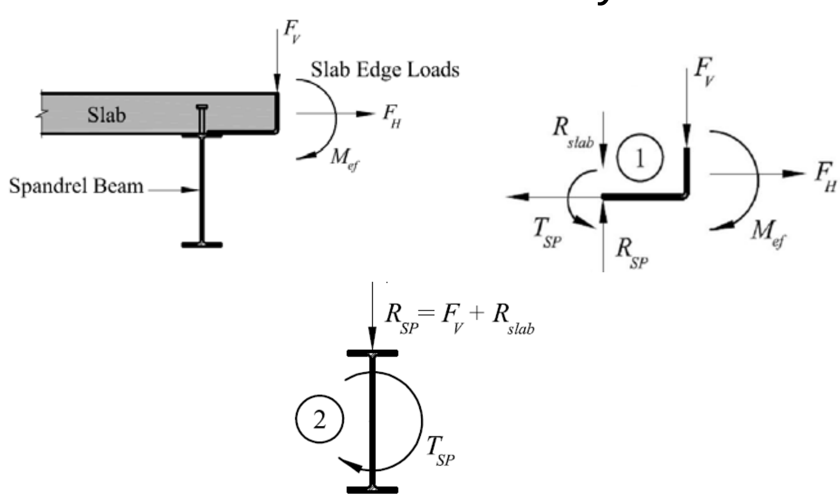
Tables for shear forces included too.

There's always a solution in steel!

103

5

Approach 2: Slab Cantilever Does Not Resolve Eccentricity

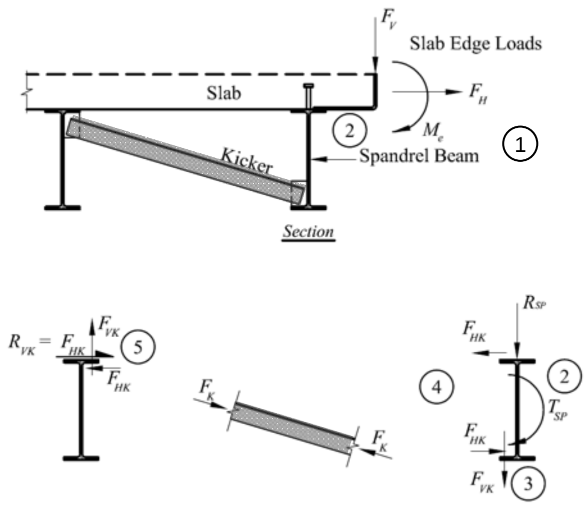


There's always a solution in steel!

104

5

Kickers

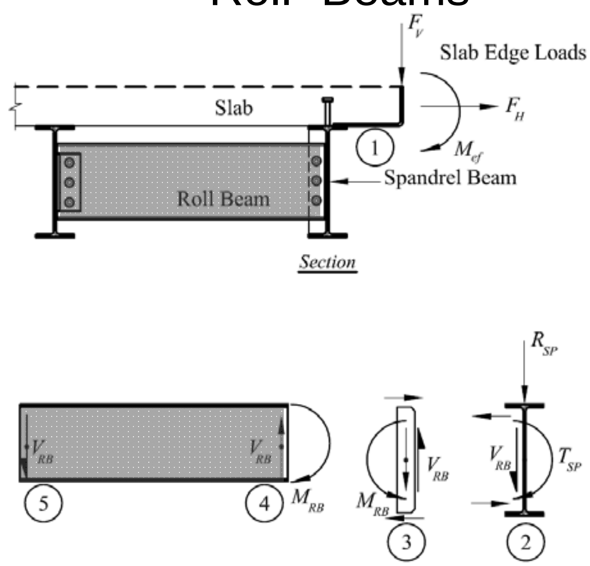


There's always a solution in steel!

105

5

"Roll" Beams



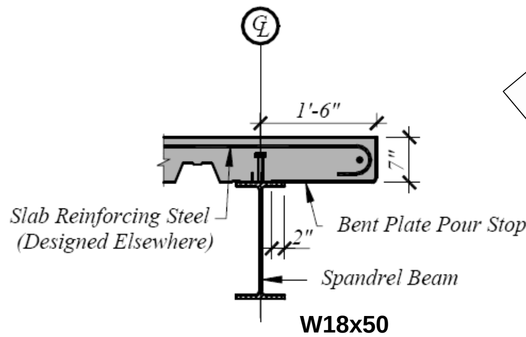
There's always a solution in steel!

106

5

Example 5.3- Design Bent Plate as a Pour Stop

Excerpts from Design Guide. See Design Guide for complete, detailed example.



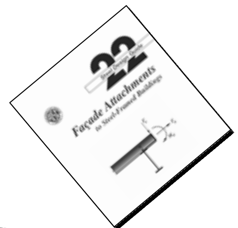


Fig. E5.3(a) Edge of slab with bent plate pour stop.

There's always a solution in steel!

107

6

Design of Steel Spandrel Beams

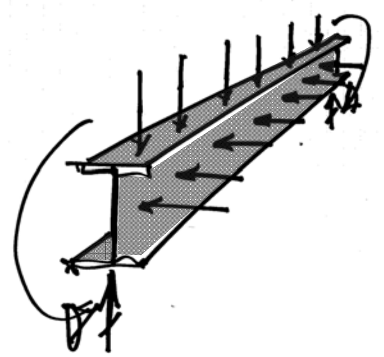
The design of the spandrel beam is more than selecting a wide flange shape that meets flexural strength and stiffness criteria.

There's always a solution in steel!

108

6

General Design Considerations



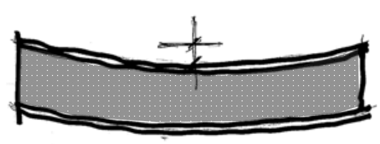
- Flexural Strength
  - Composite or Noncomposite?
  - Part of a Moment Frame?
  - Any weak axis bending?

There's always a solution in steel!

109

6

General Design Considerations



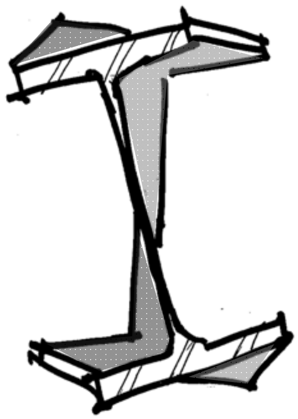
- Flexural Stiffness
  - Precomposite DL
  - Post-composite DL
    - Façade load
    - Superimposed DL
  - Superimposed LL
  - Floor vibrations
  - Creep, long-term
  - Weak axis loads

There's always a solution in steel!

110

6

General Design Considerations



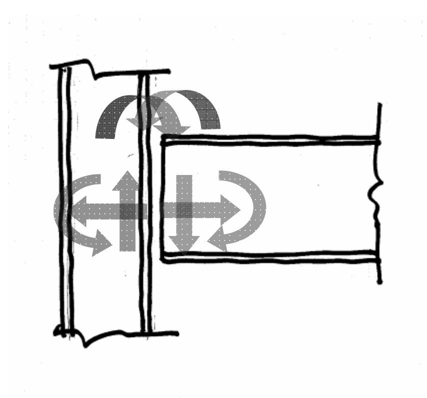
- Torsion?
  - Resolved at columns?
  - Kickers?
  - Roll beams?
  - Rotation and projected translations?

There's always a solution in steel!

111

6

General Design Considerations



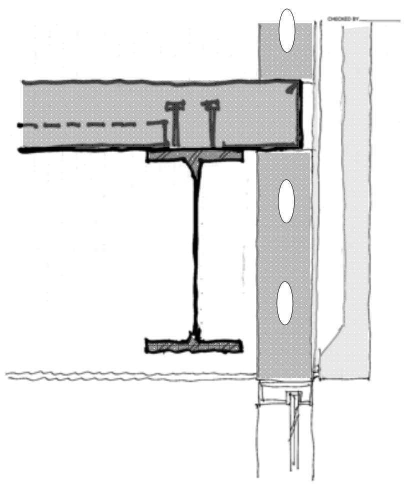
- Connection to Columns
  - Simple shear?
  - Special copes, non standard?
  - Horizontal forces?
  - Torsional forces?

There's always a solution in steel!

112

6

General Design Considerations



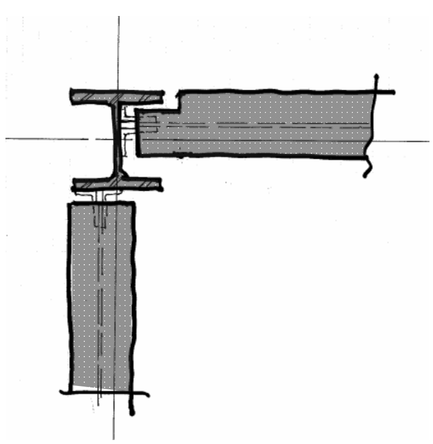
- Spandrel dimensions
  - Depth
  - Flange width
  - Flange thickness
  - Project consistency

113

There's always a solution in steel!

6

General Design Considerations



- Centerline location
  - Column connections?
  - Minimize façade eccentricities?
  - Clearances for adjustments?

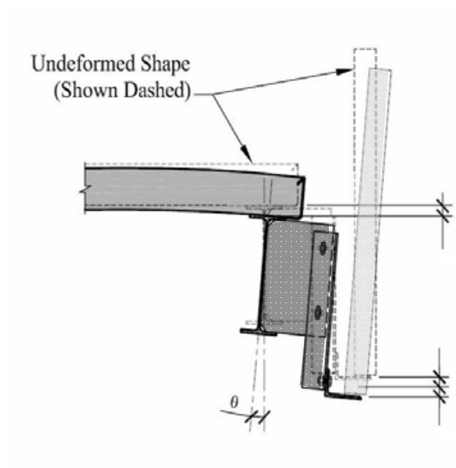
114

There's always a solution in steel!

6

Deflection and Movement Limitations

- Curvature
  - L/360, L/400, L/600, etc.
- Absolute magnitude for joints
- Must consider rotation as well as vertical deformations

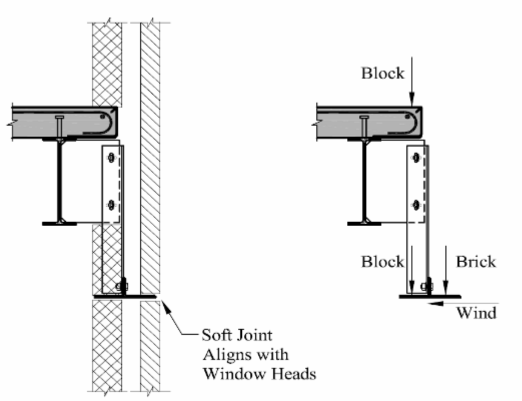


There's always a solution in steel!

115

6

Designing for Torsion



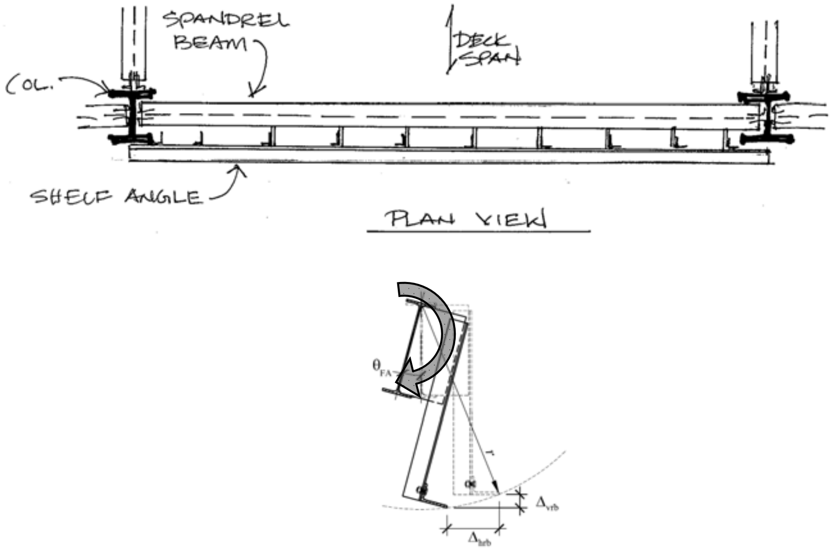
(a) Brick veneer and block facade system

(b) Facade forces impose torsion on spandrel beam

There's always a solution in steel!

116

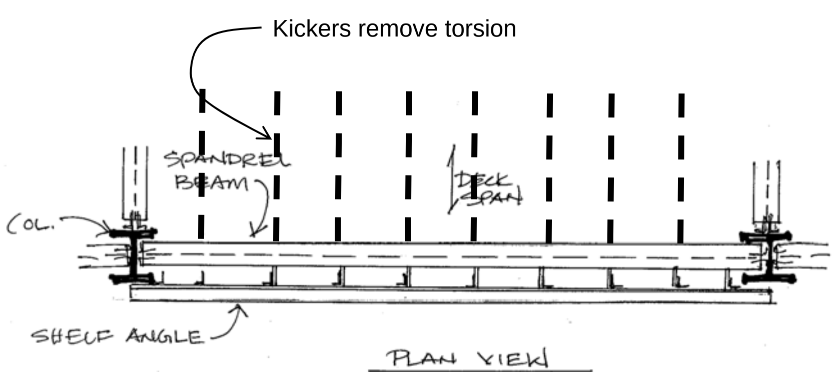
6



There's always a solution in steel!

117

6

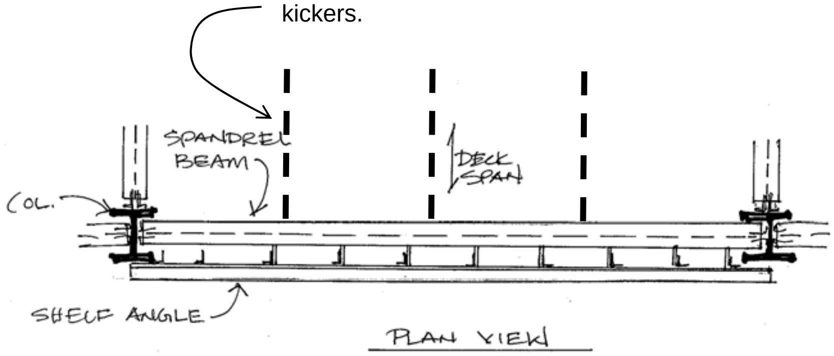


There's always a solution in steel!

118

6

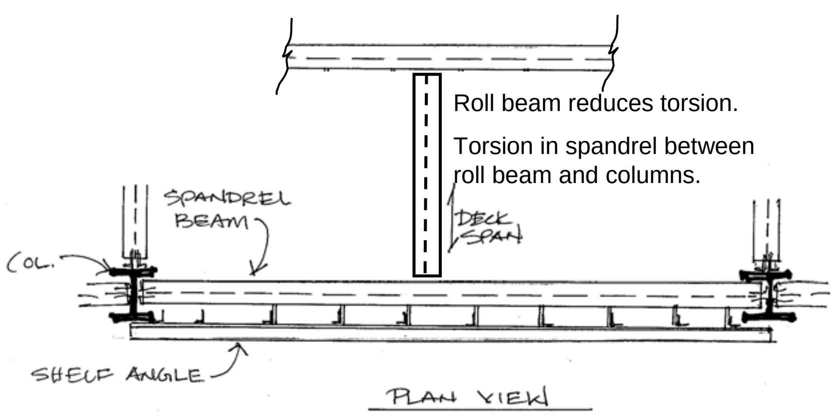
Kickers reduce torsion –
torsion in spandrel between
kickers.



There's always a solution in steel!

119

6



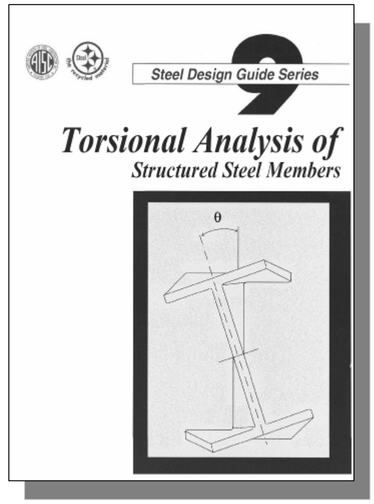
There's always a solution in steel!

120

6

Design approaches

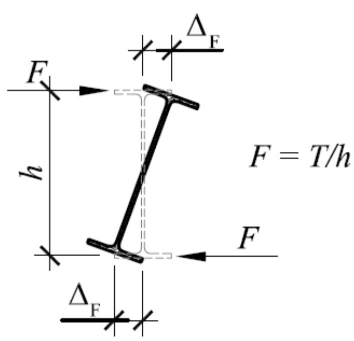
- Detailed guidance on torsional stresses and rotations of bare steel wide-flange shapes.
- Rotation about center of shape.



There's always a solution in steel!
121

6

Design approaches

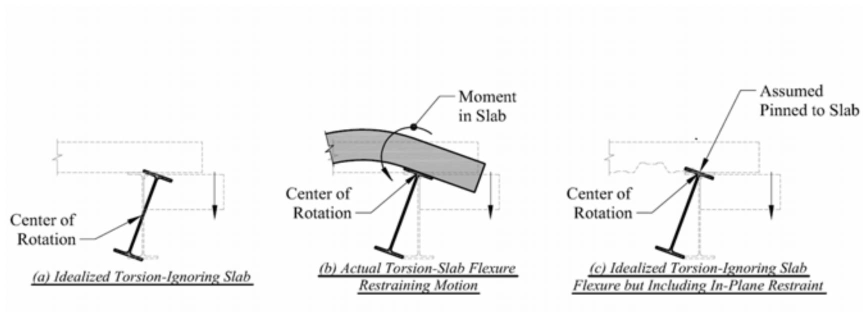


(a) Flexural Analogy for Calculating Idealized Rotation Ignoring Slab Restraint

There's always a solution in steel!
122

6

Center of Rotation

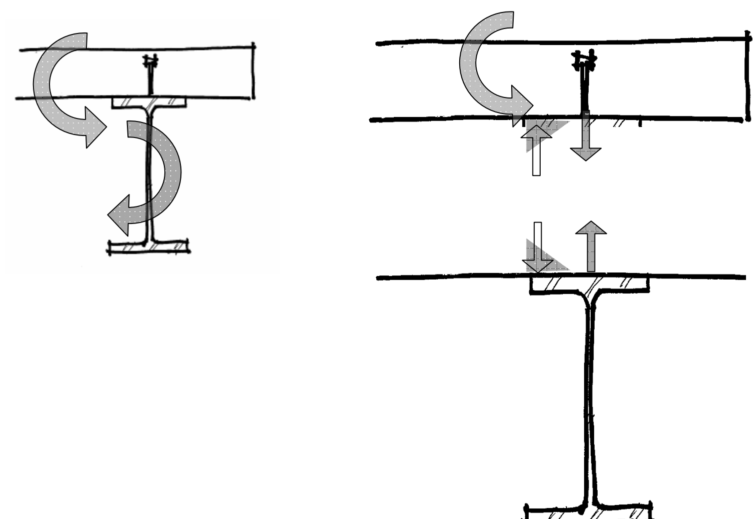


There's always a solution in steel!

123

6

Slab Resisting Torsion

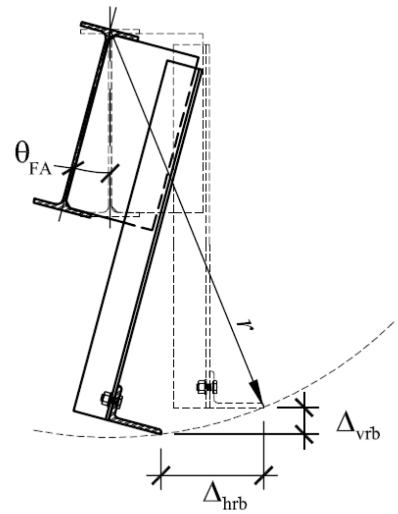


There's always a solution in steel!

124

6

Effects of Rotation at Slab

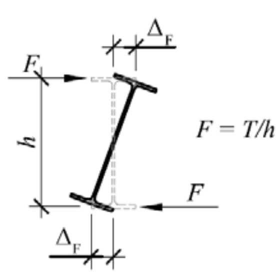


There's always a solution in steel!

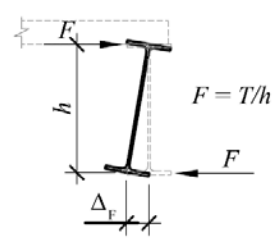
125

6

Modified Flexural Analogy



(a) Flexural Analogy for Calculating Idealized Rotation Ignoring Slab Restraint



(b) Flexural Analogy for Calculating Rotation with Top Flange Braced Laterally - No Rotational Restraint by Slab or Deck

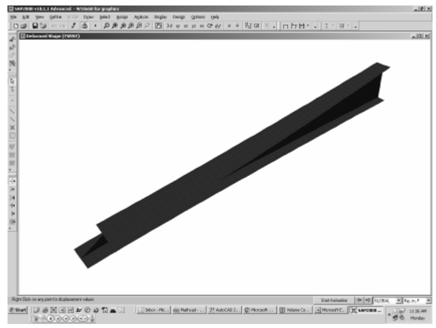
There's always a solution in steel!

126

6

Appendix A Study

- Three models
  - FEM
  - Modified DG #9
  - Modified Flex. Analogy
- Two spans
  - 10 ft
  - 30 ft
- Two load shapes
  - Concentrated
  - Uniform

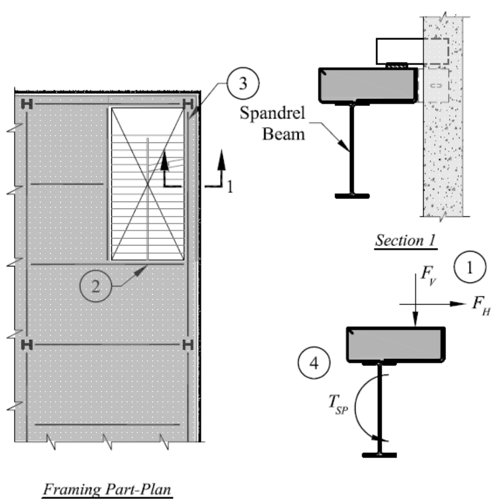


There's always a solution in steel!

127

6

Conditions with Torsion

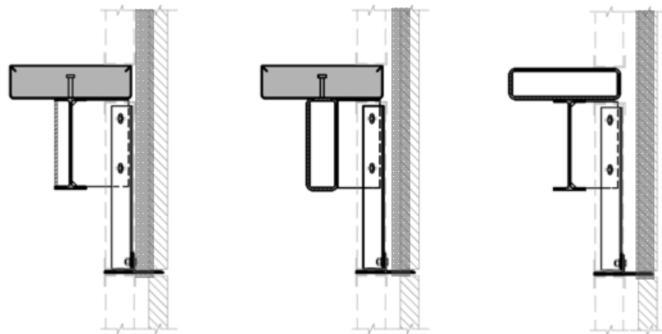


There's always a solution in steel!

128

6

Options for Increasing Rotation Resistance



(Note: Sheathing and Insulation Not Shown for Clarity, Typ.)

(a) Wide-Flange Beam with Cover Plate

(b) HSS

(c) Wide-Flange Beam/HSS Combination

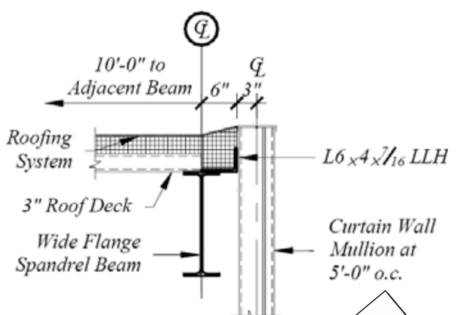
There's always a solution in steel!

129

6

Example 6.1

Excerpts from Design Guide. See Design Guide for complete, detailed example.



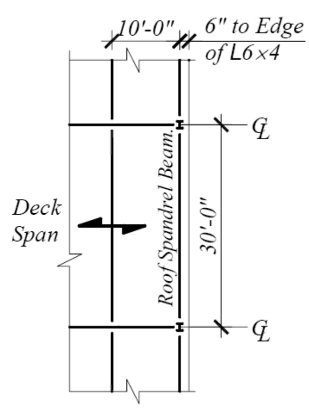


Fig. E6.1(b) Roof plan at spandrel beam.

There's always a solution in steel!

130

7

Masonry Cavity Walls



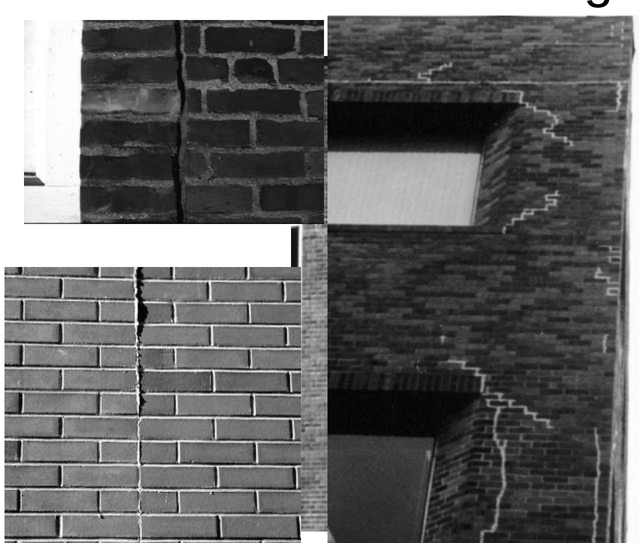
The strategy for supporting masonry cavity walls starts with the decision for the location of the horizontal movement joints.

There's always a solution in steel!

131

7

Volume Change

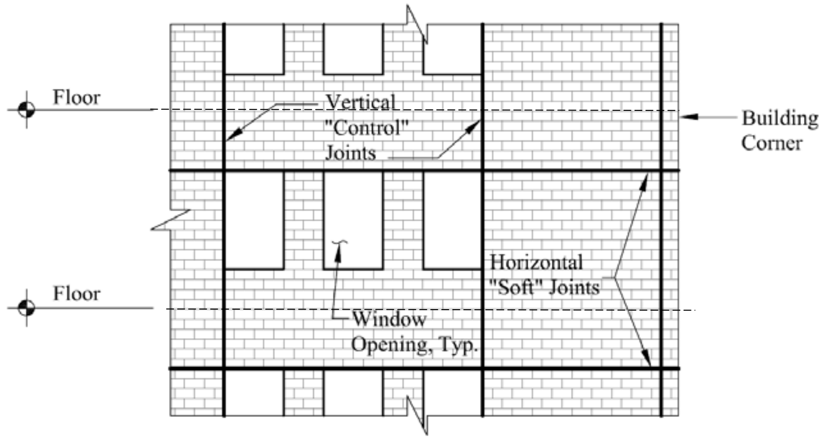


There's always a solution in steel!

132

7

Good Movement Joints



There's always a solution in steel!

133

7

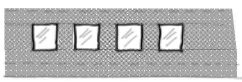
Movement Joints

There's always a solution in steel!

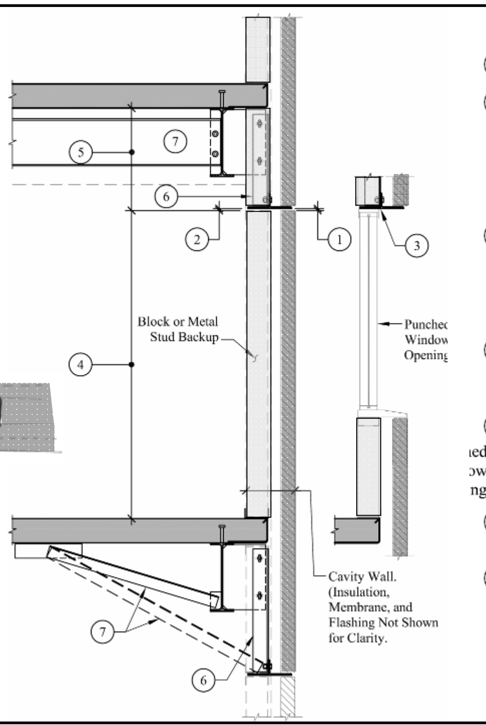
134

7

Strategies: Punched Openings



Elevation



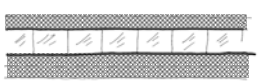
NOTES:

1. Soft joint below shelf angle.
2. Movement joint between shelf angle assembly and backup wall below. The connection to underside of shelf angle assembly provides out-of-plane lateral support to the backup wall.
3. Movement joint between shelf angle assembly and window head. The window head connection provides out-of-plane support of the window.
4. Backup wall of block or metal studs below movement joint is supported on floor slab.
5. Backup wall above movement joint is supported on shelf angle assembly and anchored to underside of floor slab.
6. Hangers from plate brackets support the shelf angle assembly.
7. Roll beams or kickers can resist the twist of the spandrel beam.

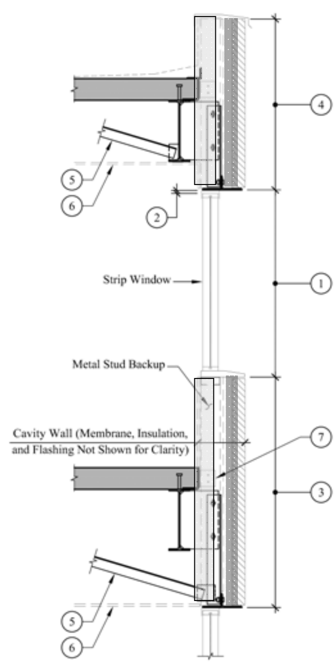
135

7

Strategies: Strip Windows



Elevation



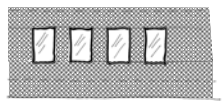
NOTES:

1. Strip window. The shelf angle is at the window head.
2. Movement joint between shelf angle assembly and window head. The window head connection provides out-of-plane support of the window.
3. Metal stud backup wall is supported off of the hung shelf angle assembly. Studs are connected to the edge of the slab and cantilever up to provide vertical and out-of-plane support at the sill of the strip window.
4. At the roof, the metal studs cantilever up past the slab edge to form the parapet.
5. Kickers or roll beams can resist the twist of the spandrel beam.
6. The finish ceiling location may dictate the location of the kickers.
7. Lateral tie to slab so studs can cantilever by edge of slab up to sill of window for out-of-plane support of window.

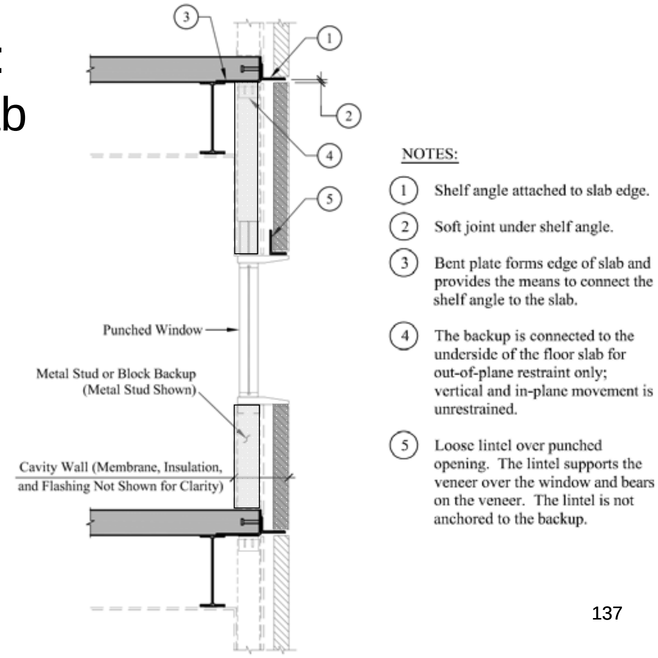
136

7

Strategies: Shelf at Slab



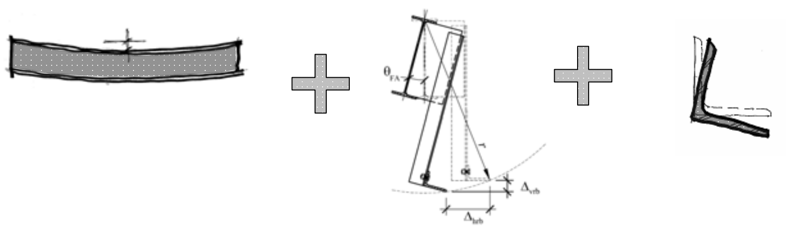
Elevation

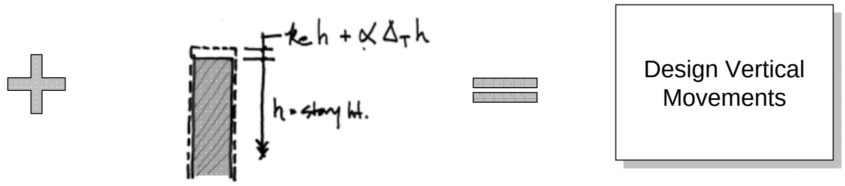


137

7

Vertical Movements





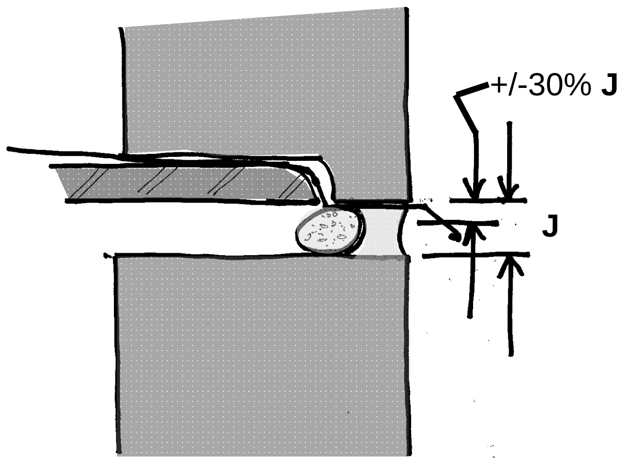
Note: Column shortening is important too for tall building's bottom story.

There's always a solution in steel!

138

7

Vertical Movements

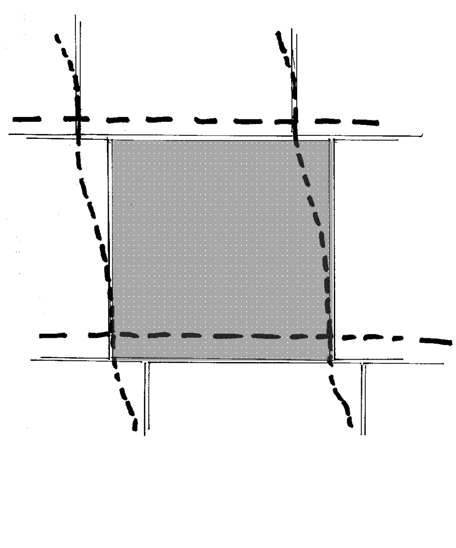


There's always a solution in steel!

139

7

In-Plane Movements

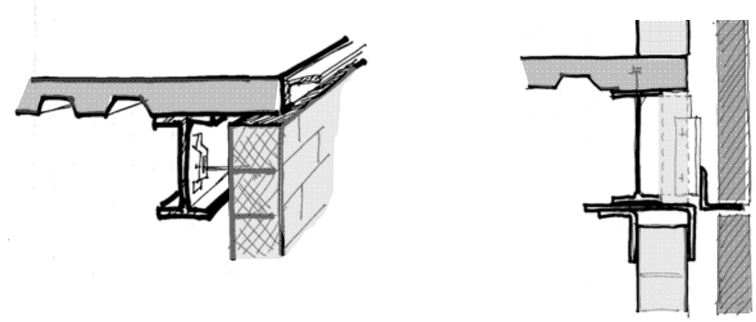


There's always a solution in steel!

140

7

Top of Wall Connections

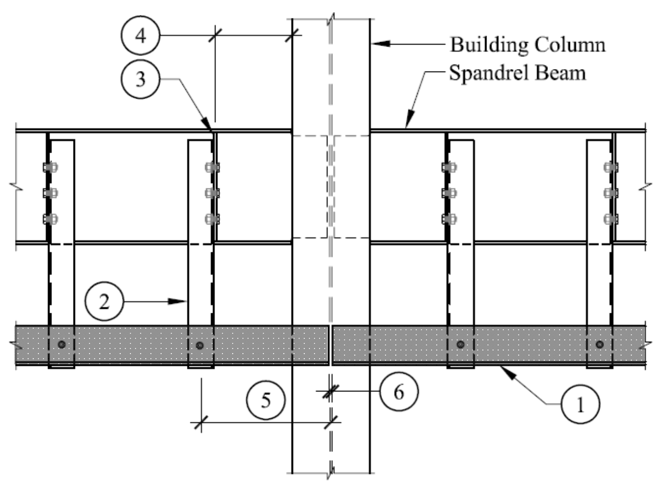


There's always a solution in steel!

141

7

Plan Locations Of Hangers



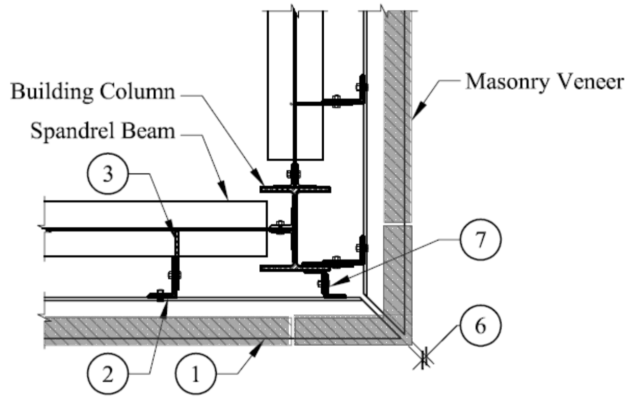
(a) Hung Shelf Angle at Column

There's always a solution in steel!

142

7

Plan Locations Of Hangers



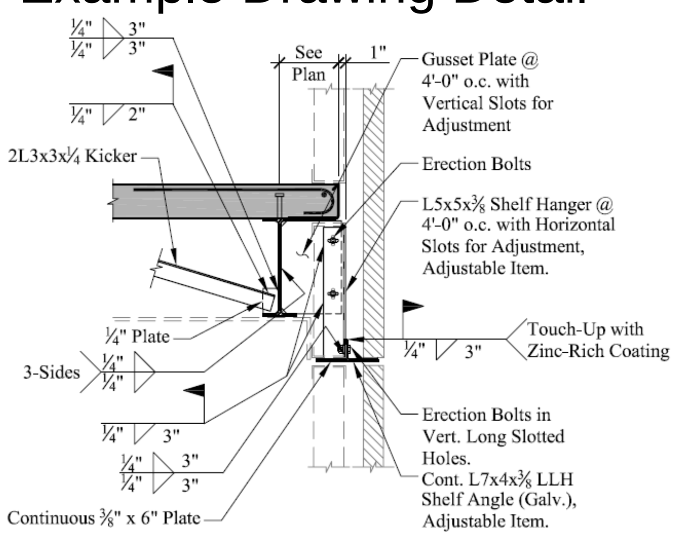
(c) Hung Shelf Angle at Building Corner

There's always a solution in steel!

143

7

Example Drawing Detail



(Note: Sheathing and Insulation Not Shown for Clarity, Typ.)

There's always a solution in steel!

144

7

Shelf Angle Tables

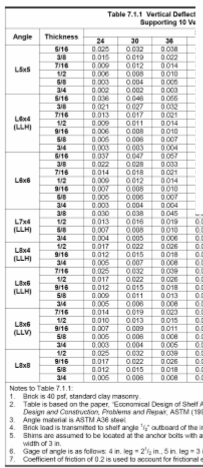
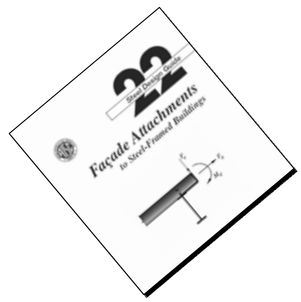


Table 7.1.1 Vertical Deflection at Tip for Shelf Angle (in.) Supporting 10 Vertical Feet of Brick[1]

Angle	Thickness	Spacing of Attachment (in)								
		24	30	36	42	48	54	60	66	72
L5x5	5/16	0.025	0.032	0.038	0.045	0.051	0.063	0.076	0.091	0.110
	3/8	0.015	0.019	0.022	0.026	0.030	0.037	0.045	0.054	0.065
	7/16	0.009	0.012	0.014	0.017	0.020	0.024	0.029	0.035	0.043
	1/2	0.006	0.008	0.010	0.011	0.013	0.016	0.020	0.024	0.030
	5/8	0.003	0.004	0.005	0.006	0.007	0.009	0.011	0.013	0.016
	3/4	0.002	0.002	0.003	0.003	0.004	0.005	0.007	0.008	0.010
L6x4 (LLH)	5/16	0.036	0.046	0.055	0.065	0.074	0.082	0.092	0.112	0.135
	3/8	0.021	0.027	0.032	0.038	0.043	0.048	0.054	0.067	0.081
	7/16	0.013	0.017	0.021	0.024	0.027	0.031	0.035	0.043	0.053
	1/2	0.009	0.011	0.014	0.016	0.018	0.021	0.024	0.030	0.037
	9/16	0.006	0.008	0.010	0.011	0.013	0.015	0.018	0.022	0.027
	5/8	0.005	0.006	0.007	0.008	0.010	0.011	0.013	0.017	0.021



There's always a solution in steel!

145

8

Precast Concrete Wall Panels

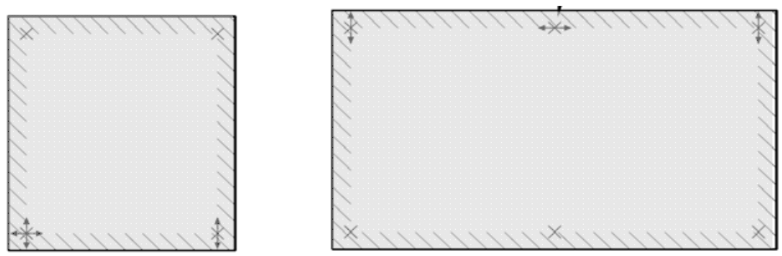
The most important strategy for support of precast concrete panels is to support the weight of each panel on no more than two points.

There's always a solution in steel!

146

8

Strategies For Support



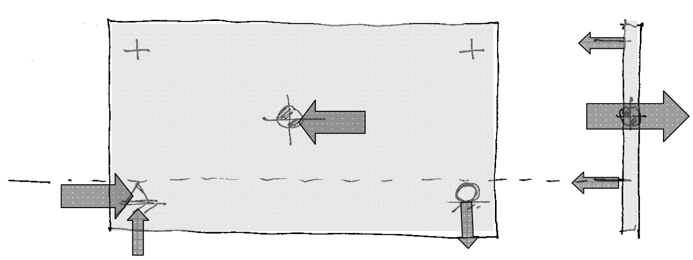
KEY:
↕ Indicates direction of in-plane load resistance.
× Indicates out-of-plane load resistance.

There's always a solution in steel!

147

8

Seismic Forces

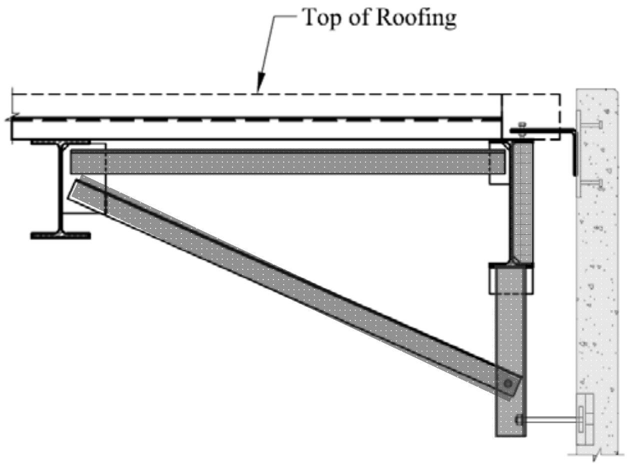


There's always a solution in steel!

148

8

Spandrel Supported

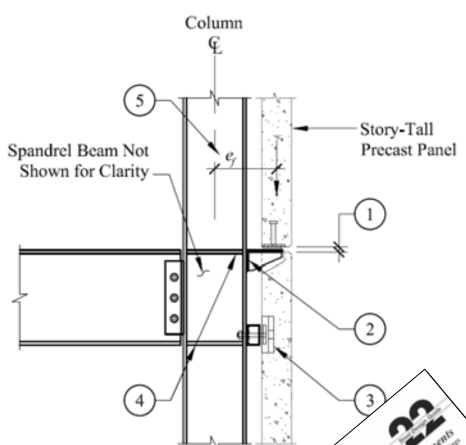


There's always a solution in steel!

149

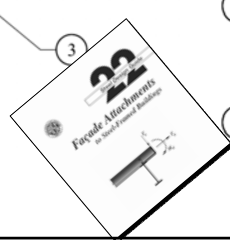
8

Column Supported Story-tall



NOTES:

1. Shim stack (or leveling bolt) bearing support at panel joint. Joint to allow differential vertical movement.
2. Steel bracket bearing connection. Typically designed by the SSE.
3. Tie-back connection at top of lower panel to allow vertical and horizontal relative movement.
4. Stiffener plates (as required). Consider impact of stiffeners on the out-of-plane spandrel beam connection.
5. Maximum allowable eccentricity (e_f) specified by the Structural Engineer of Record.



There's always a solution in steel!

150

9

Aluminum Curtain Walls

Often the most important part of the aluminum curtain wall design is anchorage adjustability to the base building structure.

There's always a solution in steel!

151

9

Strategies for Support

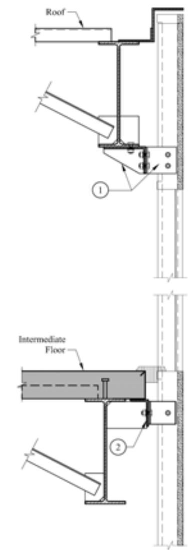
- Easily accessible attachments
- Adjustability
- Limit eccentricity
- Block-outs of fire proofing
- Factory drilled bolt holes in curtain wall
- Welded field connections

There's always a solution in steel!

152

9

Strategies for Support



NOTES:

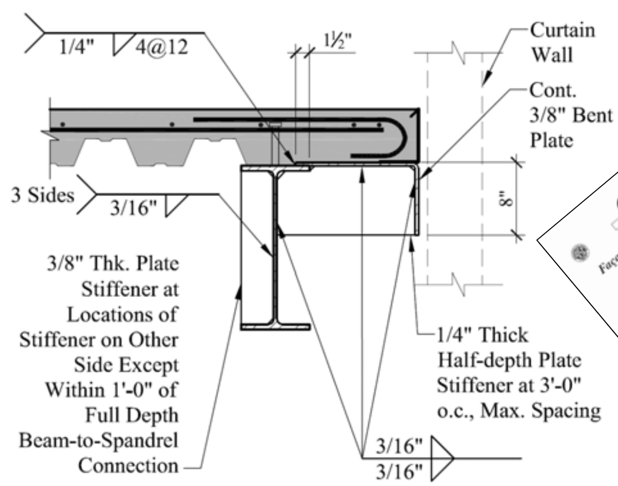
1. Dead load attachment. Curtain wall hangs from roof structure in this example. Attachment detail needs to provide vertical and horizontal adjustments.
2. Wind load attachment. Detail provides out-of-plane support of mullion and allows vertical movement relative to structure.

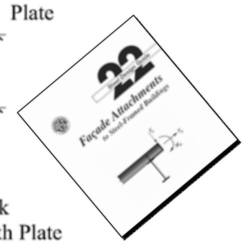
There's always a solution in steel!

153

9

Attachments





There's always a solution in steel!

154

10

Glass Fiber Reinforced Concrete Façade Panels

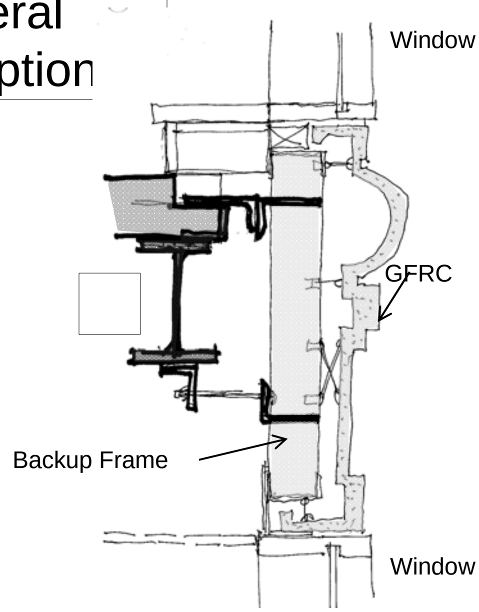
The GFRC panel and the backup frame comprise the GFRC façade; a lightweight alternative to precast concrete panels that can be highly articulated.

There's always a solution in steel!

155

10

General Description

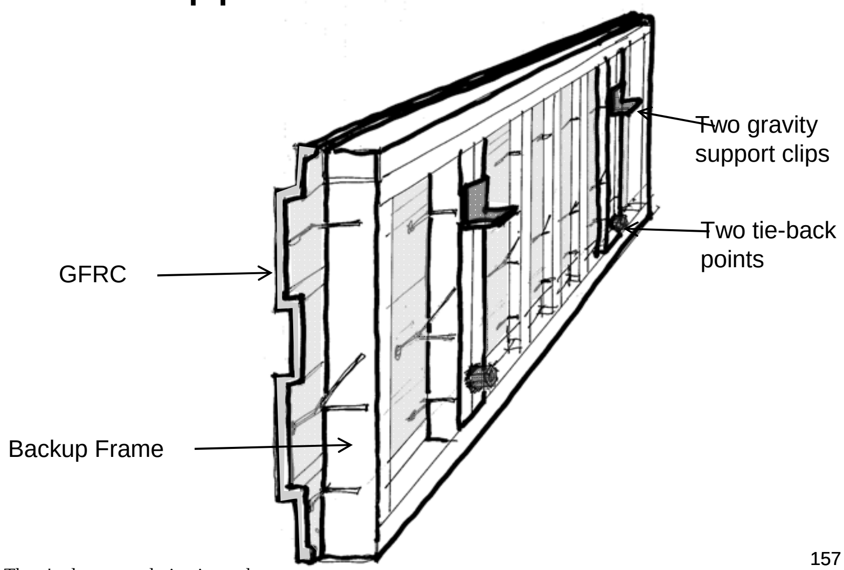


There's always a solution in steel!

156

10

Support of Backup Frame

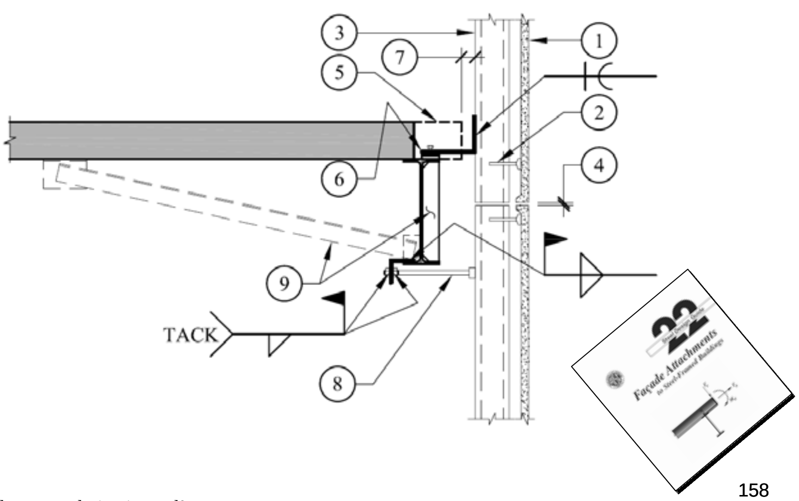


There's always a solution in steel

157

10

GFRC Field Adjustability

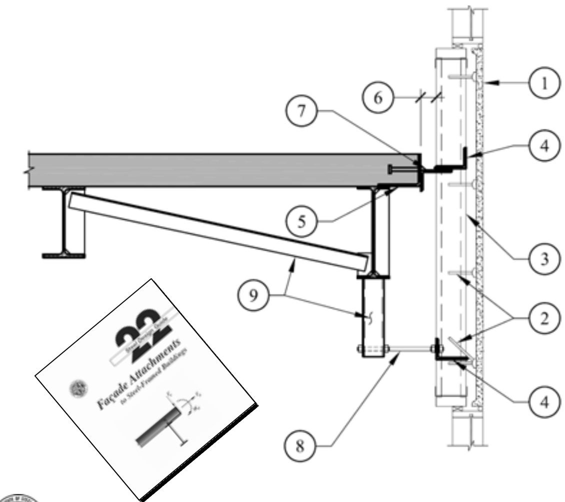


There's always a solution in steel!

158

10

GFRC Field Adjustability



NOTES:

1. GFRC panel skin.
2. Skin anchors to backup frame.
3. Backup frame.
4. Connector angles in backup frame.
5. Bent plate at slab edge designed as pour stop and anchored to slab to transfer panel loads to the slab.
6. Slab edge clearance. 1 inch minimum, 2 inch preferred. Provide adjustable slab edge detail if possible.
7. Attachment clip. Attachment to provide both vertical and horizontal adjustment.
8. Tie-back attachment. Lateral flexibility through bending of threaded rod.
9. Hanger and kickers as required for tie-back forces.

There's always a solution in steel!

11

Exterior Insulation Finish System

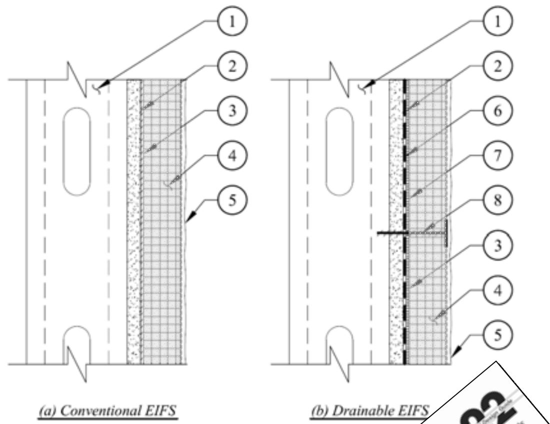
EIFS – Finish and base coat; expanded polystyrene insulation; drainage plane; membrane; exterior sheathing; metal studs; interior sheathing; interior finish.

160

There's always a solution in steel!

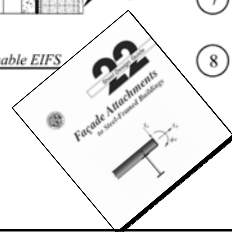
11

The EIFS Panel



NOTES:

1. Metal stud backup panel frame.
2. Sheathing.
3. Adhesive.
4. EPS insulation.
5. Polymer-modified cement base coat, glass-fiber fabric, and acrylic-based, textured finish.
6. #15 asphalt saturated felt paper.
7. Ribbed PVC lathe for drainage plane.
8. Mechanical fastener with disc washer.

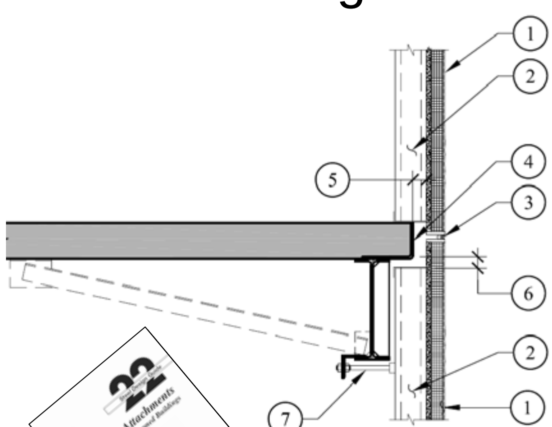


There's always a solution in steel!

161

11

EIFS Strategies



NOTES:

1. EIFS full-story panel.
2. Backup frame, integral with panel.
3. Joint between story panels must accommodate vertical movement of spandrel beam and lateral movement from inter-story drift of frame.
4. Pour stop. Bent plate or light gage metal. Needs in-out adjustment.
5. Clearance needed between slab edge and back of EIFS sheathing.
6. Clearance needed between underside of slab and top of backup frame.
7. Tie-back connection.

There's always a solution in steel!

162

12

Stone Veneer

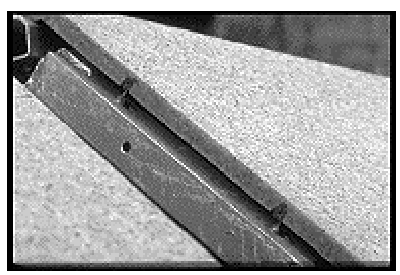

We distinguish stone veneer from masonry veneer when the stone is assembled in prefabricated wall panels or each stone is individually supported.

There's always a solution in steel!

163

12

Thin Stone Veneer Panels

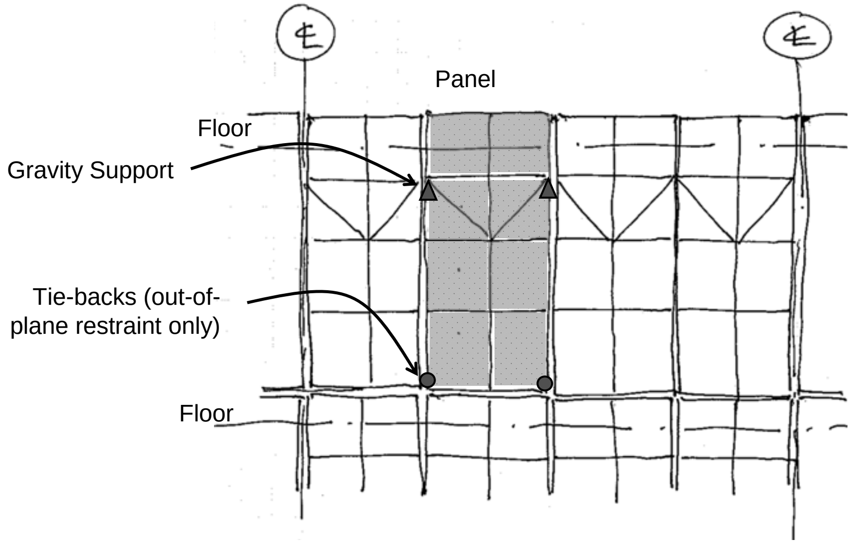



There's always a solution in steel!

164

12

Thin Stone Veneer Panels

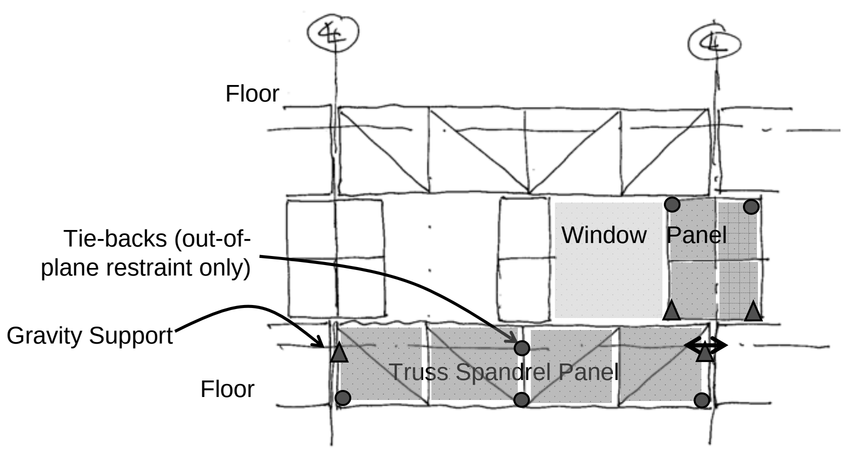


There's always a solution in steel!

165

12

Thin Stone Veneer Panels

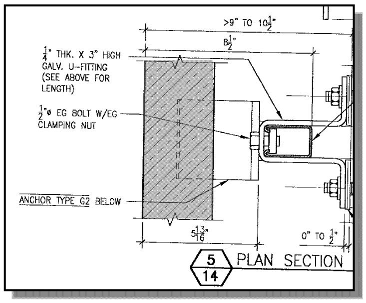


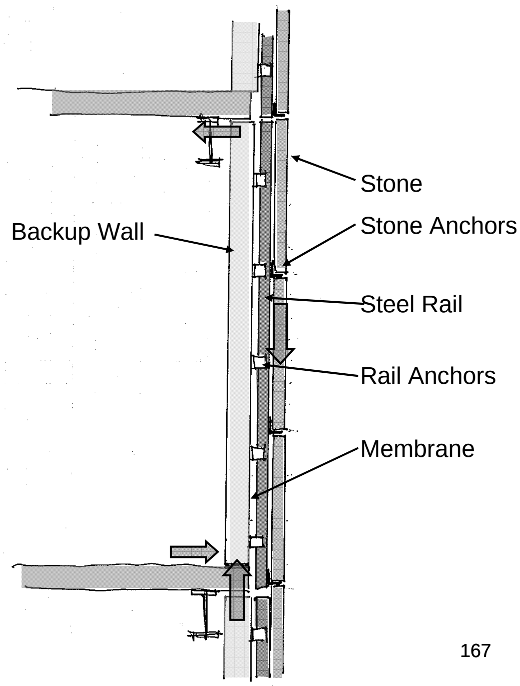
There's always a solution in steel!

166

12

Stone Veneer on Rails



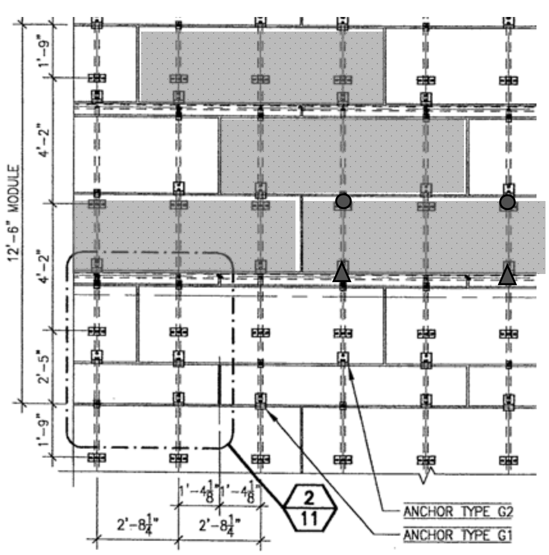


There's always a solution in steel!

167

12

Stone Veneer on Rails



There's always a solution in steel!

168

12

Key “Take-Aways”

1. The design team needs to develop a strategy for façade attachment and the SER has a role in its development.
2. The current ASCE 7 and IBC have explicit criteria for façade attachments especially for seismic considerations.
3. The façade attachment strategy chosen by the team will affect the design of slab edges and spandrel beams.

There's always a solution in steel! 169

AISC Seminars

2011 Spring Schedule – 6 seminar topics coming to 26 cities

Upcoming Cities for March:
Cleveland, OH - Omaha, NE
Richmond, VA - Buffalo, NY
Harrisburg, PA - Washington DC
Las Vegas, NV - Portland, OR

www.aisc.org/seminars

There's always a solution in steel! 170

AISC Webinars

2nd Thurday of the month

- **April 14, 2011: High Strength Bolting – Geoff Kulak**
- **June 9, 2011: Extended Shear Plate Connections – Larry Muir**
- **July 14, 2011: Design For Stability – Lou Geschwindner**

www.aisc.org/webinars

There's always a solution in steel!

171

AISC eLearning

Over 60 hours of presentations available anytime, online.

CEUs/PDHs are available.

www.aisc.org/elearning

There's always a solution in steel!

172

AISC SteelCamp

2 day, 4 topics, 15 hours of Continuing Education,
One low price.

New York City – June 16-17
San Francisco – July 21-22

www.aisc.org/steelcamp

There's always a solution in steel!

173

Please give us your feedback!

www.aisc.org/cesurvey

Thank You!

There's always a solution in steel!

174