AMERICAN BUILDINGS COMPANY

A NUCOR COMPANY

Presenter:

Jennifer Smith, P.E.

Lead Sales Engineer, ABC-South

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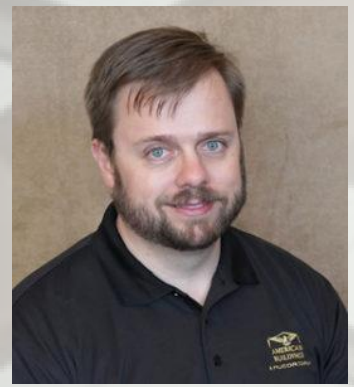
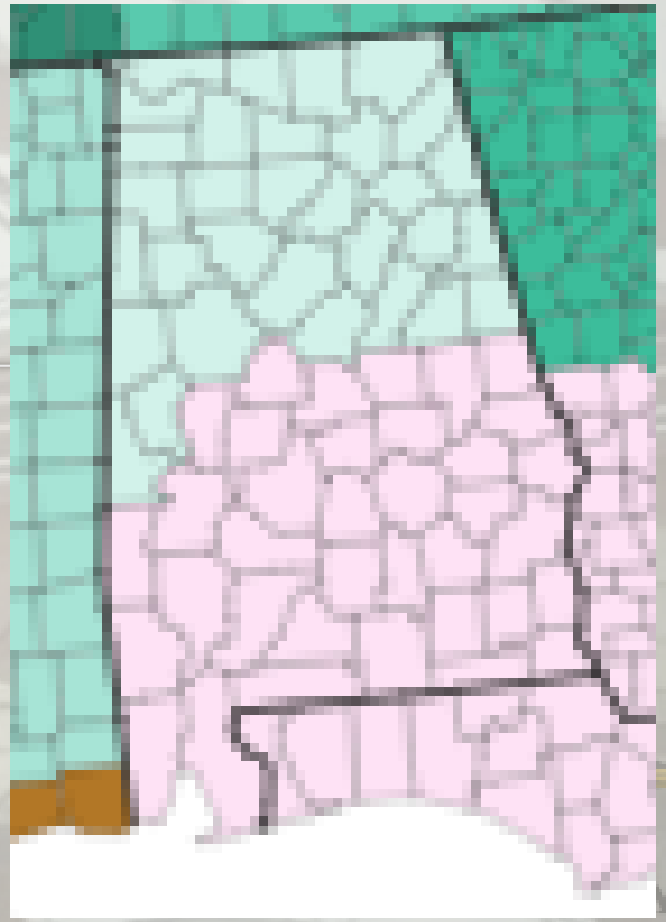


District Sales Managers:

Jason McKee (North AL)

Larry Burkhalter (South AL)



MBMA
METAL BUILDING MANUFACTURERS ASSOCIATION®
Research • Leadership • Education

Intro to Metal Building Systems for Engineers

Topics

- What is a Metal Building System?
- Professional Design Responsibilities
- Specifying a Metal Building System
- Serviceability

Attributes of a Metal Building System

- Custom engineered, Site-specific
- One- and two-story non-residential buildings
- Metal roof - standing seam or through-fastened
- Fast construction
- Wall materials – steel cladding, glass, aluminum, masonry, or concrete
- Energy efficient
- Sustainable
- Flexible
- Economical
- Durable

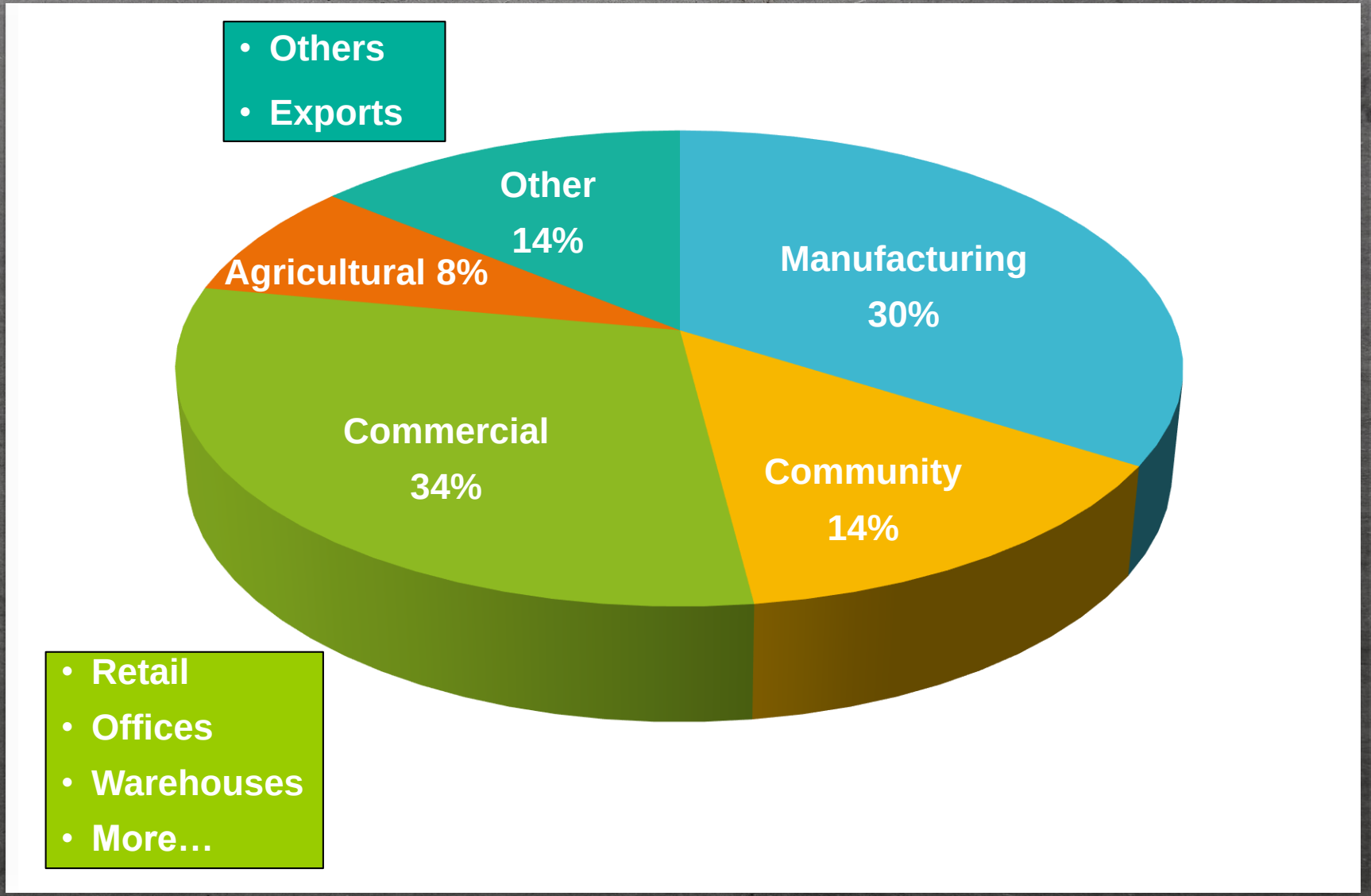
Today's Metal Building Systems:

Uses

- Offices
- Retail Stores
- Shopping Centers
- Auto Show Rooms
- Churches
- Schools
- Recreation Facilities
- Agricultural
- Auto Repair Shops
- Aircraft Hangars
- Distribution Centers
- Factories
- Warehouses
- Military

Percent of Buildings

By Dollars ($)

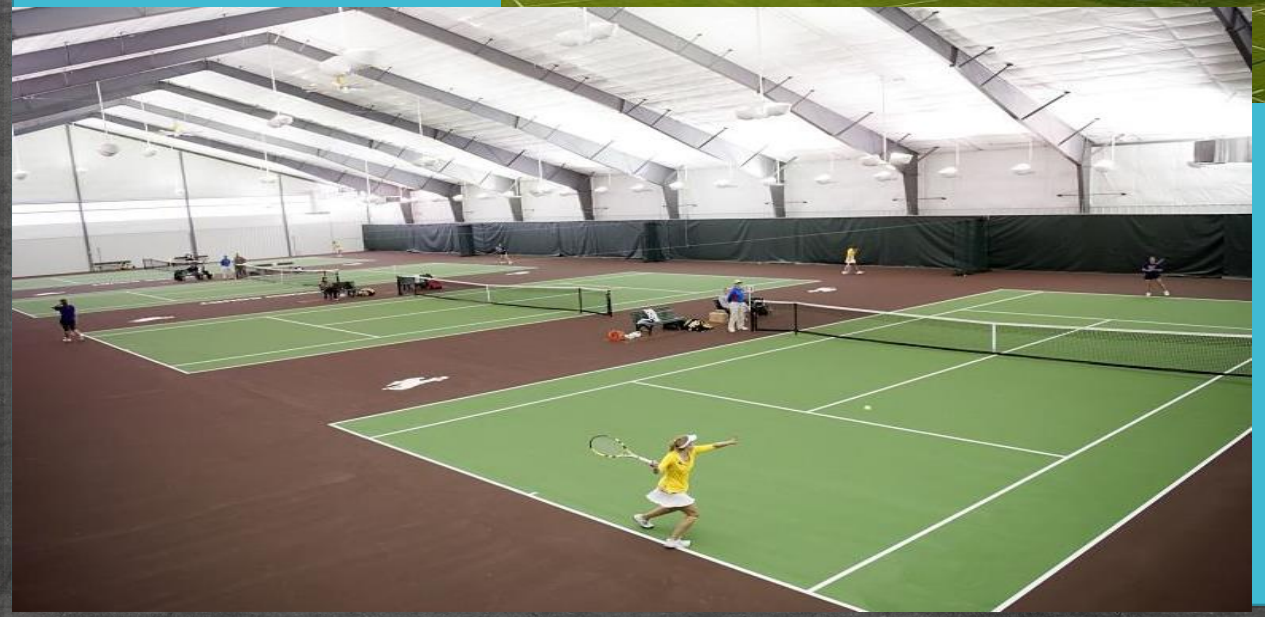


Today's Metal Building Systems:

Manufacturing/ Distribution

Today's Metal Building Systems:

Recreational



Today's Metal Building Systems:

Schools

Today's Metal Building Systems:

Churches

Today's Metal Building Systems:

Aircraft Hangars

Today's Metal Building Systems:

Community

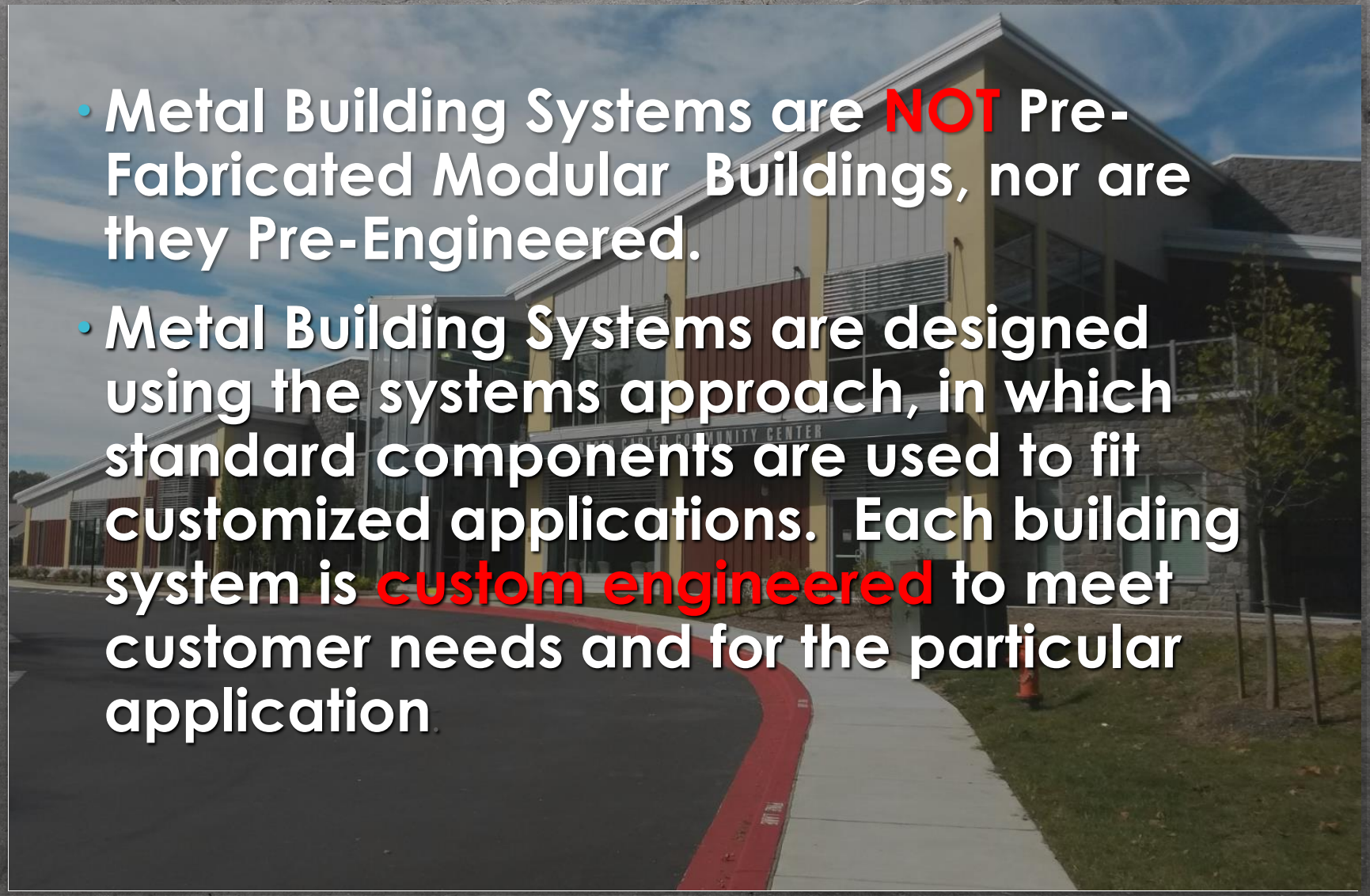
Today's Metal Building Systems:

Offices

Today's Metal Building Systems:

Retail

Misconception: *"Metal Buildings are Pre-Engineered"*

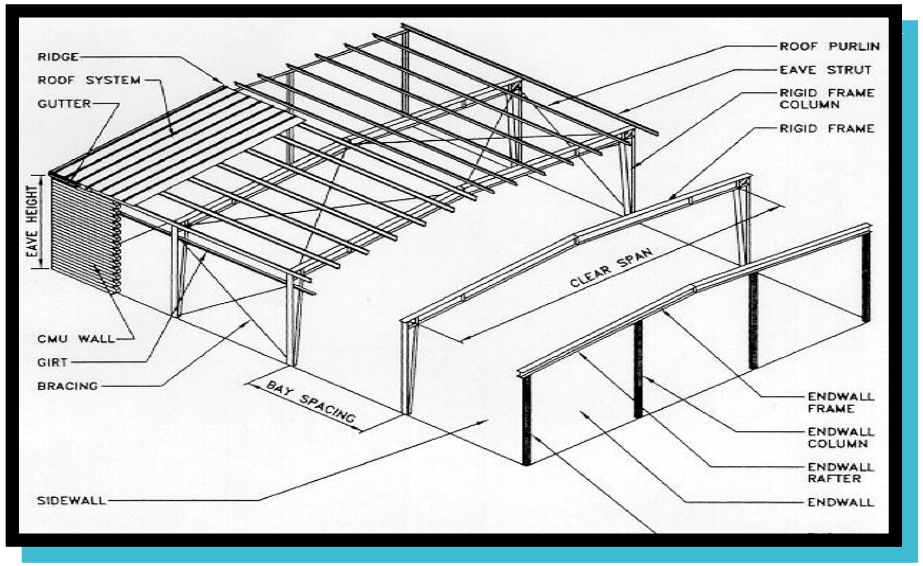


- Metal Building Systems are **NOT** Pre-Fabricated Modular Buildings, nor are they Pre-Engineered.
- Metal Building Systems are designed using the systems approach, in which standard components are used to fit customized applications. Each building system is **custom engineered** to meet customer needs and for the particular application.

What is a Metal Building?

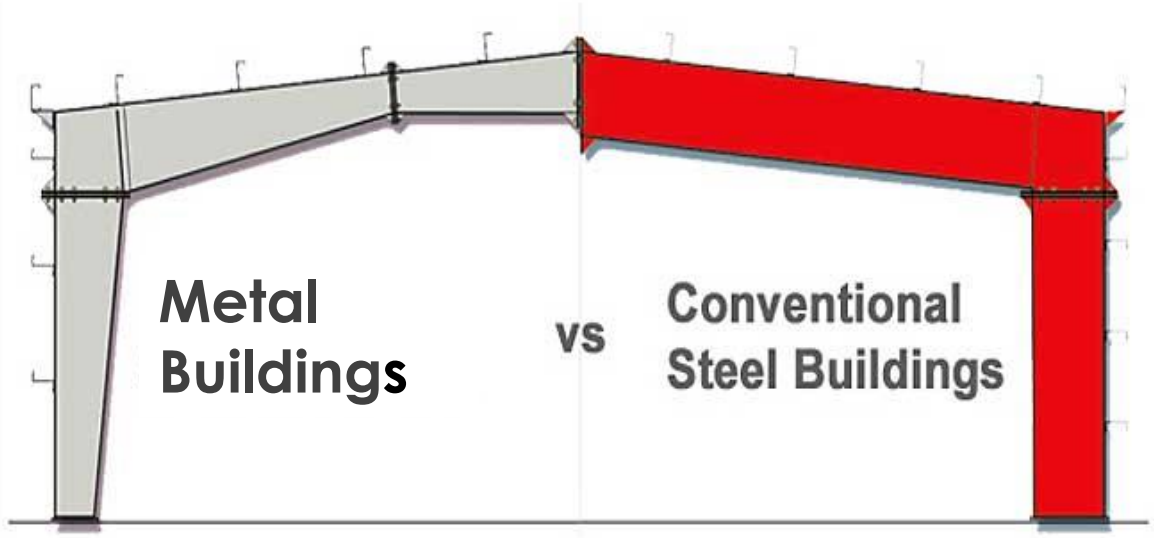
Metal Building Components

- Primary Frames
- Secondary Framing
  - Purlins
  - Girts
- Cladding
  - Metal Roof Sheeting
  - Wall Sheeting or Finish
- End Wall Beams and Columns
- Bracing
  - Lateral Bracing
  - Stability Bracing
- Connections
- Screws and Bolts
- Non-Structural Parts



Primary Frames

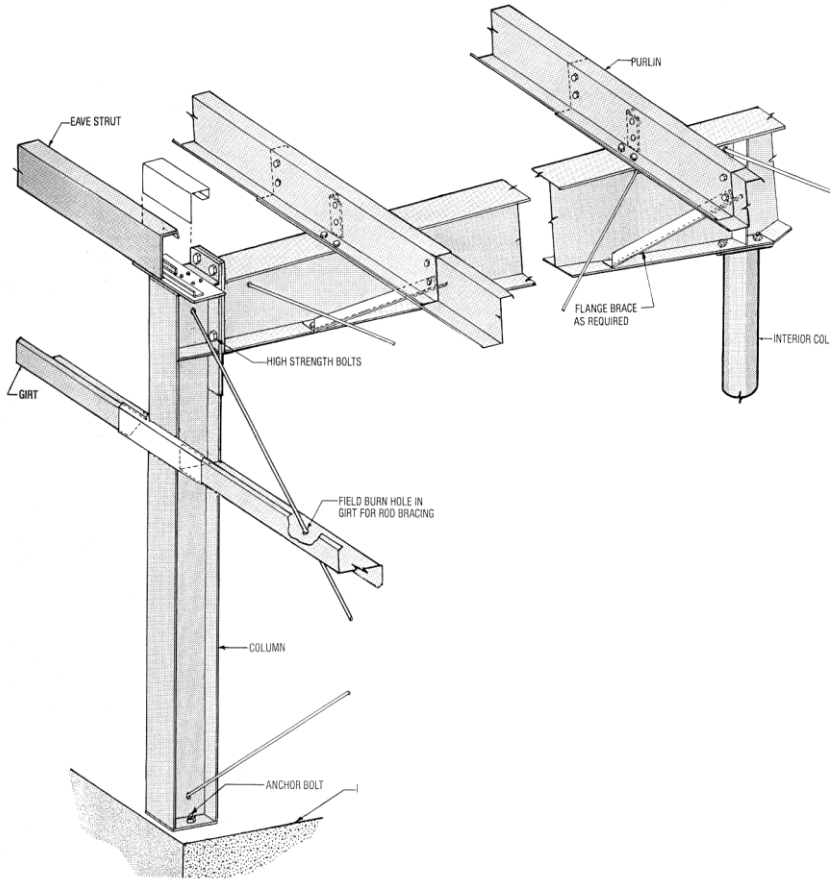
- Tapered
- Built-Up
- Bolted End-Plates



Metal Buildings are a more efficient use of steel, and can be 30% lighter than conventional steel buildings

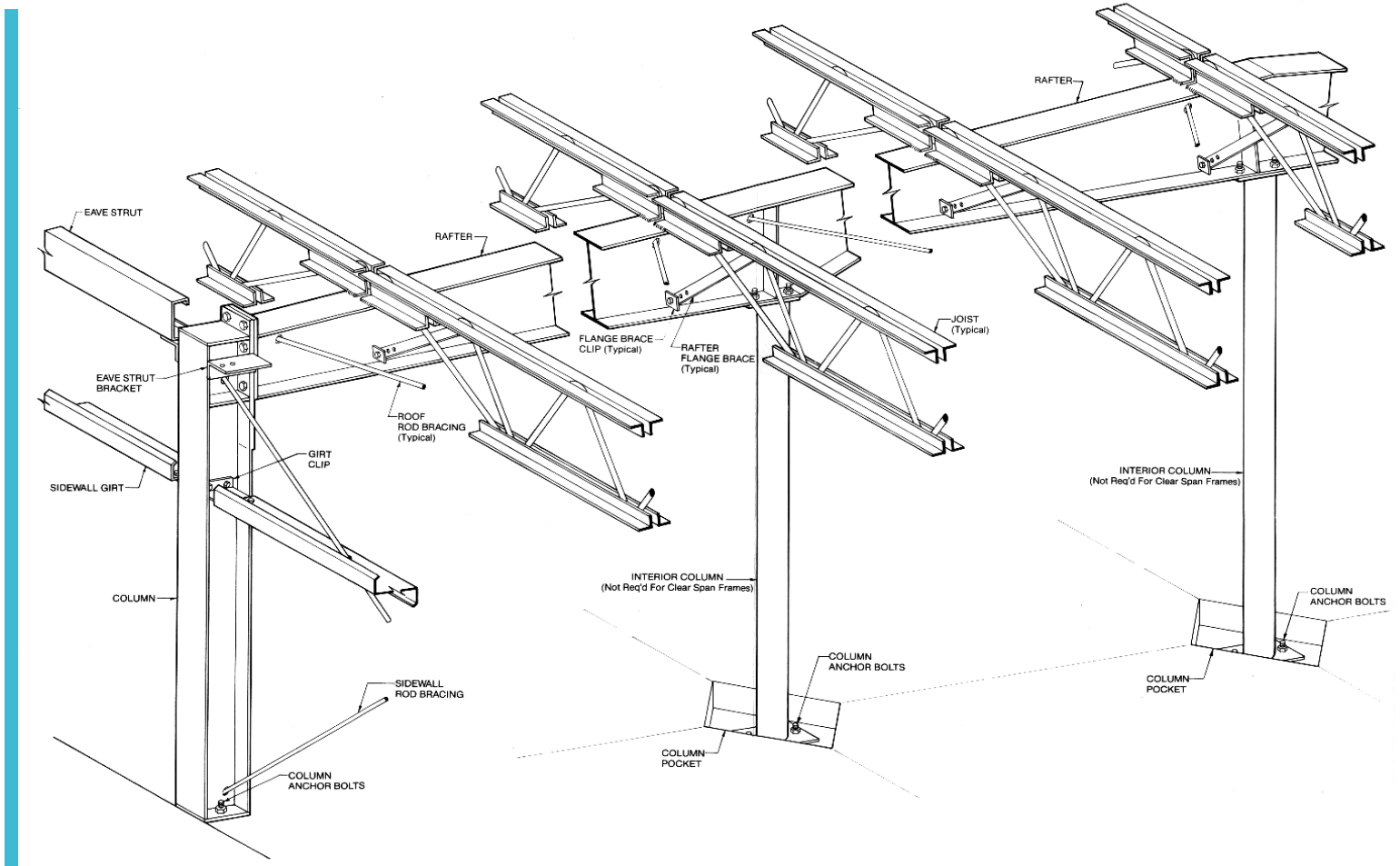
Secondary Members

- Roof
  - Z purlins
  - Bar Joists
- Wall
  - Z girts



Secondary Members

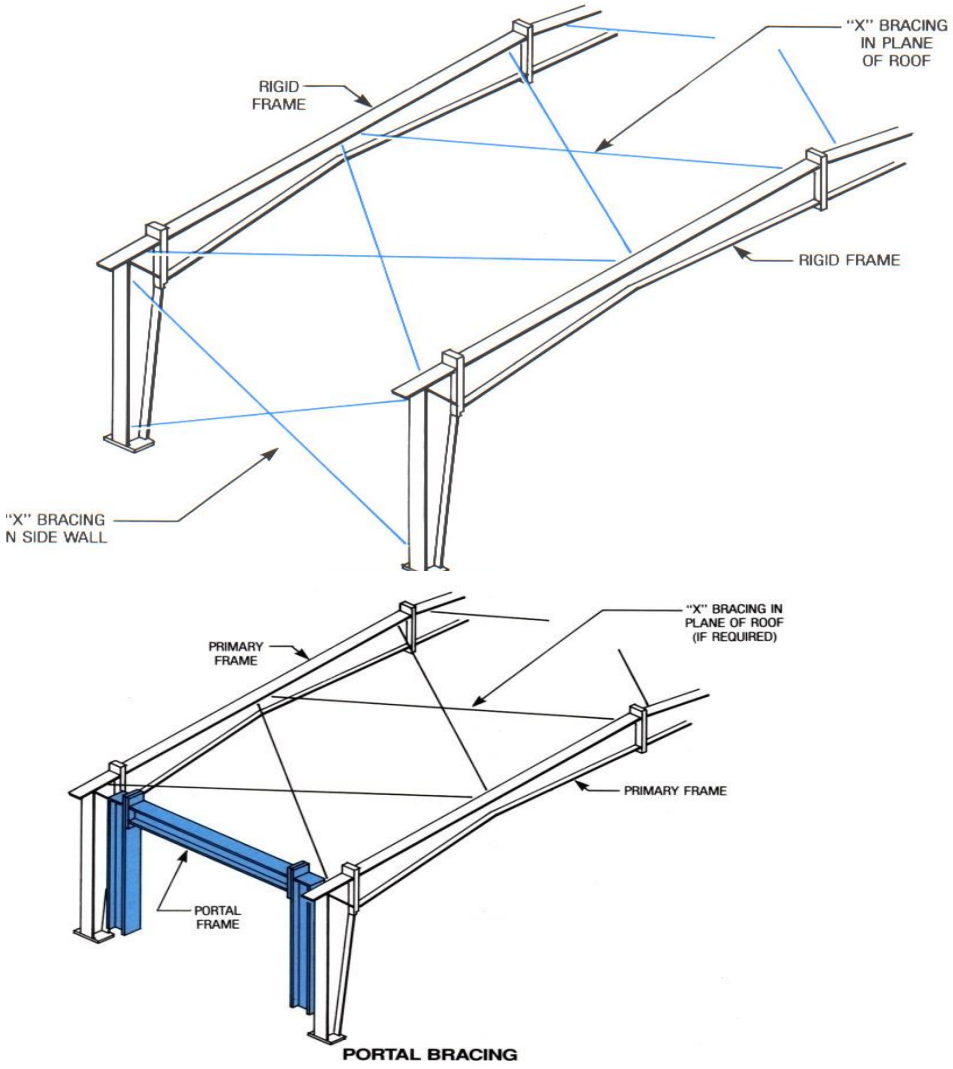
Bar Joists



Bracing:

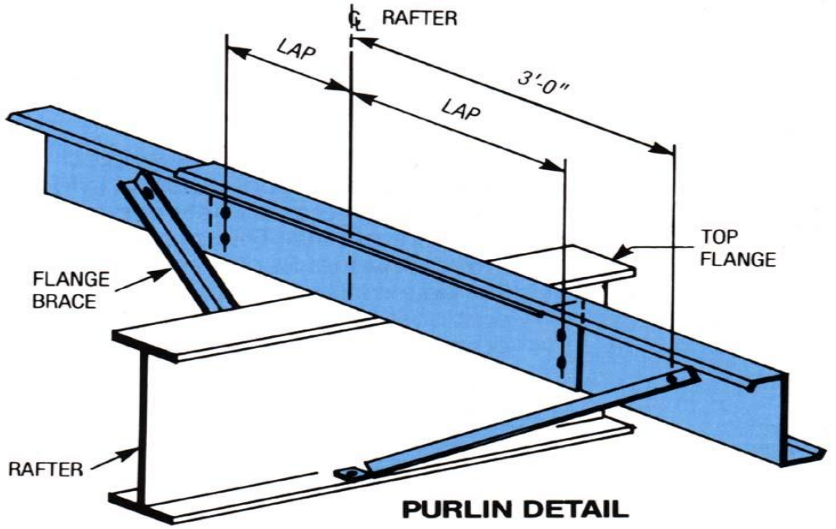
Longitudinal Lateral Bracing

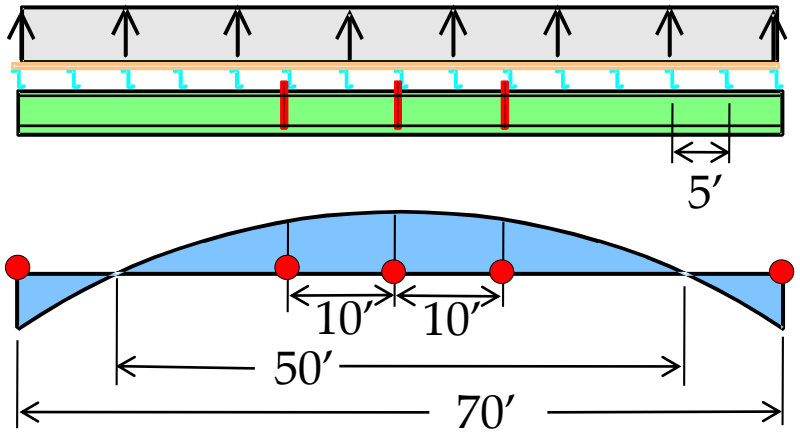
- Rods
- Cables
- Portal Frames

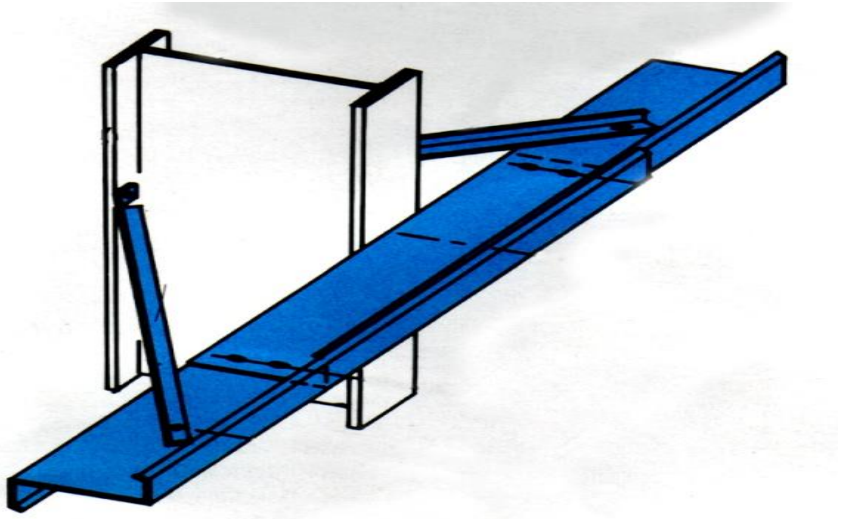


Member Bracing

- Stability Bracing
  - Flange Braces
- Critical to Unbraced Length Assumption

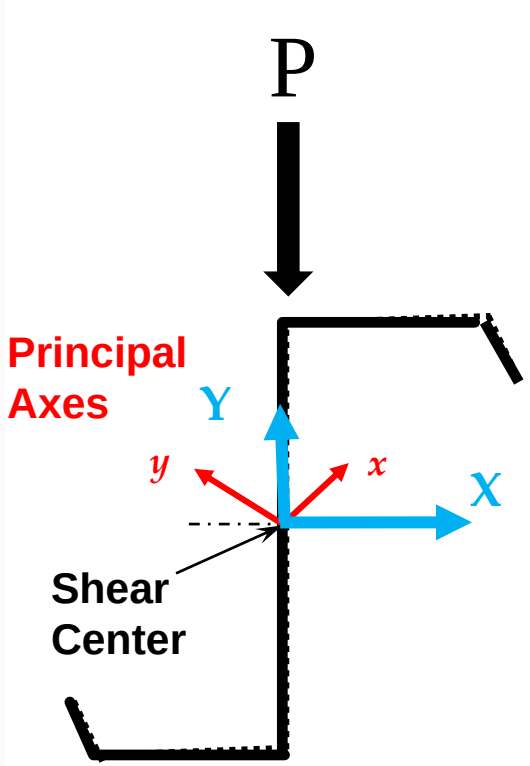


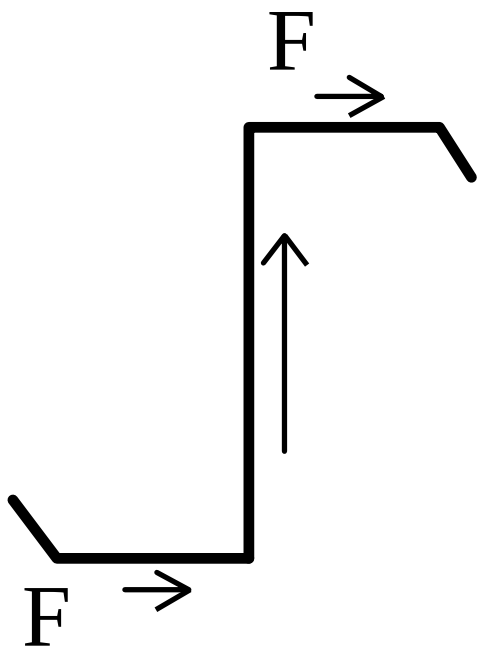


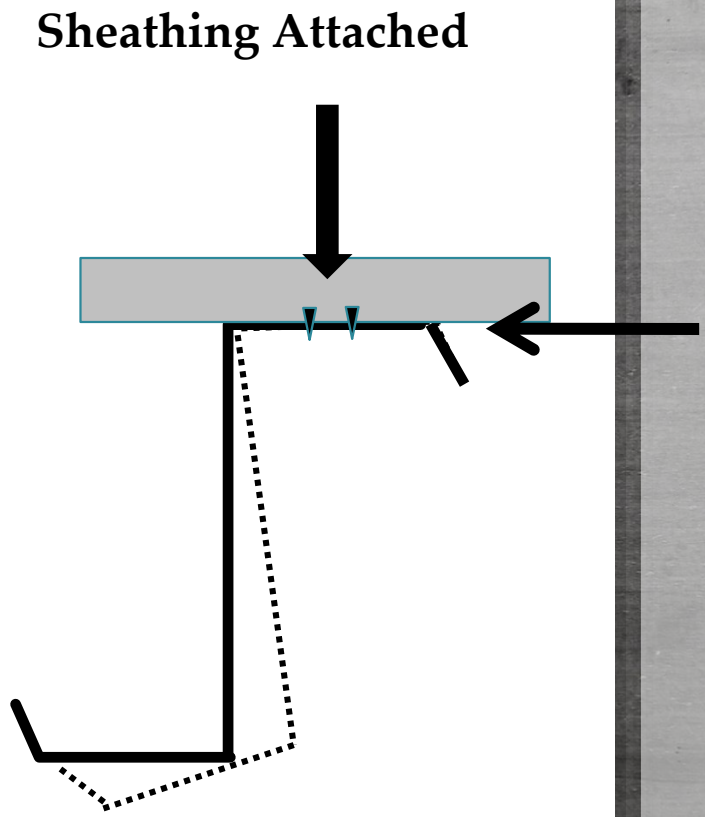


Z Purlin Behavior

Shear Center Axes





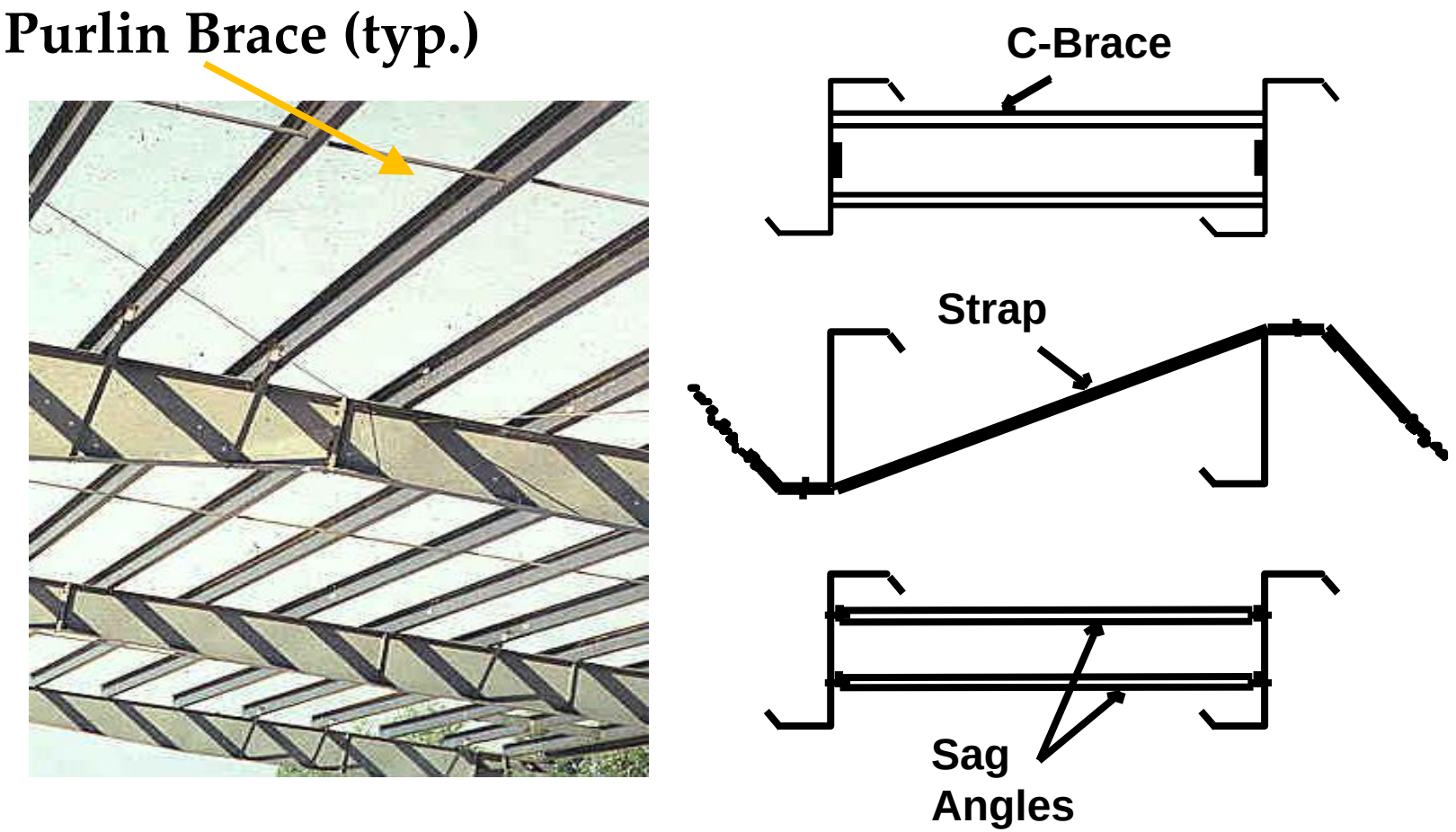


$$F = \frac{P}{2}\left(\frac{I_{xy}}{I_x}\right)$$

$$\frac{I_{xy}}{I_x} = 0.25 \leftrightarrow 0.30$$

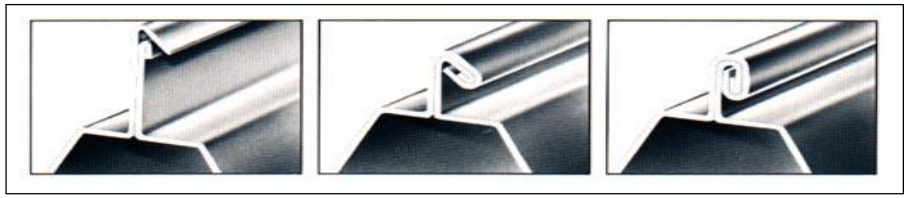
Bracing:

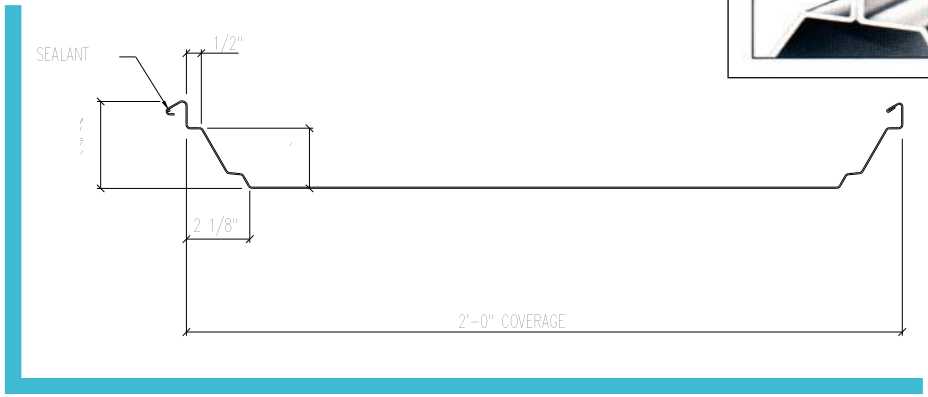
Purlin Anchorage

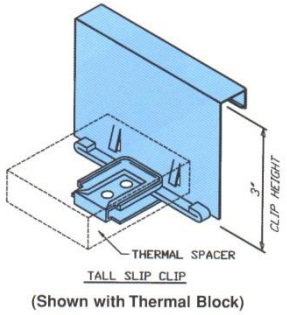


Metal Roof Systems:

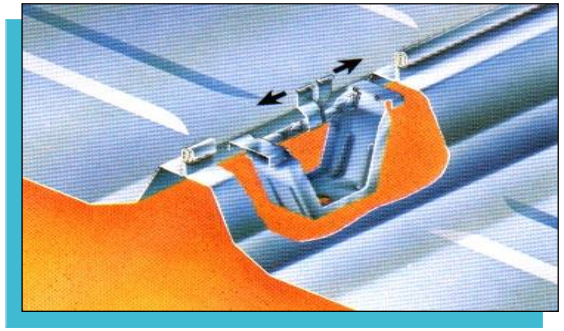
Standing Seam

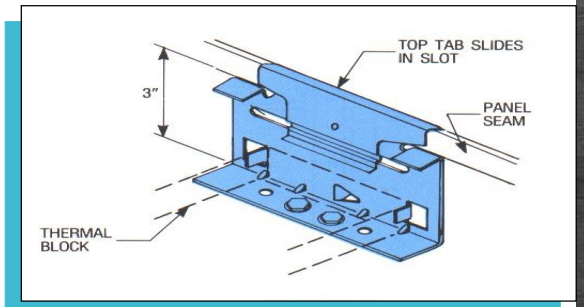






Fixed Clip

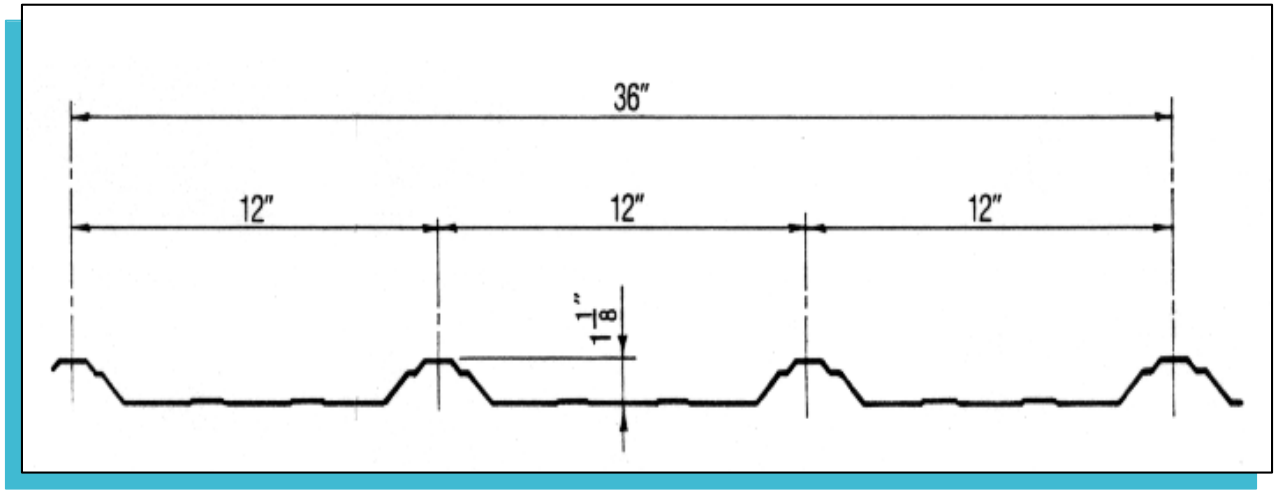


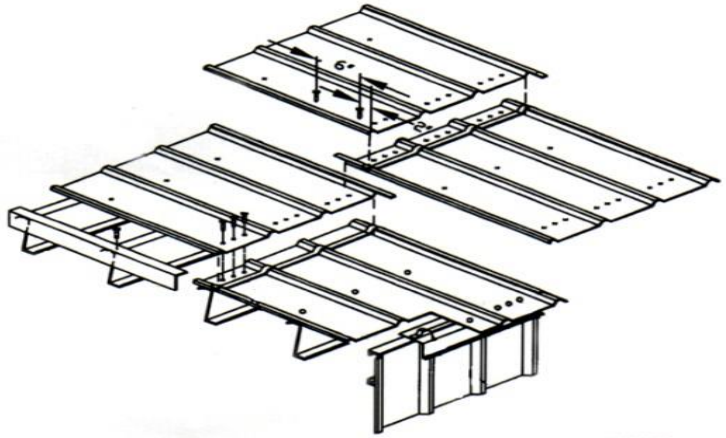


Sliding Clips

Metal Roof Systems:

Through-Fastened

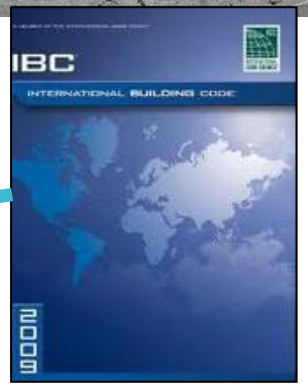


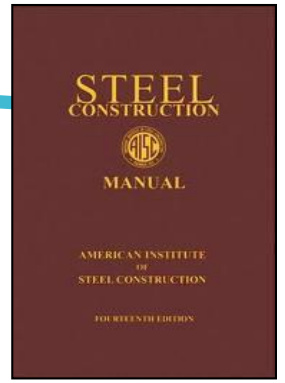


Design:

Standards & Codes

- IBC
  - Adopted Legal Document
- ASCE 7
  - Minimum Loads
- AISC 360
  - Design of Primary Frames
- AISI S100
  - Design of Secondary Members





Professional Design Responsibilities

Shared Design Responsibility

EOR and MB Manufacturer

Players and Their Roles

- Owner - End Customer of the project
- Design Professional - an architect or engineer, retained by the owner or builder, to assist with preparation of design specifications, foundation design, and/or design and interface of components not provided by manufacturer
- Builder - serves as contractor (many are design-build firms), orders and purchases the metal building system from manufacturer
- Manufacturer - designs and fabricates the metal building system

EOR Responsibilities

- Prepare complete specifications
- Provide builder with the following:
  - Geometric requirements
  - Applicable codes and/or design loads
  - Site and construction conditions that affect design criteria
  - Serviceability criteria, especially for compatibility of materials not supplied by building manufacturer
  - Foundation Design
  - Design of Components not Supplied by Metal Building Manufacturer

Manufacturer's Responsibility

- Design of Metal Building System
  - Seals and Signs Drawings for Supplied Steel Framing
- Not Engineer of Record
- Provide Evidence of Compliance/Deliverables

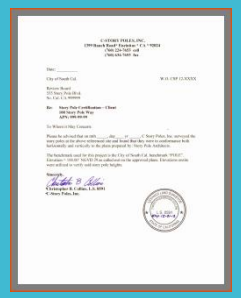
  (As Specified in the Order Documents)
  - Approval Documents
  - Engineering Data
  - Plans

Approval Documents

- Approval Required to Proceed with Fabrication Drawings
- Reviewed and Approved by Builder/Owner (EOR)
- May Include:
  - Plans
  - Design Calculations
  - Other Specified Information

Engineering Data:

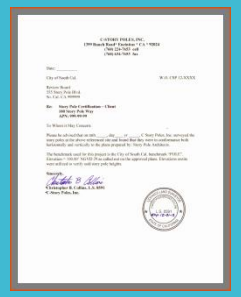
Letter of Design Certification



- Sealed by Manufacturer's PE
- Includes the following:
  - Order Number
  - Design Criteria (Including Design standards, loads, and other design information supplied to manufacturer
  - Certifies structural design complies with the requirements of the Order Documents

Engineering Data:

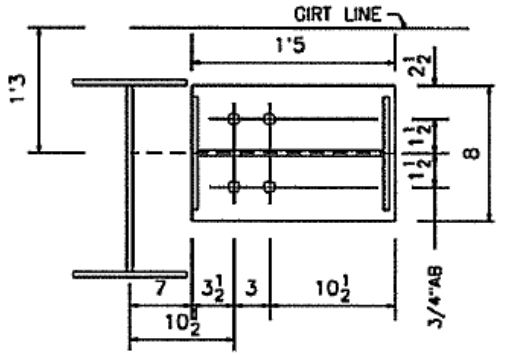
Design Calculations



- Sealed by Manufacturer's PE
- Structural Design Data
  - Magnitude and location of design loads
  - Support conditions
  - Material properties
  - Type and size of major structural members
  - May be manually or computer generated
- Other As Specified on Order Documents

Plans

- Anchor Bolt Plans
- Erection Drawings
- Fabrication Drawings Not Furnished



BP04–A
3/8 PLATE

Construction Specifier - Dec 2004

The Specification and Design of a Metal Building System

by W. Lee Shoemaker, PE, Ph.D.

Metal building systems have many functional advantages, ranging from durability and energy efficiency, to longevity and sustainability (see Green Steel, page 38). When a project calls for a metal building system, responsibilities may be divided between the manufacturer and the design professional. Therefore, coordination and communication are crucial for success, and this begins with the specifications.

As with any component or system, a clear and accurate metal specification ensures the builders/manufacturers bidding on the project understand and interpret the requirements similarly. A proper specification also ensures the building performs satisfactorily and meets the owner's requirements.

A typical construction project involving a metal building system begins with the contract arrangements. The contractual parties may include:

- the design professional (i.e. architect/engineer [A/E] of record);
- the owner;
- the general contractor (GC) for the project;
- the subcontractor responsible for erecting the metal components;
- the builder who prepares the order documents and purchases the metal building system; and
- the manufacturer.

Depending on the construction project, certain parties may perform more than one function (e.g. the builder may commonly perform the functions of the GC).

In the sale of most metal building systems, there are at least two independent written agreements—the building order documents and the contract documents. The former is normally required in the course of entering and processing the order for the metal building system, while the latter (including the drawings and specifications) defines the material and work to be provided by the contractor for the total construction project. The manufacturer typically reviews the order documents, while the design professional often evaluates the contract documents to ensure the specifications and drawings have been properly interpreted.

Specifying a Metal Building System

What to Specify

- Governing building code, including edition
- Design loads to be used
- HVAC equipment
- Structural scheme
- Building dimensions
- Exterior wall materials
- Locations where wall bracing is to be avoided
- Corrosion protection requirements
- Restrictions to frame size
- Lateral drift and vertical deflection criteria
- Crane requirements
- Design requirements of insurance provider
- IAS AC472 Accreditation

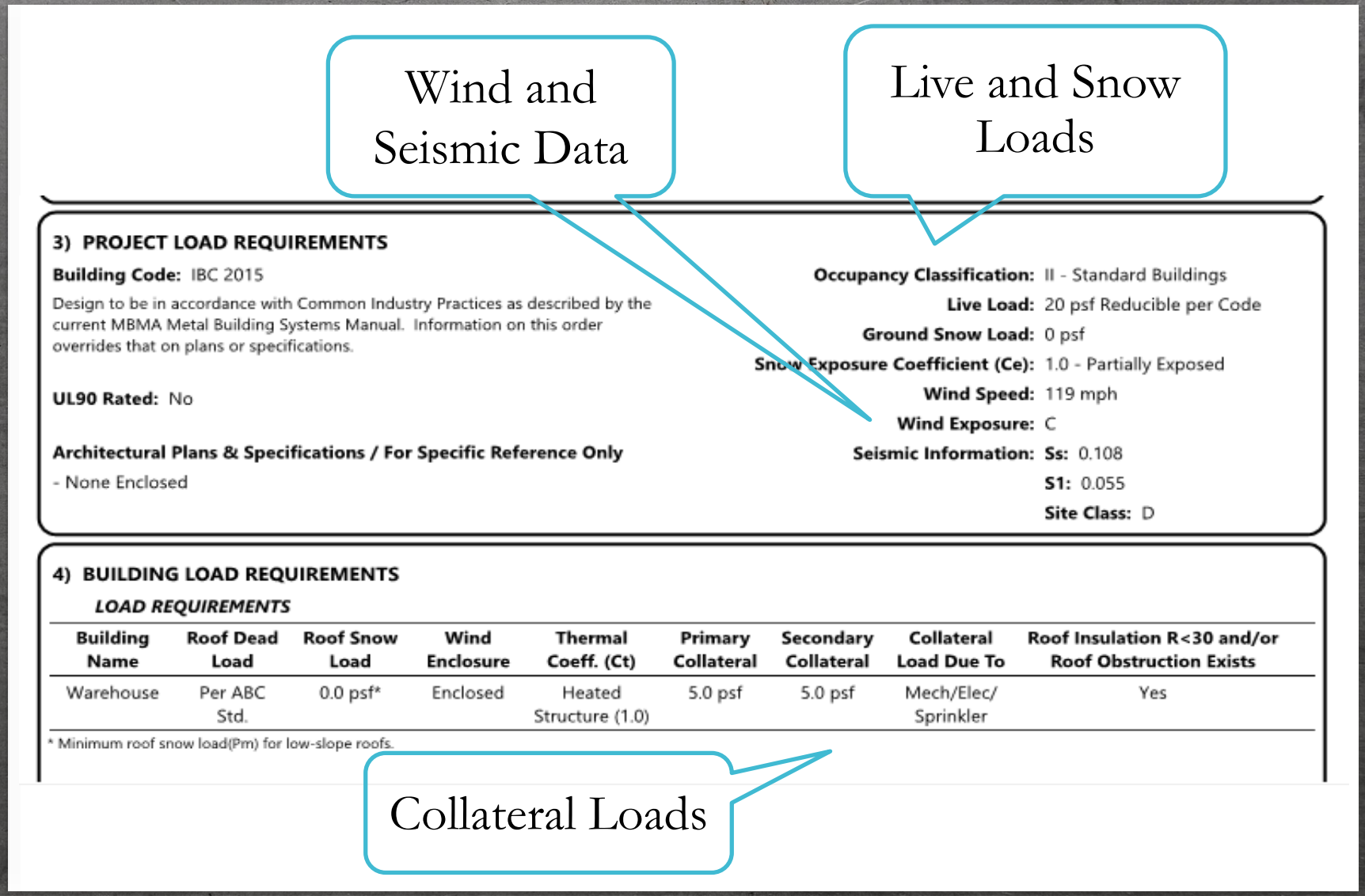
Don’t forget roof live loads…or is it a second floor?

Design Criteria and Loads

What information should be specified in the contract documents?

- Metal Buildings are required to comply with all locally adopted building codes
- Wind, Seismic, Snow, Live loads
- Local jurisdiction may have modified loads
- Usually provided via form sent from builder or salesman to manufacturer
- Solar Panels? Metal Roofs are excellent mounting surface but collateral loads need to be included (~ 2 psf)
- Manufacturers typically seek clarification for any load that seems odd or not in accordance with code

Design Loads



Wind and Seismic Data

Live and Snow Loads

3) PROJECT LOAD REQUIREMENTS

Building Code: IBC 2015

Design to be in accordance with Common Industry Practices as described by the current MBMA Metal Building Systems Manual. Information on this order overrides that on plans or specifications.

UL90 Rated: No

Architectural Plans & Specifications / For Specific Reference Only

- None Enclosed

Occupancy Classification: II - Standard Buildings
Live Load: 20 psf Reducible per Code
Ground Snow Load: 0 psf
Snow Exposure Coefficient (Ce): 1.0 - Partially Exposed
Wind Speed: 119 mph
Wind Exposure: C
Seismic Information: **Ss:** 0.108
S1: 0.055
Site Class: D

4) BUILDING LOAD REQUIREMENTS

LOAD REQUIREMENTS

Building Name	Roof Dead Load	Roof Snow Load	Wind Enclosure	Thermal Coeff. (Ct)	Primary Collateral	Secondary Collateral	Collateral Load Due To	Roof Insulation R<30 and/or Roof Obstruction Exists
Warehouse	Per ABC Std.	0.0 psf*	Enclosed	Heated Structure (1.0)	5.0 psf	5.0 psf	Mech/Elec/ Sprinkler	Yes

* Minimum roof snow load(Pm) for low-slope roofs.

Collateral Loads

Serviceability

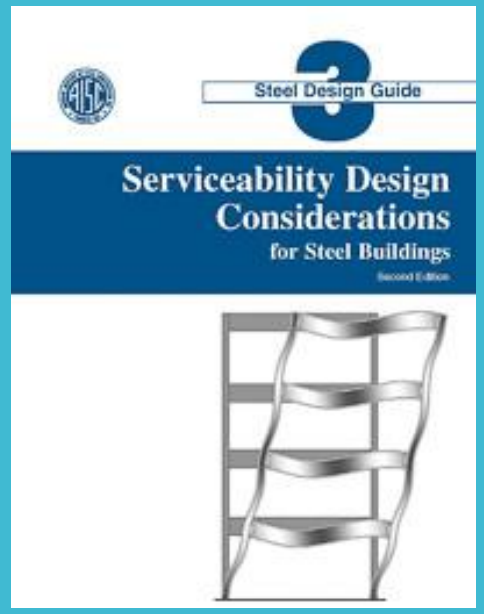
Standard Deflection Criteria

DEFLECTION REQUIREMENTS (Serviceability Criteria)

Building Name	Purlin / Joist Deflection		Main Frame Deflection		Girt Deflection		Main Frame Sidesway	
	General	Ceiling	General	Ceiling	Steel Panel	Reinf. Masonry	Steel Panel	Reinf. Masonry
Warehouse	L/150 Std.	N/A	L/180 Std.	N/A	L/90 Std.	N/A	H/100	H/100 Std.

"Other" Deflection Requirements: (See Special Requirements)

EOR Deflection Criteria



Serviceability

Building Code Requirements

- Strength – buildings shall be designed and constructed to safely support the loads
- Serviceability – structural systems shall be designed to have adequate stiffness to limit deflections and lateral drift
- Meet any material specification serviceability requirements (i.e. AISC, AISI, ACI)

Serviceability:

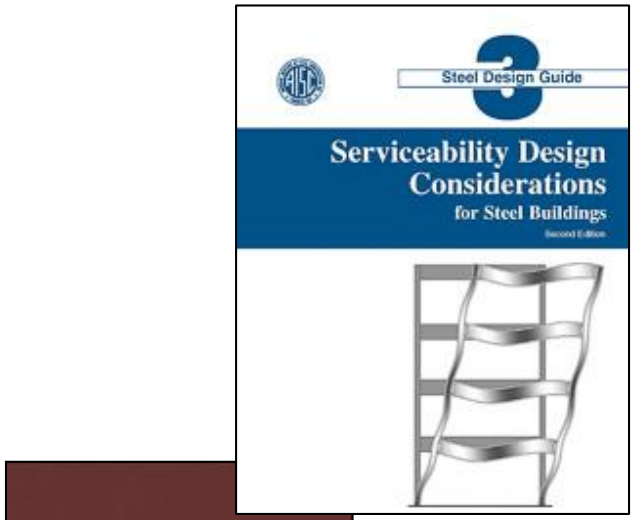
Who Specifies?

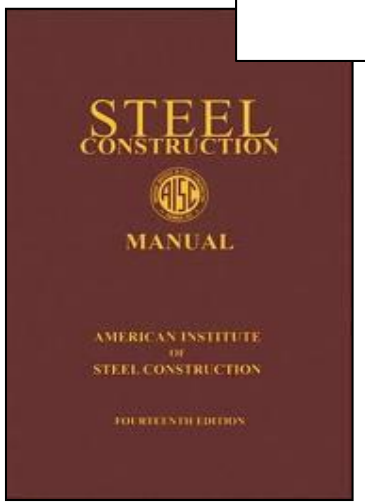
- End Customer hires design professional
  - Design professional is responsible for serviceability criteria for project
- End Customer does not hire design professional
  - End Customer is responsible for serviceability criteria for project
- Builder responsibility
  - Interpret and incorporate End Customer's serviceability criteria into the Order Documents submitted to Manufacturer

AISC Specification:

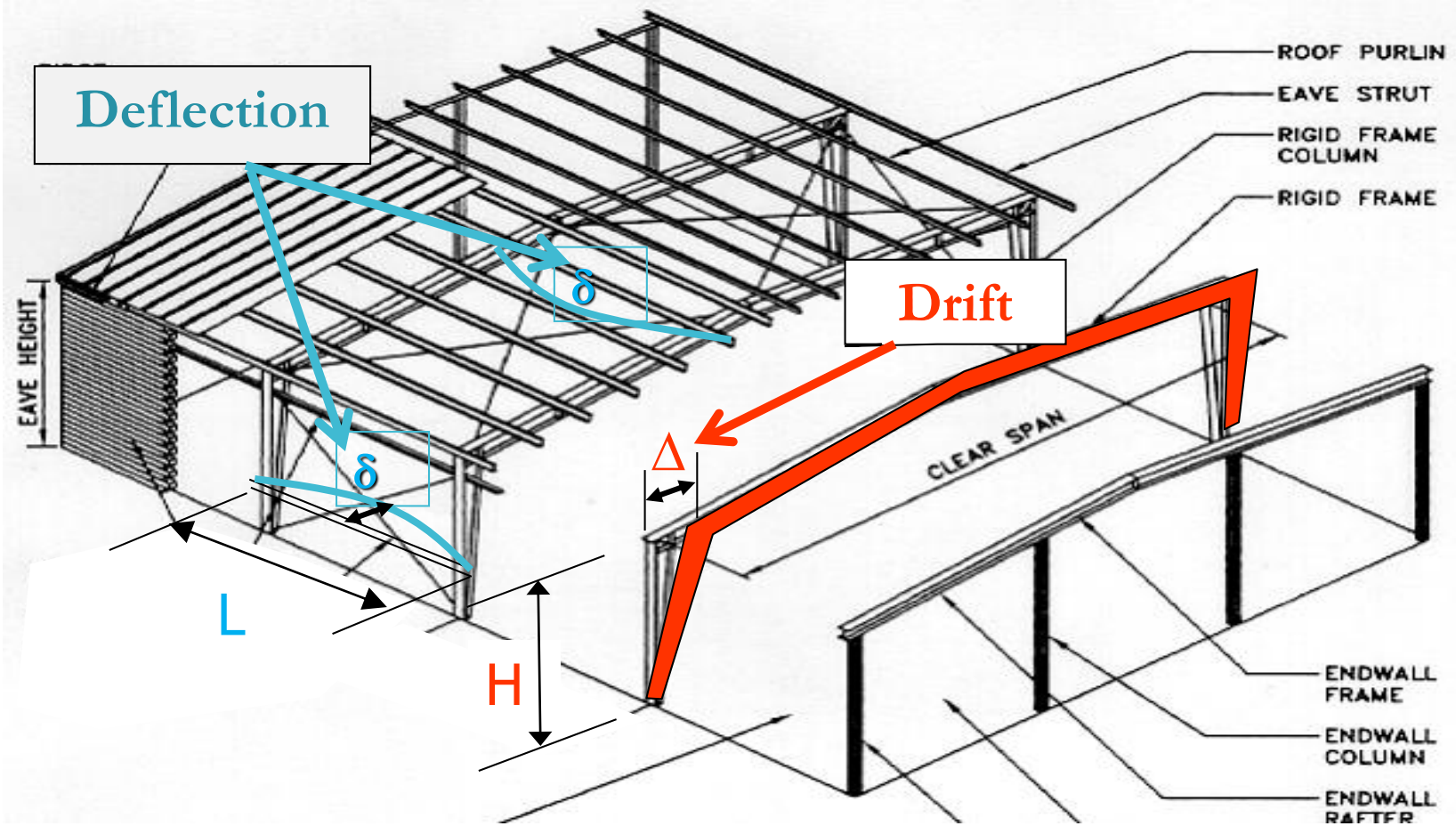
Chapter L - Serviceability

- Camber
- Deflections
- Drift
- Vibration
- Wind-Induced Motion
- Expansion and Contraction
- Connection Slip
- Corrosion





Deflection vs. Drift



IBC:

Deflection Limits

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

a. For structural roofing and siding made of formed metal sheets, the total load deflection shall not exceed *l*/60. For secondary roof structural members supporting formed metal roofing, the live load deflection shall not exceed *l*/150. For secondary wall members supporting formed metal siding, the design wind load deflection shall not exceed *l*/90. For roofs, this exception only applies when the metal sheets have no roof covering.

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.

AISC Design Guide No. 3:

Drift Limits

WALL CLADDING	RECOMMENDATION	LOADING
METAL PANELS / BARE FRAME	*H* / 60 TO *H*/ 100 (MAXIMUM)	10 YEAR WIND
PRECAST WALLS / BARE FRAME	*H* / 100 (MAXIMUM)	10 YEAR WIND
UNREINFORCED MASONRY WALLS / BARE FRAME	1 / 16 IN. CRACK (BASE OF WALL)	10 YEAR WIND
REINFORCED MASONRY WALLS / BARE FRAME	*H* / 200 (MAXIMUM)	10 YEAR WIND

Metal Building Systems Manual:

Deflection Limits

Table 1.3.1(b): Deflection Limits[a,b,c,h,i]

(Limits and footnotes are from IBC 2012 Table 1604.3)

Construction	Load		
	Live	Snow or Wind[f]	Dead + Live[d,g]
Roof Members:[e]			
Supporting plaster ceiling	L/360	L/360	L/240
Supporting non-plaster ceiling	L/240	L/240	L/180
Not supporting ceiling	L/180	L/180	L/120
Roof members supporting metal roofing:	L/150	---	---
Structural Metal Roof and Siding Panels[a]	---	---	L/60
Floor members	L/360	---	L/240
Exterior walls and interior partitions:			
With brittle finishes	---	L/240	---
With flexible finishes	---	L/120	---
Wall members supporting metal siding:	---	L/90	---
Farm buildings	---	---	L/180
Greenhouses	---	---	L/120

Thank You!