Presenter:
Jennifer Smith, P.E.
Lead Sales Engineer, ABC-South
District Sales Managers:

Jason McKee (North AL)

Larry Burkhalter (South AL)
Intro to Metal Building Systems for Engineers
• 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 ($)

- Manufacturing 30%
- Commercial 34%
- Community 14%
- Agricultural 8%
- Other 14%
- Others
- Exports
- Retail
- Offices
- Warehouses
- More…
Today’s Metal Building Systems: Manufacturing/Distribution
Today’s Metal Building Systems: Recreational
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?

An integrated set of components and assemblies, including but not limited to frames that are built-up structural steel members, secondary members that are cold-formed steel or steel joists.
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:
- Rods
- Cables
- Portal Frames
Member Bracing

- Stability Bracing
- Flange Braces
- Critical to Unbraced Length Assumption
Z Purlin Behavior

Shear Center Axes

Principal Axes

Sheathing Attached

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

\[ \frac{I_{xy}}{I_x} = 0.25 \leftrightarrow 0.30 \]
Bracing:

Purlin Anchorage

Purlin Brace (typ.)

C-Brace

Strap

Sag Angles
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
• 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 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
Specifying a Metal Building System

Metal building systems have many functional advantages, including their durability and energy efficiency, as well as attractive and cost-effective design options (see Green Fleet, page 38). When a project calls for a metal building system, responsibility may be shared between the manufacturer and the design professional. Therefore, specification and communication are essential for success, and this begins with the specifications.

As with any engineering or design, a clear and accurate specification serves as both a foundation and a roadmap for the construction process. A proper specification also serves as the building economy, reliability, and maintenance underpinning. A typical construction project involving a metal building specification includes the following participants:

- The architect
- The design professional (of record)
- The contractor
- The contractor
- The general contractor (if the project is being built)

The architect is responsible for ensuring the metal component is compatible with the overall design and will work closely with the manufacturer to ensure that the requirements are met. The design professional is responsible for preparing the contract documents and the construction documents. The contractor is responsible for the actual construction process and is required to construct the building as designed and specified. The general contractor is responsible for the overall management of the project and is responsible for ensuring that the contract documents are accurate and that the project is completed on time and within budget.

Regardless of the construction process, effective project management requires the application of best practices. The following tips can help ensure success:

- Clearly define the scope of work:
- Establish a clear communication plan:
- Establish a quality assurance program:
- Establish a construction schedule:
- Ensure that all participants are aware of their responsibilities:
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- Ensure that all participants are aware of their responsibilities:

By following these best practices, you can ensure that your metal building project is completed on time, within budget, and to the satisfaction of all stakeholders.
<table>
<thead>
<tr>
<th>What to Specify</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Governing building code, including edition</td>
</tr>
<tr>
<td>• Design loads to be used</td>
</tr>
<tr>
<td>• HVAC equipment</td>
</tr>
<tr>
<td>• Structural scheme</td>
</tr>
<tr>
<td>• Building dimensions</td>
</tr>
<tr>
<td>• Exterior wall materials</td>
</tr>
<tr>
<td>• Locations where wall bracing is to be avoided</td>
</tr>
<tr>
<td>• Corrosion protection requirements</td>
</tr>
<tr>
<td>• Restrictions to frame size</td>
</tr>
<tr>
<td>• Lateral drift and vertical deflection criteria</td>
</tr>
<tr>
<td>• Crane requirements</td>
</tr>
<tr>
<td>• Design requirements of insurance provider</td>
</tr>
<tr>
<td>• IAS AC472 Accreditation</td>
</tr>
</tbody>
</table>
Don’t forget roof live loads...or is it a second floor?
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

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

Wind and Seismic Data

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: Sa: 0.108
- Site Class: D

Live and Snow Loads

4) BUILDING LOAD REQUIREMENTS
LOAD REQUIREMENTS

<table>
<thead>
<tr>
<th>Building Name</th>
<th>Roof Dead Load</th>
<th>Roof Snow Load</th>
<th>Wind Exposure</th>
<th>Thermal Coeff. (CI)</th>
<th>Primary Collateral</th>
<th>Secondary Collateral</th>
<th>Collateral Load Due To</th>
<th>Roof Insulation R&lt;30 and/or Roof Obstruction Exists</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warehouse</td>
<td>Per ABC Std.</td>
<td>0.0 psf*</td>
<td>Enclosed</td>
<td>Heated Structure (1.0)</td>
<td>5.0 psf</td>
<td>5.0 psf</td>
<td>Mech/Elec/ Sprinkler</td>
<td>Yes</td>
</tr>
</tbody>
</table>

* Minimum roof snow load per psf for low slope roofs.
## Deflection Requirements (Serviceability Criteria)

<table>
<thead>
<tr>
<th>Building Name</th>
<th>Purlin / Joist Deflection</th>
<th>Main Frame Deflection</th>
<th>Girt Deflection</th>
<th>Main Frame Sidesway</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General</td>
<td>Ceiling</td>
<td>General</td>
<td>Ceiling</td>
</tr>
<tr>
<td>Warehouse</td>
<td>L/150 Std.</td>
<td>N/A</td>
<td>L/180 Std.</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*"Other" Deflection Requirements: (See Special Requirements)*

**Standard Deflection Criteria**

**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
# TABLE 1604.3
DEFLECTION LIMITS

<table>
<thead>
<tr>
<th>Construction</th>
<th>L</th>
<th>S or W’</th>
<th>D + L’+l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof members:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supporting plaster or stucco ceiling</td>
<td>1/360</td>
<td>1/360</td>
<td>1/240</td>
</tr>
<tr>
<td>Supporting nonplaster ceiling</td>
<td>1/240</td>
<td>1/240</td>
<td>1/180</td>
</tr>
<tr>
<td>Not supporting ceiling</td>
<td>1/180</td>
<td>1/180</td>
<td>1/120</td>
</tr>
<tr>
<td>Floor members</td>
<td>1/360</td>
<td>—</td>
<td>1/240</td>
</tr>
<tr>
<td>Exterior walls:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With plaster or stucco finishes</td>
<td>—</td>
<td>1/360</td>
<td>—</td>
</tr>
<tr>
<td>With other brittle finishes</td>
<td>—</td>
<td>1/240</td>
<td>—</td>
</tr>
<tr>
<td>With flexible finishes</td>
<td>—</td>
<td>1/120</td>
<td>—</td>
</tr>
<tr>
<td>Interior partitions:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With plaster or stucco finishes</td>
<td>1/360</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>With other brittle finishes</td>
<td>1/240</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>With flexible finishes</td>
<td>1/120</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Farm buildings</td>
<td>—</td>
<td>—</td>
<td>1/180</td>
</tr>
<tr>
<td>Greenhouses</td>
<td>—</td>
<td>—</td>
<td>1/120</td>
</tr>
</tbody>
</table>

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a. For structural roofing and siding made of formed metal sheets, the total load deflection shall not exceed 1/60. For secondary roof structural members supporting formed metal roofing, the live load deflection shall not exceed 1/150. For secondary wall members supporting formed metal siding, the design wind load deflection shall not exceed 1/90. 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.
## Drift Limits

<table>
<thead>
<tr>
<th>WALL CLADDING</th>
<th>RECOMMENDATION</th>
<th>LOADING</th>
</tr>
</thead>
<tbody>
<tr>
<td>METAL PANELS / BARE FRAME</td>
<td>$H / 60$ TO $H / 100$ (MAXIMUM)</td>
<td>10 YEAR WIND</td>
</tr>
<tr>
<td>PRECAST WALLS / BARE FRAME</td>
<td>$H / 100$ (MAXIMUM)</td>
<td>10 YEAR WIND</td>
</tr>
<tr>
<td>UNREINFORCED MASONRY WALLS / BARE FRAME</td>
<td>1 / 16 IN. CRACK (BASE OF WALL)</td>
<td>10 YEAR WIND</td>
</tr>
<tr>
<td>REINFORCED MASONRY WALLS / BARE FRAME</td>
<td>$H / 200$ (MAXIMUM)</td>
<td>10 YEAR WIND</td>
</tr>
</tbody>
</table>
### Table 1.3.1(b): Deflection Limits

(Limits and footnotes are from IBC 2012 Table 1604.3)

<table>
<thead>
<tr>
<th>Construction</th>
<th>Load Live</th>
<th>Snow or Wind</th>
<th>Dead + Live</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof Members:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supporting plaster ceiling</td>
<td>L/360</td>
<td>L/360</td>
<td>L/240</td>
</tr>
<tr>
<td>Supporting non-plaster ceiling</td>
<td>L/240</td>
<td>L/240</td>
<td>L/180</td>
</tr>
<tr>
<td>Not supporting ceiling</td>
<td>L/180</td>
<td>L/180</td>
<td>L/120</td>
</tr>
<tr>
<td>Roof members supporting metal roofing:</td>
<td>L/150</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Structural Metal Roof and Siding Panels:</td>
<td>---</td>
<td>---</td>
<td>L/60</td>
</tr>
<tr>
<td>Floor members</td>
<td>L/360</td>
<td>---</td>
<td>L/240</td>
</tr>
<tr>
<td>Exterior walls and interior partitions:</td>
<td>---</td>
<td>L/240</td>
<td>---</td>
</tr>
<tr>
<td>With brittle finishes</td>
<td>---</td>
<td>L/120</td>
<td>---</td>
</tr>
<tr>
<td>With flexible finishes</td>
<td>---</td>
<td>L/120</td>
<td>---</td>
</tr>
<tr>
<td>Wall members supporting metal siding:</td>
<td>---</td>
<td>L/90</td>
<td>---</td>
</tr>
<tr>
<td>Farm buildings</td>
<td>---</td>
<td>---</td>
<td>L/180</td>
</tr>
<tr>
<td>Greenhouses</td>
<td>---</td>
<td>---</td>
<td>L/120</td>
</tr>
</tbody>
</table>
Thank You!