Oregon Highway Bridge Maintenance
A Pilot Training Course / Workshop

- Rules of Orientation and Bridge Element Numbering
- Bridge Mechanics

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Rules of Orientation and Bridge Element Numbering
Presentation

- Purpose – why is this important?
- Learn about Bridge Components and Element Numbering and Labeling
Purpose

- Make some sense of order and provide a clear description of just exactly where a bridge member deficiency is located.

- Personnel do not always have a set of bridge plans.

- Bridge Plan labeling is not uniform.
Purpose

- Maximize the use of available personnel by providing a scheme that would allow personnel to go directly to the deficiency, without having to hunt for it.

- Minimize errors by making sure that the right member is repaired.
Bridge Plan labeling
Systems of Orientation and how they might work

- Orientation by Upstream & Downstream
  - Quite often the inspector can not discern what is upstream or downstream (i.e. tides, dry creek bed).

- Compass Map Direction vs Route Direction
  - Most of the time, there is a considerable difference between these two directions.
Systems of Orientation and how they might work

- **Highway System Tree** (i.e. major arterial, collector, local)
  - Mileposts increase as you go out from the trunk.
  - Good Option.

- Increasing mileposts or city street addresses.
  - *Increasing mileposts looking ahead on line.*
  - *Best Option.*
Bridge Numbers

➤ NBI Number
• Number that is reported to the Federal Highway Administration (FHWA).
• Historically this number has changed over time.

➤ Local Bridge Number
• Number used by the local agency.

➤ Bridge Design Number
• Number used by the Design Firm.
• Structure Plans can contain multiple structures.
Bridge Numbers

NBI or Local Bridge Number
Bridge Numbers

NBI Number
Bridge Numbers

Bridge Design Number

West Marquam Bridge Complex
Major Bridge Components
Major Bridge Components

- Deck
- Superstructure
- Substructure
- Foundation
Major Bridge Components

- Deck
- Girders
- Bent Cap
- Column
- Foundation
- Bearing
- Substructure
- Superstructure
- Railing
- Abutment
- Wall
Major Bridge Components

Note: members below the bearing is the Substructure members above the bearing is the superstructure
Deck\nGirders\nCap\nColumns\nTraffic Load\nSuperstructure\nRailing\nGirders\nCap\nColumns\nFoundation
Deck

- The deck carries the roadway / sidewalk.
- The deck is supported by the superstructure.
- Transfers vehicular loads to the superstructure.
Bridge Nomenclature

- Generally, everything above the superstructure is considered part of the deck:
  - Deck (Slab)
  - Railings
  - Barriers
  - Medians
  - Sidewalks
Deck
Superstructure

- Superstructure members transfer traffic loads from the deck to the substructure.

- Uses tension, compression, bending or combinations of the three.

- Superstructure is above the bearings normally.
Bridge Nomenclature

- Generally, everything above the substructures is considered part of the superstructure (excluding the deck):
  - Girders/Beams
  - Diaphragms
    - End (Abutments)
    - Intermediate
  - Bearings
Superstructure
Superstructure
Substructure

- The substructure transfers loads from the superstructure to the foundation material.
- Typically everything below the bearings.
Bridge Nomenclature

- Generally, everything below the superstructure is considered a substructure:
  - Abutments
  - Piers
Substructure
Major Bridge Components: Substructure
Major Bridge Components: *Foundation or Footing*

- Supports the substructure (transfers the entire bridge load into ground).
- Most common types are spread footings, drilled shafts, and/or driven piles.
- Usually top of the footings are below the ground line (can’t be visually inspected).
- Piles (timber, steel, or concrete) or shafts can be driven tens of feet below ground.
Bridge Elements

LONGITUDINAL SECTION

- Spread Footing
- Pile-Supported Footing
Foundation
Foundation
Bridge Nomenclature

Describing where the problem is?
Rules of Orientation and Bridge Element Numbering

1. Orientation: Look ahead at increasing mileposts or city street addresses.

2. All bridge elements (girders, cross beam, columns, piles, etc.) are numbered in consecutive order from the leading end of the bridge and left to right.
Rules of Orientation and Bridge Element Numbering

- Bent - a substructure unit that supports the superstructure of a bridge and is supported by the foundation.

- Bents are numbered consecutively in the same direction as increasing highway mileposts, or city street addresses.
Bridge Nomenclature

- **Span** - portion of the bridge superstructure that is located between two bents.

- **Spans** are numbered numerically, in consecutive order, in the same direction as increasing highway mileposts, or city street addresses.
Bridge Nomenclature

Increasing Mileposts

Span 9

Span 11
Bridge Nomenclature

- Superstructure Members can be timber, steel or concrete.

- Superstructure Members are numbered numerically, in consecutive order, from left to right, while looking ahead, on line, at increasing mileposts, or city street addresses.
Bridge Nomenclature

- Substructure Members can be steel, concrete or timber.

- Substructure Members are numbered numerically, in consecutive order, from left to right, when looking ahead, on line, at increasing mileposts or city streets.
Rules of Orientation and Member Numbering
Bridge Nomenclature

- A Truss is a structure that is made up of individual members that are arranged and connected, in triangular patterns, to create a long span.

- A Truss is made up of at least two chords, an upper chord and a lower chord.

- Truss Panel Points - are located on the chords where two or more truss members are connected.
Panel points are numbered consecutively, in the same direction as the designated bent or span, starting with “0”, along with an identifier to show whether the panel point is on the upper chord, lower chord, an intermediate point, and whether it is on the left or right truss.

Truss Members are identified by using two panel point designations.
This is a type of 3D View of a Truss.....

Portal strut and bracing

Sway bracing

Lateral (wind) bracing

Struts

Deck

Top Chord

Bottom Chord

Floor beams

Stringers

Panel Points
Increasing Mileposts

right side of arch

L5R

U6R

U8RL9R

L12RU13R
So…

When in Doubt………

- Remember the Three Rules.
- Get your bearings.
- Orient yourself.
- Talk to someone who knows……..
Bridge Mechanics
Bridge Mechanics

- Load Paths
- Bending, Tension, and Compression
Load Paths
Bridge Mechanics

Compression

Tension

Bending

(Compression)

(Tension)
Deck is in bending

Girders are in bending

Cap is in bending

Columns are in compression
Bridge Mechanics

Members in compression will be much thicker members.

Visualize a rope hanging from two panel points.

Members in Tension will be much thinner in section.
Properties of Bridge Materials (Timber)

- If the structure is provided with proper lateral bracing and all of the components are adequately tied together, timber is one of the more efficient and cost effective bridge building materials.

- Timber is strong, light, simple to work with, and a resilient material.

- Properties are not consistent and vary with direction.
Typical Timber Members

Rectangular (Plank)  |  Round (Pile)  |  Rectangular (Beam)

4" - 12"  |  Up to 12" diameter  |  6" - 10"

2" - 4"  |  10" - 14"  |
Properties of Bridge Materials (Reinforced Concrete)

- Even though Reinforced Concrete tends to be very massive, it can be used effectively if it is properly reinforced.

- The proper amount of steel reinforcement and correct detailing plays a very important role.

- Used to carry axial or bending loads
Concrete does not resist tension well without steel or other reinforcement.
Typical Reinforced Concrete Girder

- Primary Steel Reinforcement
- Rebar Stirrups
Reinforced Concrete Section

- Rebar Stirrups
- Primary Longitudinal Steel Reinforcement
Properties of Bridge Materials (Prestressed (P/S) Concrete)

- Members are free from cracks as concrete is under compression.
- P/S members are more durable than Reinforced concrete.
- The sections are smaller, can be transported easily, and they can also be used for longer spans than reinforced concrete.
Typical Pre-stress Concrete Girder

Prestress Strand Jacking Load ± 160,000 psi

Prestressing Strands or Post-tensioning Conduits
Properties of Bridge Materials (Steel)

- Stronger and more fire resistant than wood.
- Has compressive and tensile strength and elasticity.
- Resists shock and vibration
- Various shapes for various uses
Properties of Bridge Materials (Steel)

1. Because of its high strength per unit weight, Structural Steel members are usually very slender. Thus buckling becomes a serious problem.

2. Member Connections can also be a problem for steel structures.
Typical Structural Steel Sections

- Flange
- Web
Comments or Questions?