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

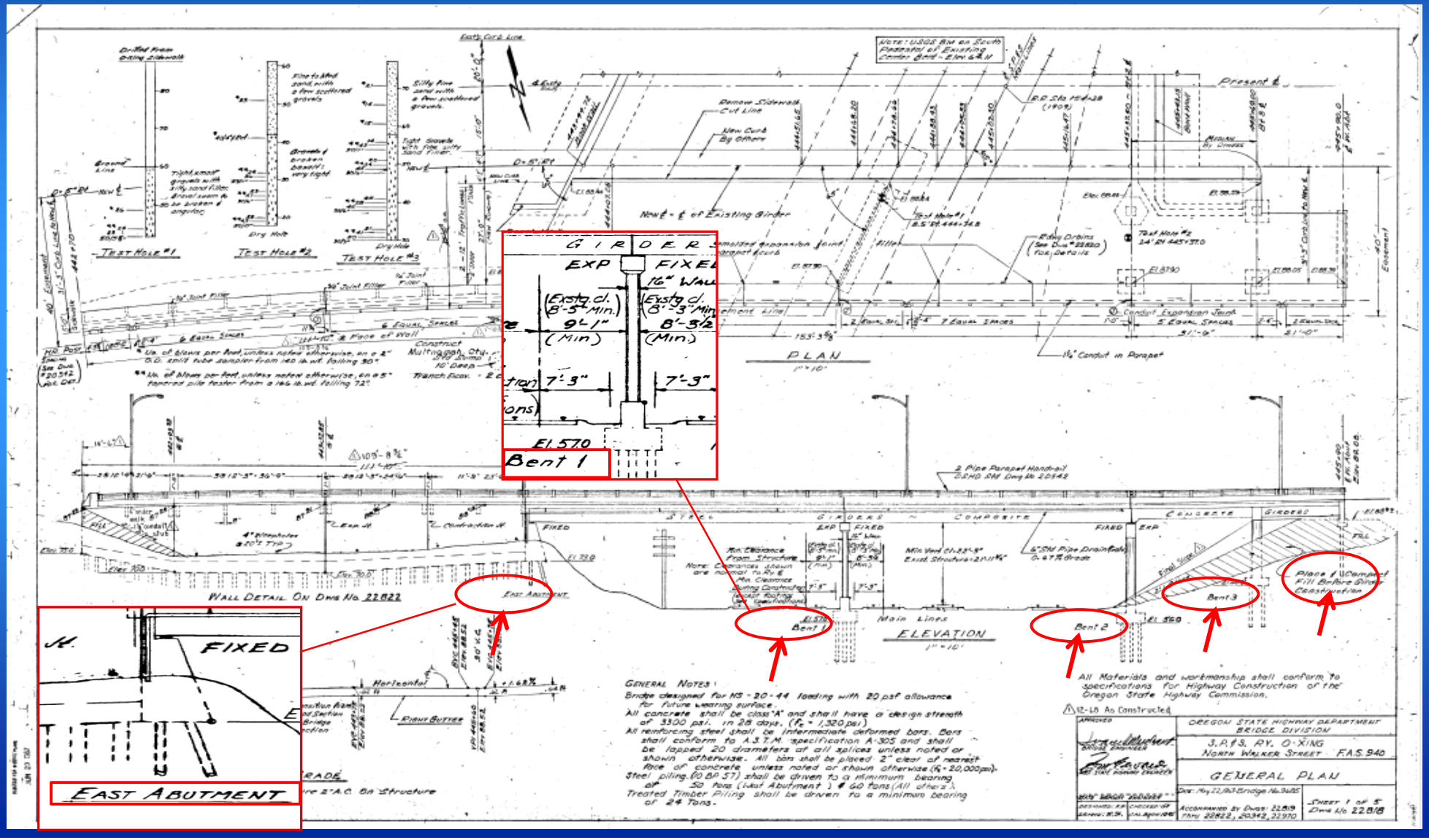
- Make some sense of order and provide a clear description of just exactly where a bridge member deficiency is located.
- Personnel do not always have a set of bridge plans.
- Bridge Plan labeling is not uniform.

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

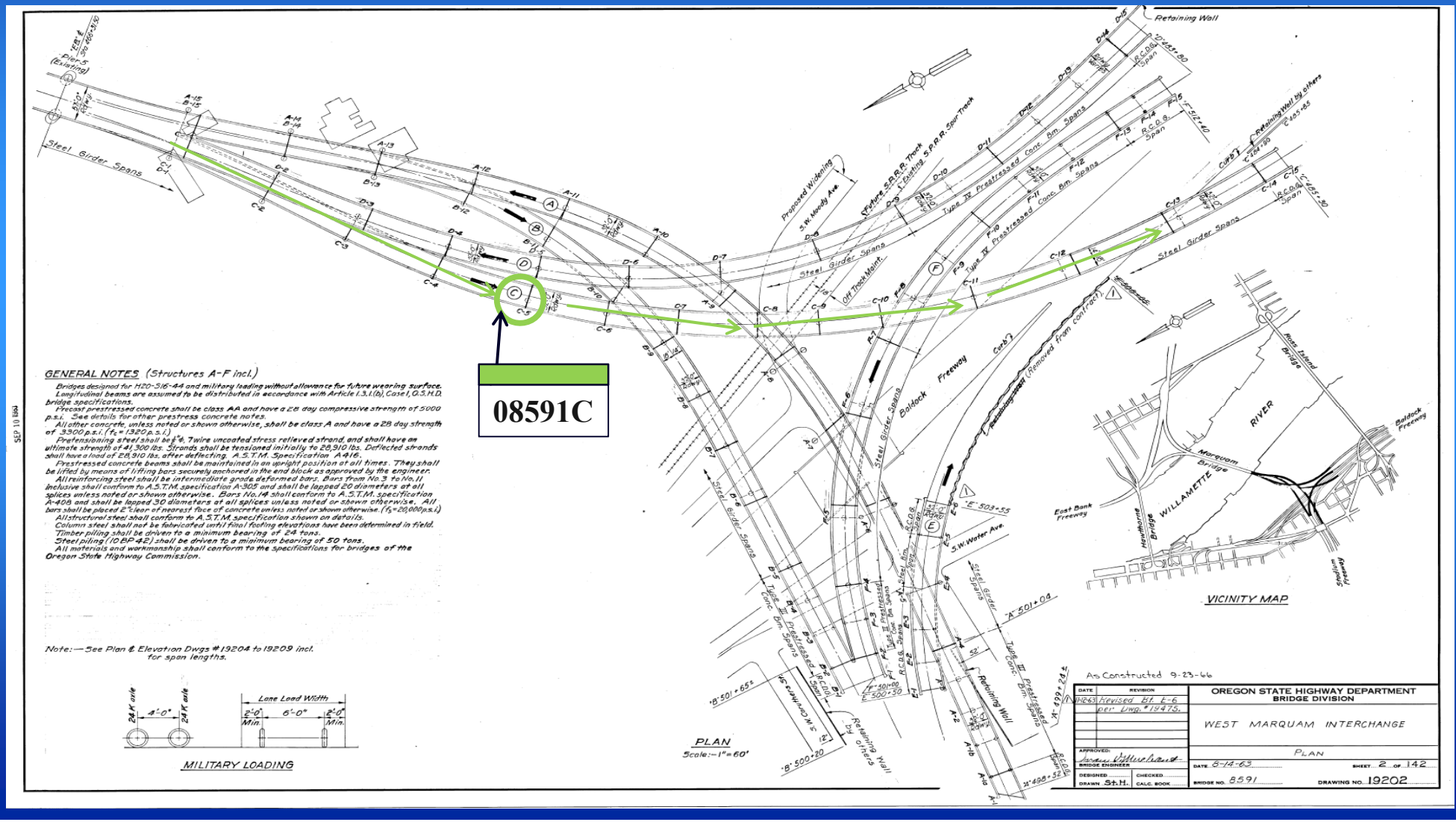
Bridge Numbers

Bridge Design Number

West Marquam Bridge Complex

Bridge Numbers

Bridge Design Number

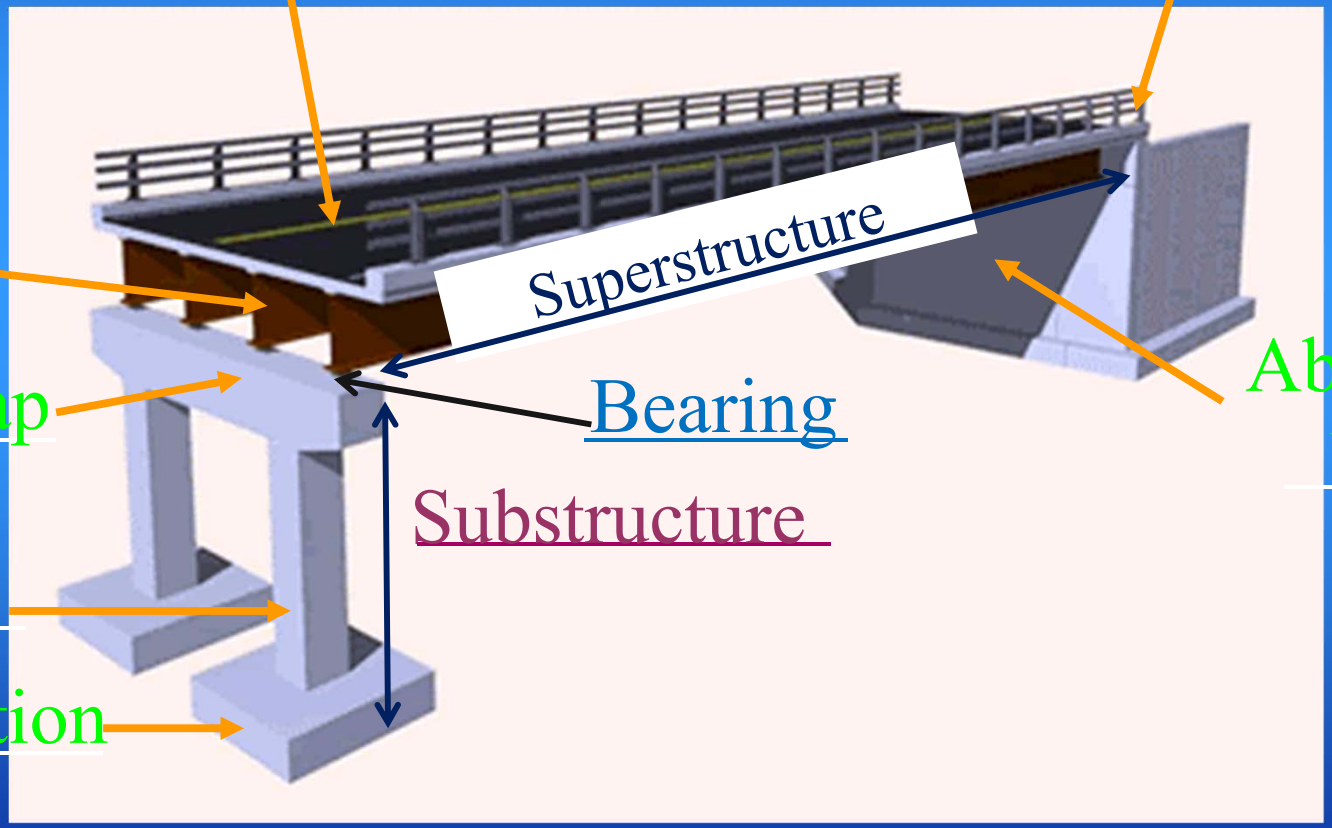


Major Bridge Components

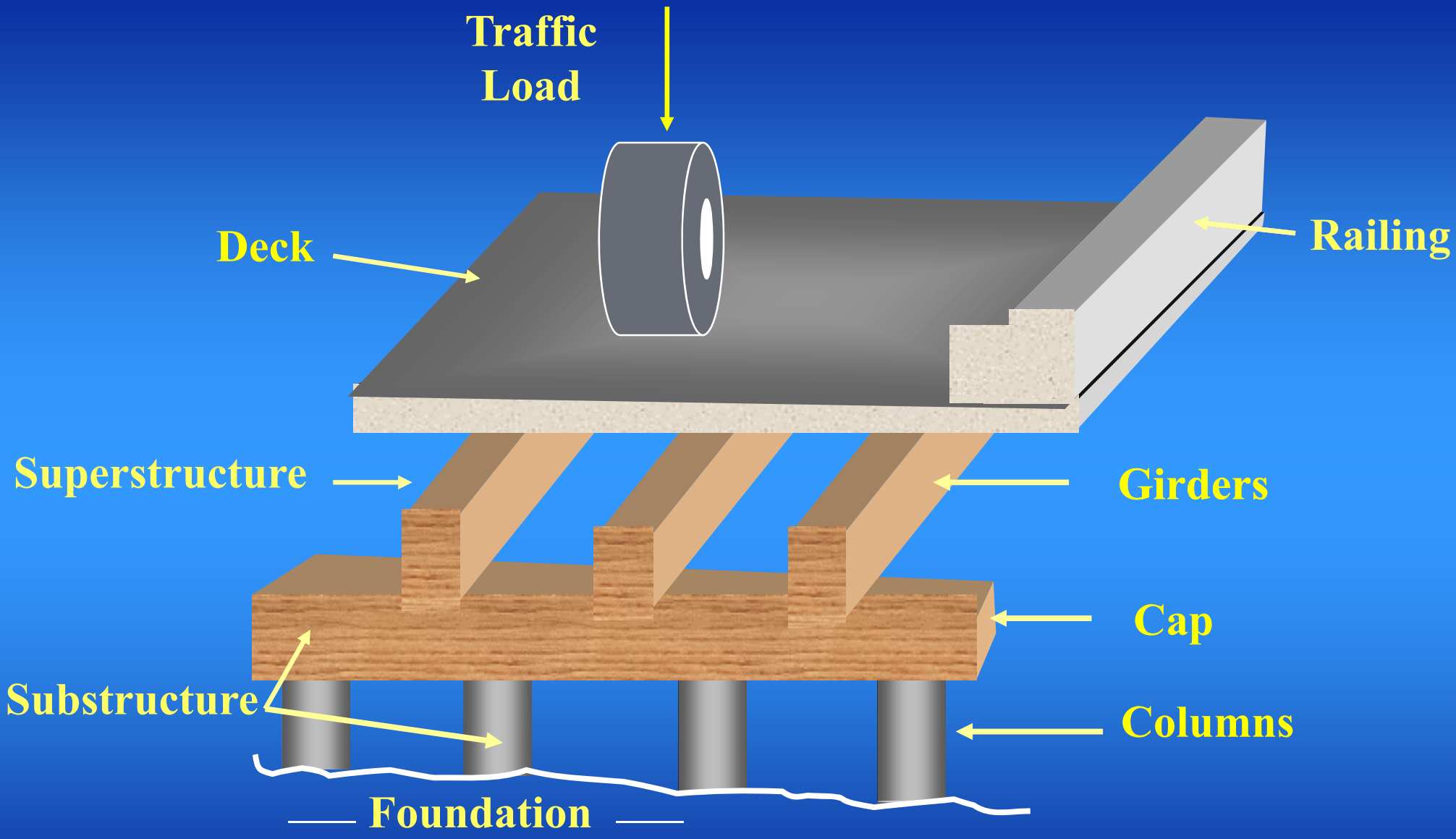
Major Bridge Components

- Deck
- Superstructure
- Substructure
- Foundation

Major Bridge Components



Major Bridge Components


Traffic Load
Deck
Railing
Superstructure
Girders
Cap
Substructure
Columns
Foundation

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

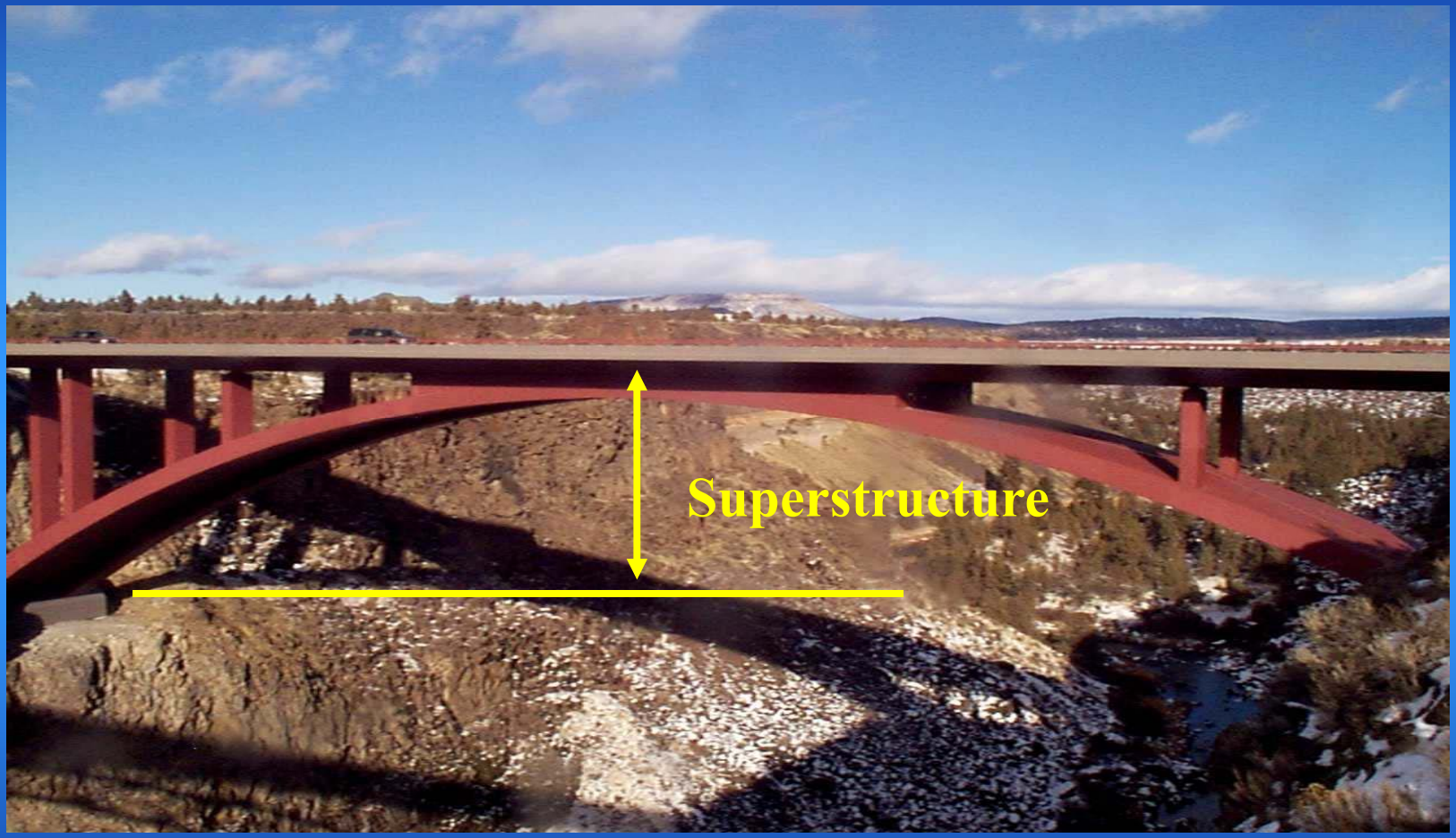
Superstructure

- 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.

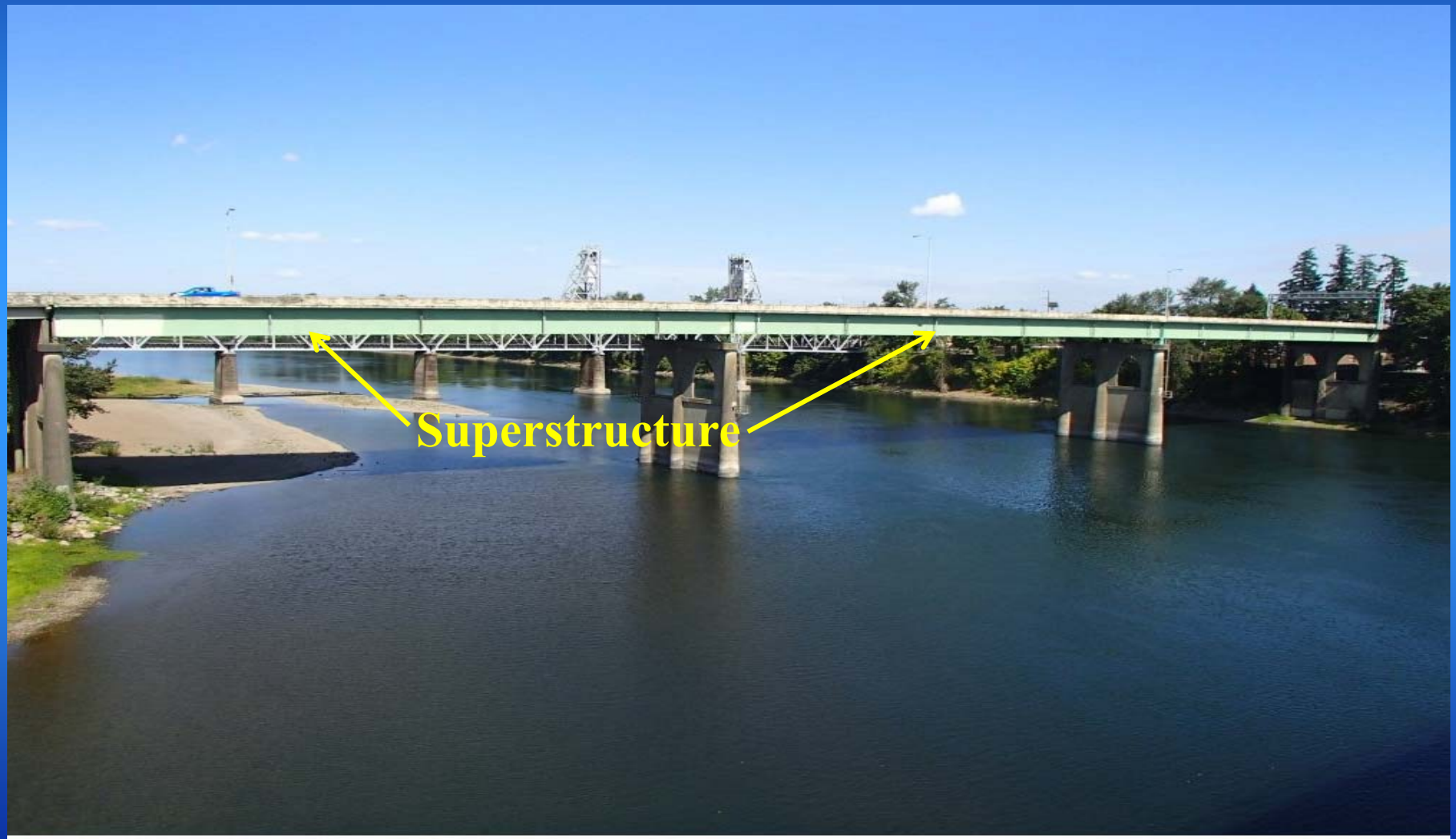
Bridge Nomenclature

- **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**

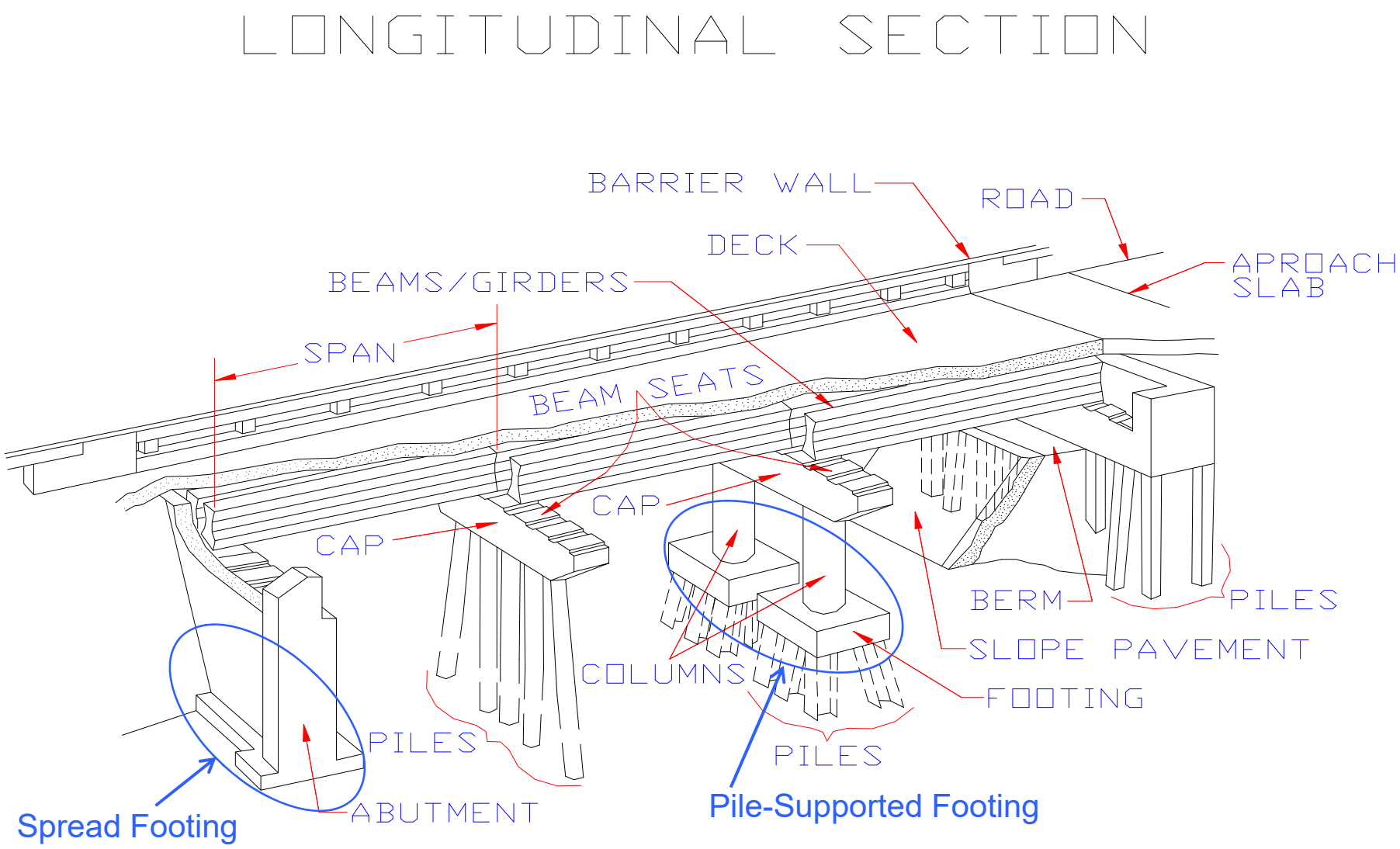
Substructure

Major Bridge Components: *Substructure*

Major Bridge Components: *Foundation or Footing*

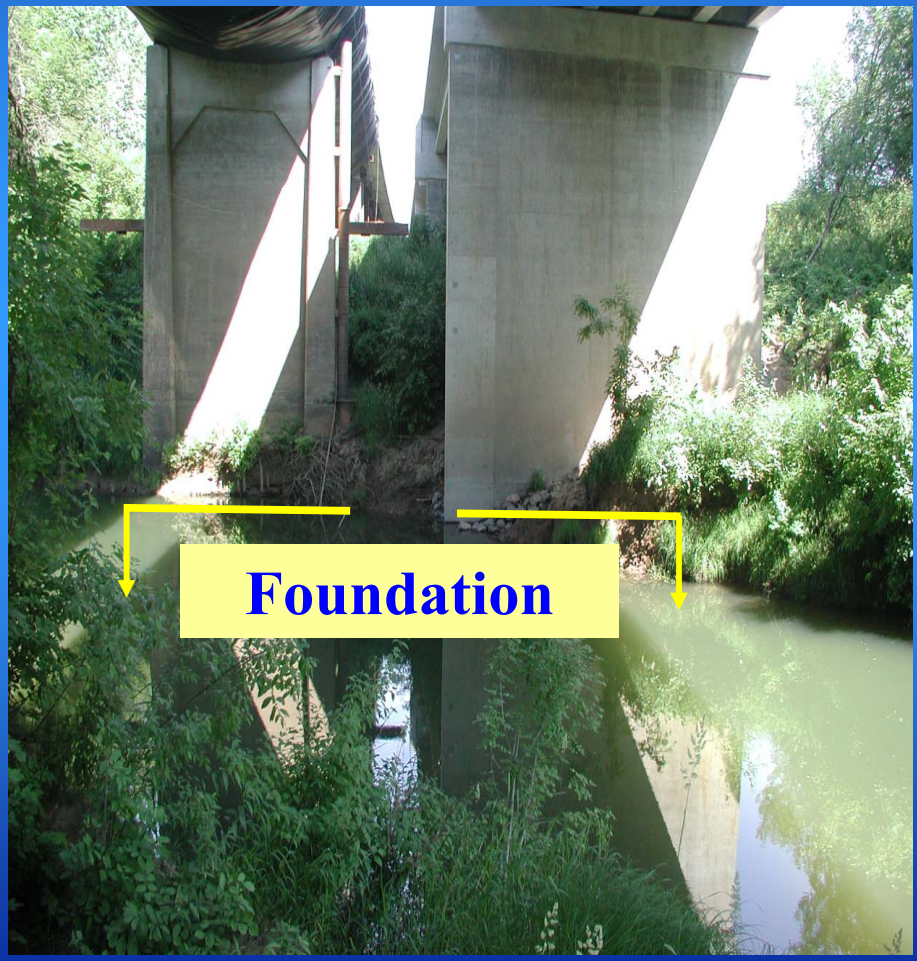
- Supports the substructure (transfers the entire bridge load into ground).
- Most common types are spread footings, drilled shafts, and/or driven piles.
- Usually top of the footings are below the ground line (can't be visually inspected).
- Piles (timber, steel, or concrete) or shafts can be driven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

Bridge Elements



Foundation

Foundation



Bridge Nomenclature

Describing where the problem is?

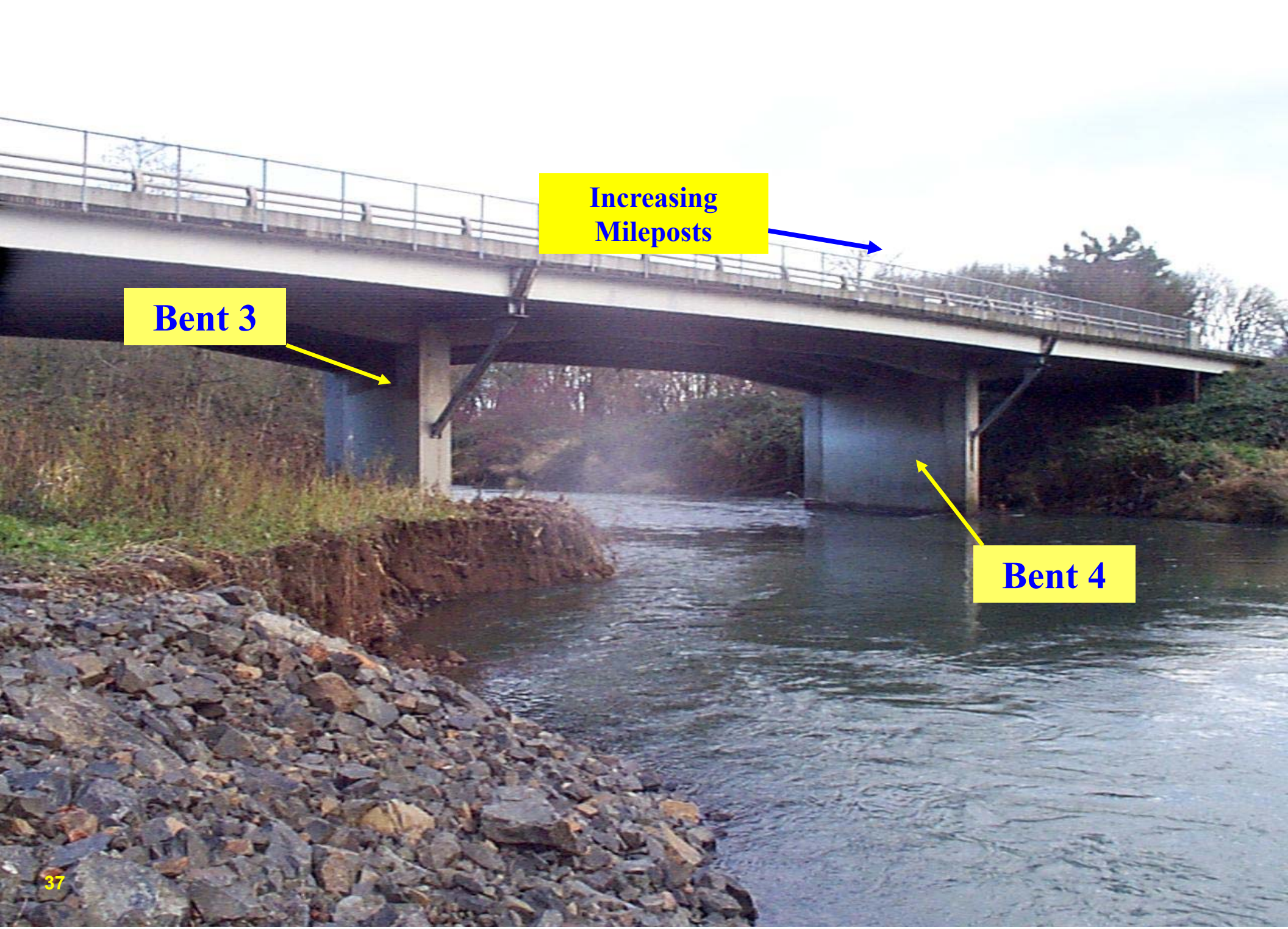
Rules of Orientation and Bridge Element Numbering

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

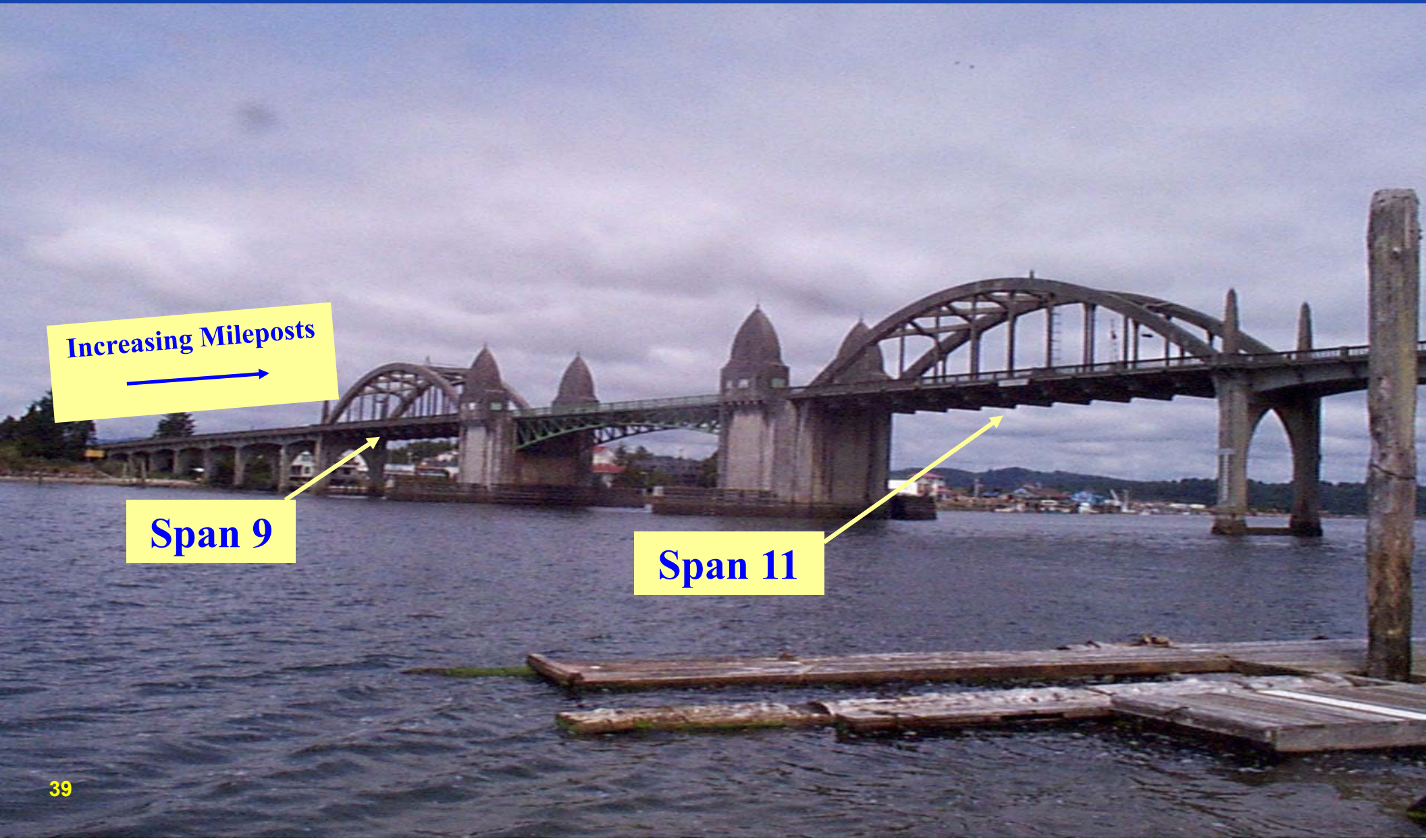
- Bents are numbered consecutively in the same direction as increasing highway mileposts, or city street addresses.


Increasing
Mileposts
Bent 3
Bent 4

Bridge Nomenclature

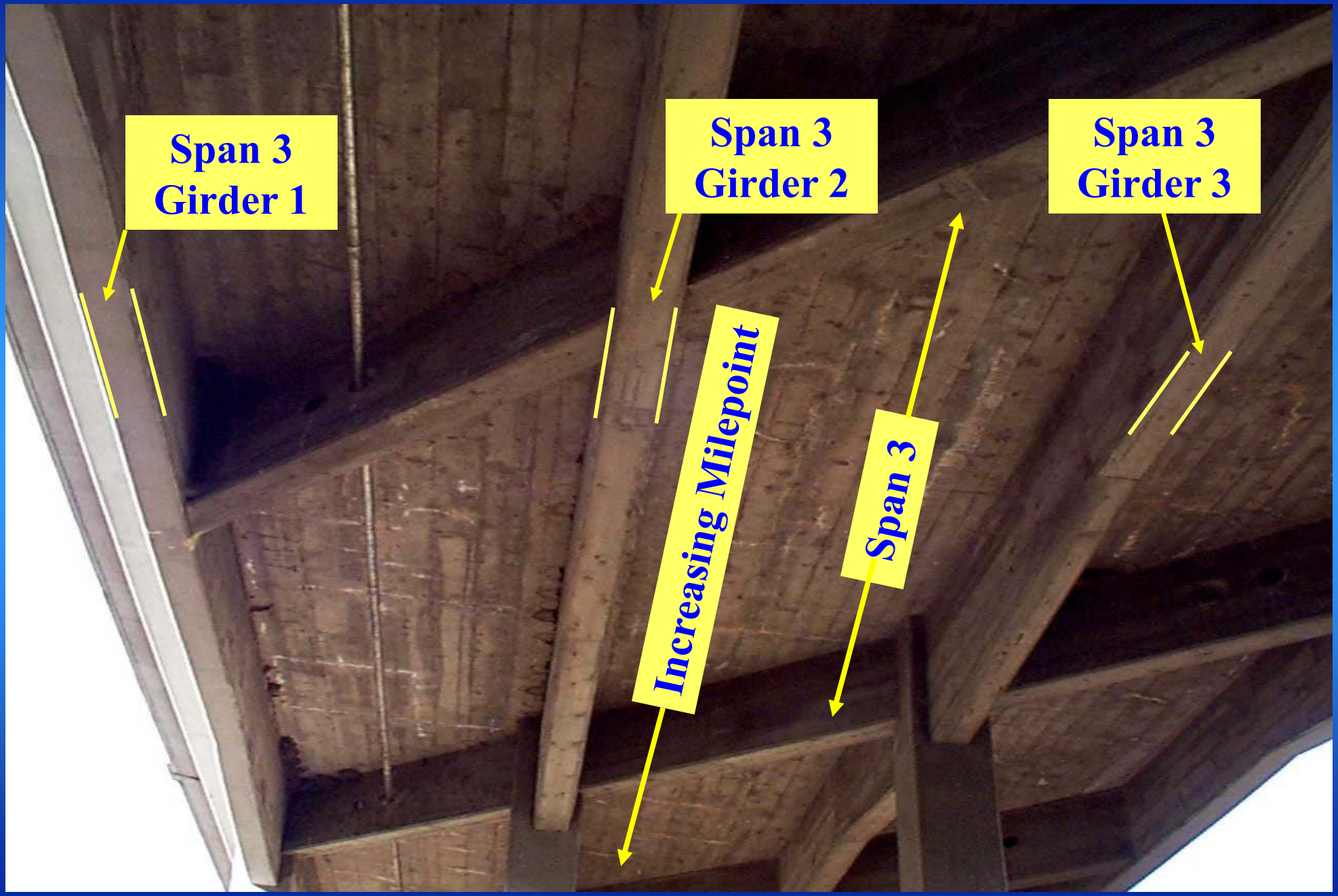
- Span - portion of the bridge superstructure that is located between two bents.
- Spans are numbered numerically, in consecutive order, in the same direction as increasing highway mileposts, or city street addresses.

Bridge Nomenclature



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.


Span 3
Girder 1
Span 3
Girder 2
Span 3
Girder 3
Increasing Milepoint
Span 3

Bridge Nomenclature

- Substructure Members can be steel, concrete or timber.

- Substructure Members are number numerically, in consecutive order, from left to right, when looking ahead, on line, at increasing mileposts or city streets.


Span 4
Increasing
Mile point
Bent 3,
Column 4
Bent 3,
Column 5

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.

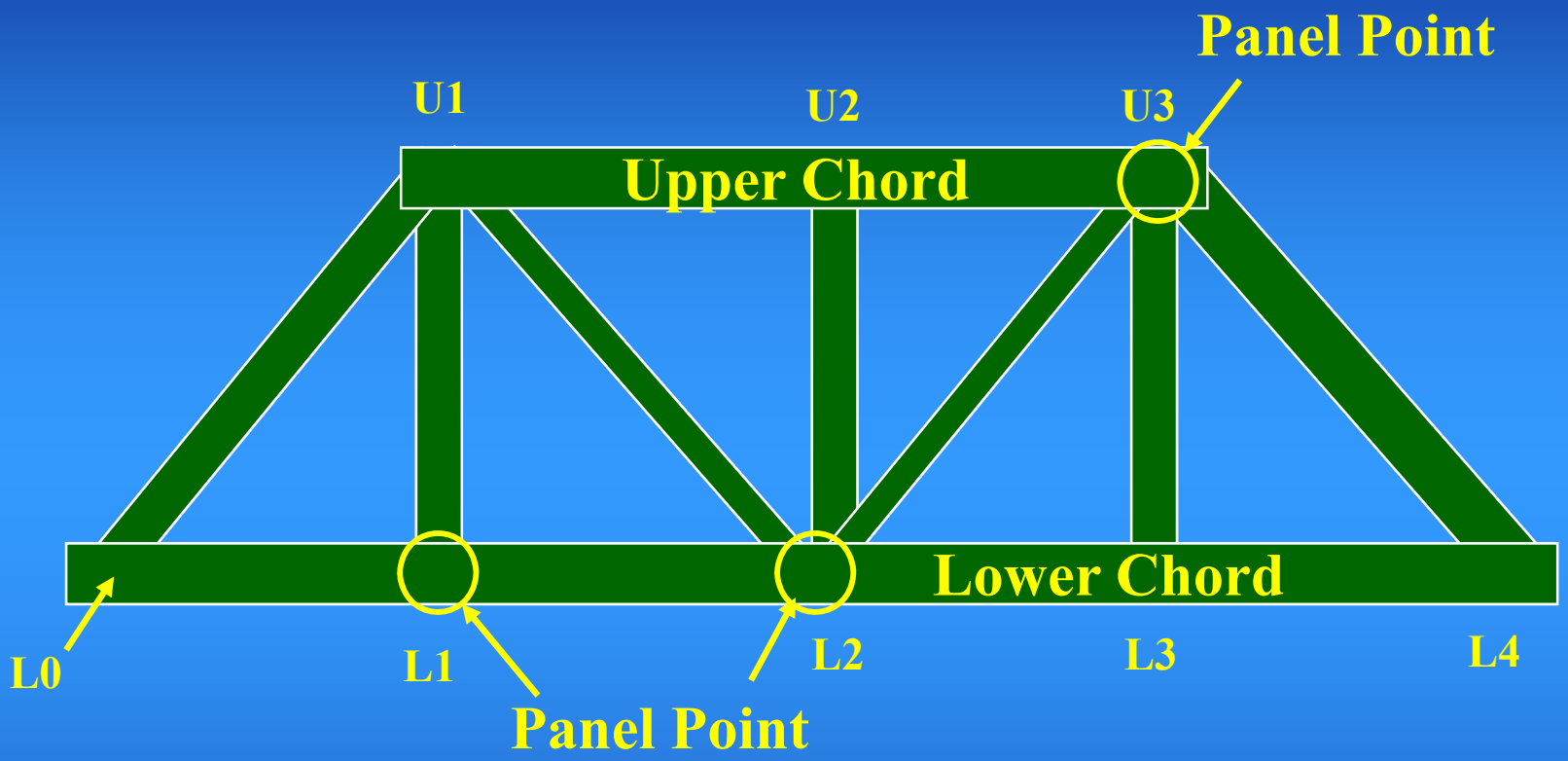
- Truss Panel Points - are located on the chords where two or more truss members are connected.

Bridge Nomenclature

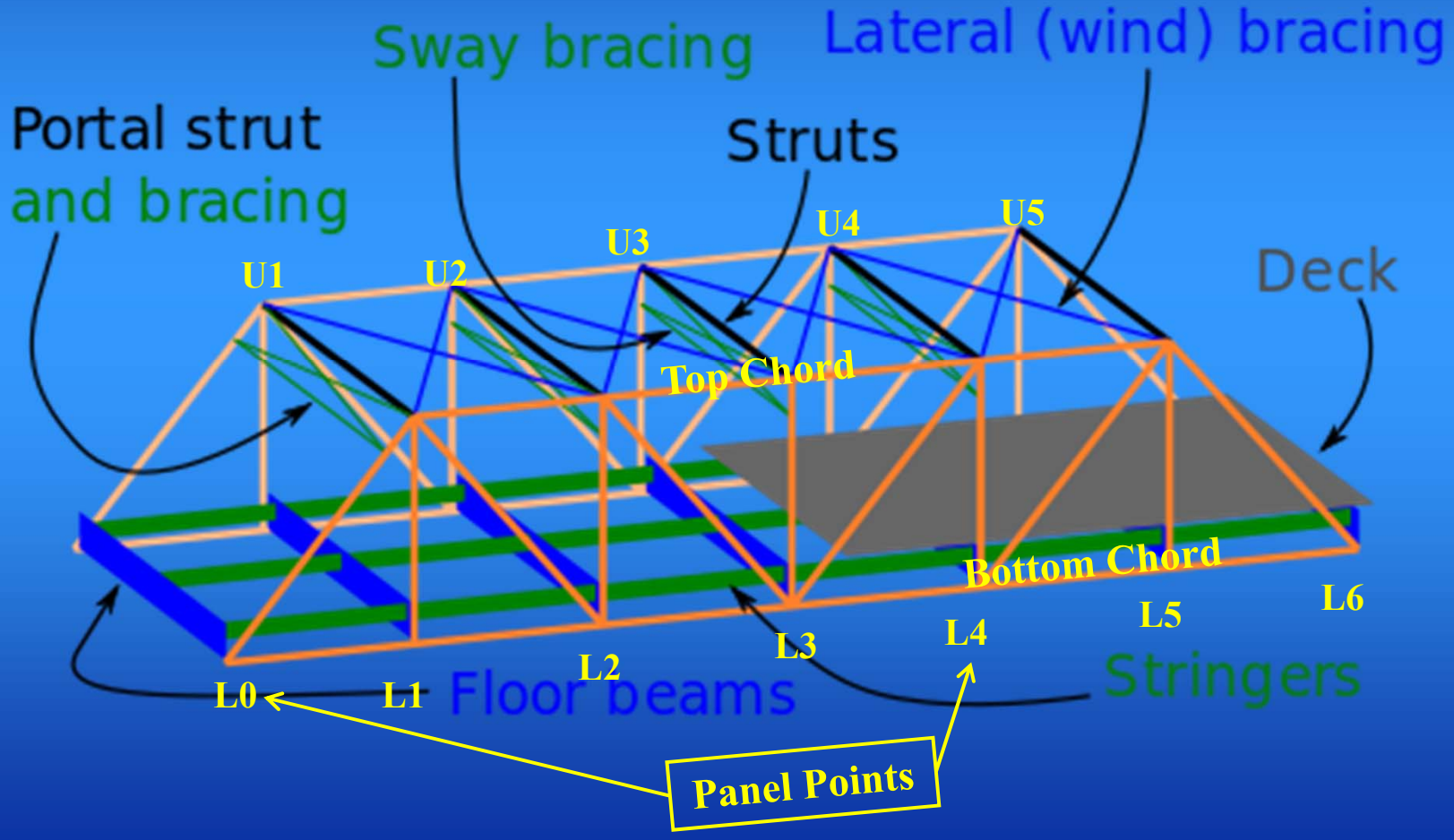
- Panel points are numbered consecutively, in the same direction as the designated bent or span, starting with “0”, along with an identifier to show whether the panel point is on the upper chord, lower chord, an intermediate point, and whether it is on the left or right truss.

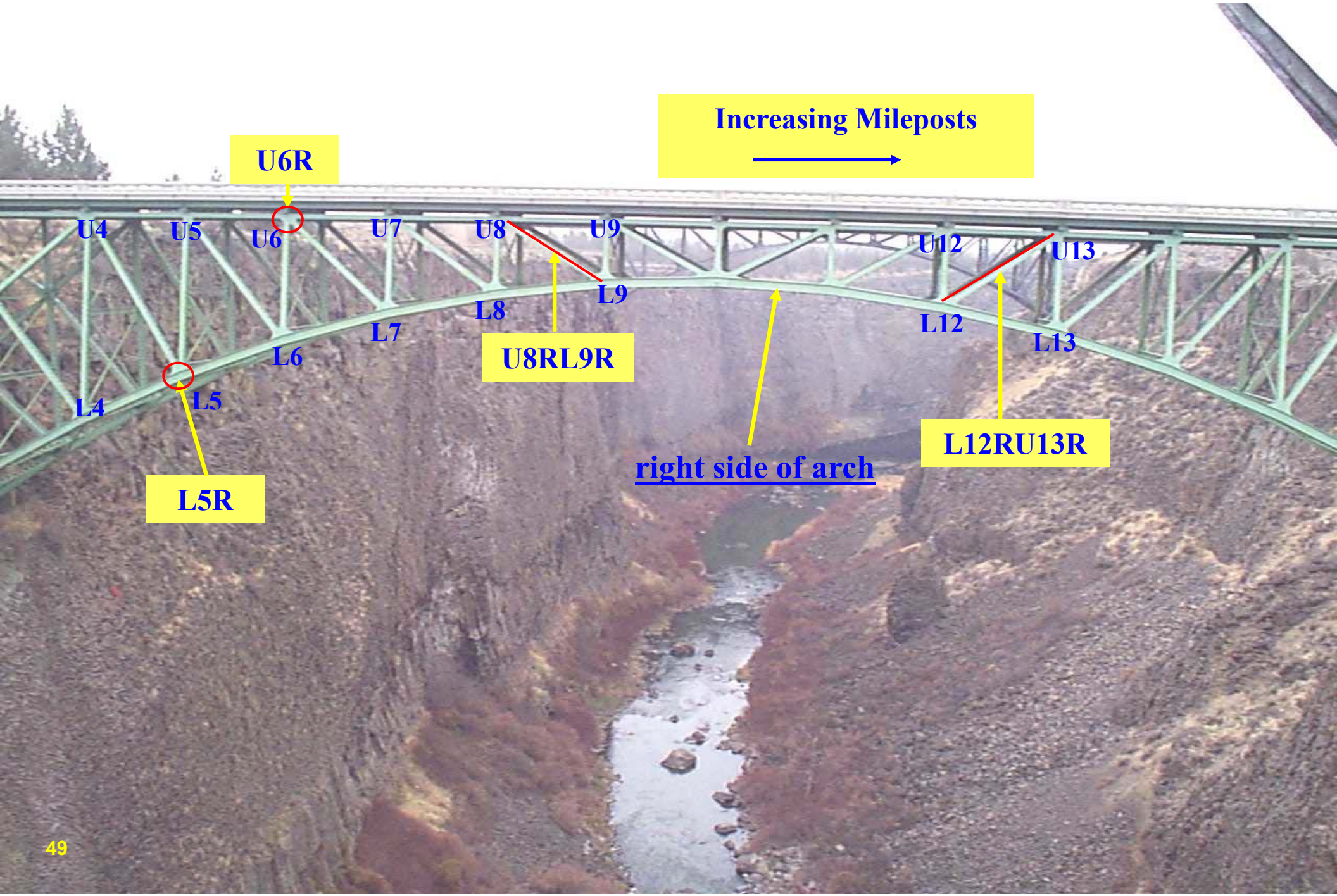
- Truss Members are identified by using two panel point designations.

Truss


Panel Point
U1
U2
U3
Upper Chord
Lower Chord
L0
L1
L2
L3
L4
Panel Point

This is a type of 3D View of a Truss…..

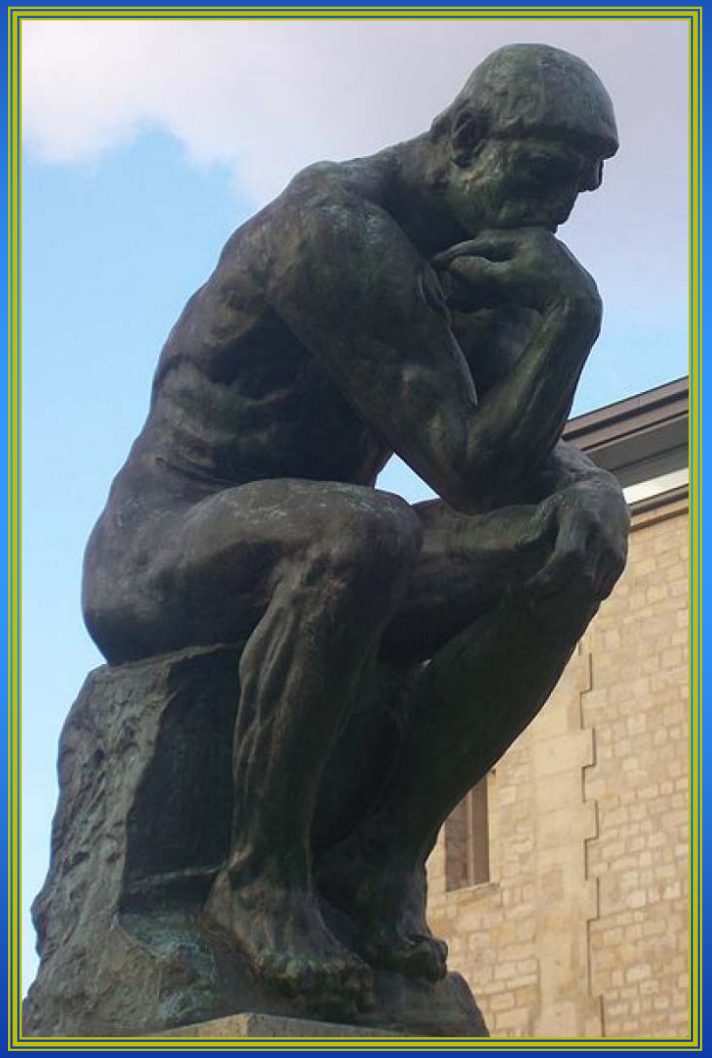



Increasing Mileposts
U6R
U4
U5
U6
U7
U8
U9
U12
U13
L4
L5
L6
L7
L8
L9
L12
L13
U8RL9R
L5R
right side of arch
L12RU13R

So….

When in Doubt……..

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

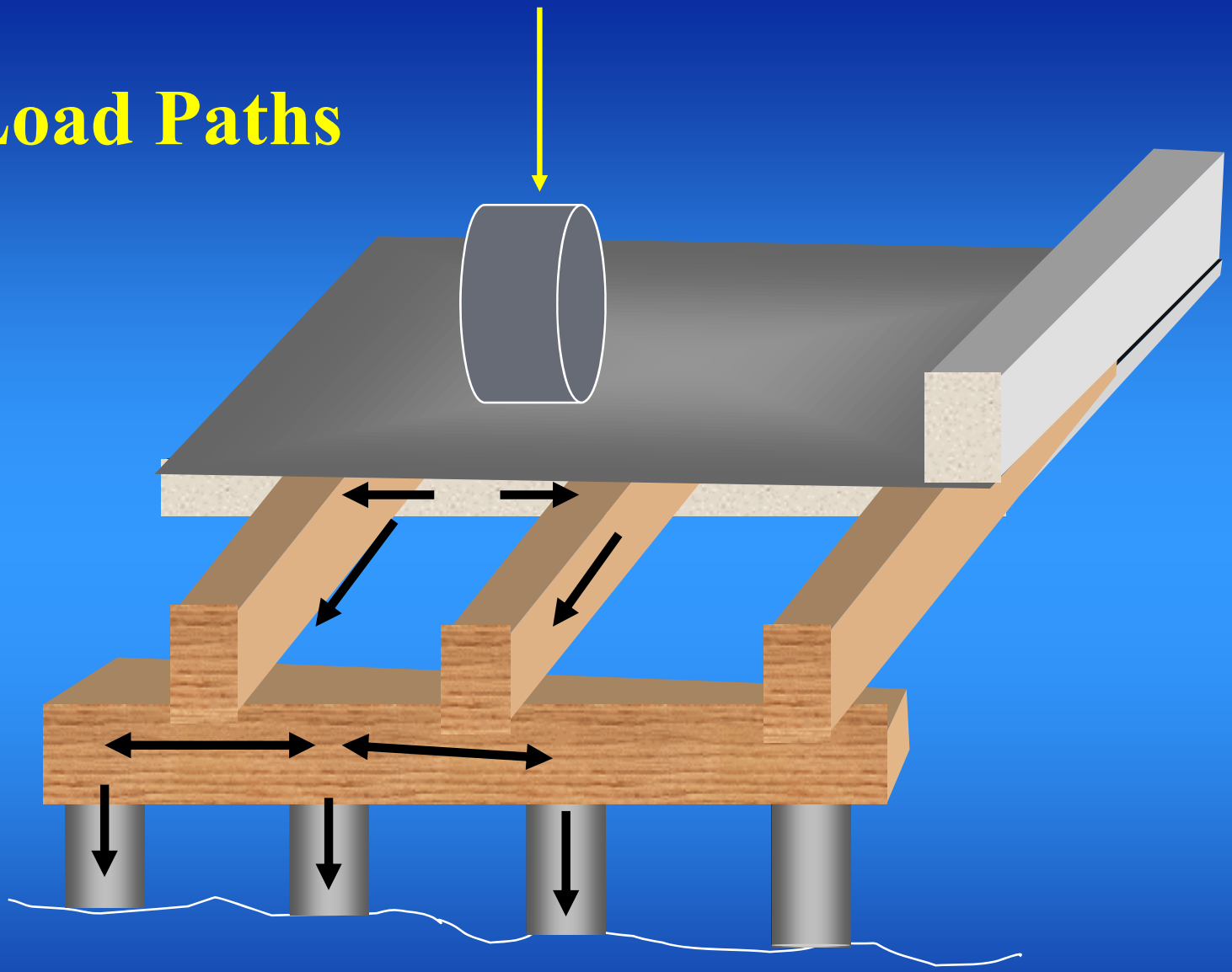


Bridge Mechanics

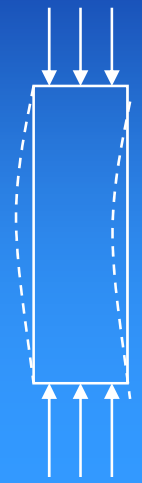
Bridge Mechanics

- Load Paths
- Bending, Tension, and Compression

Load Paths

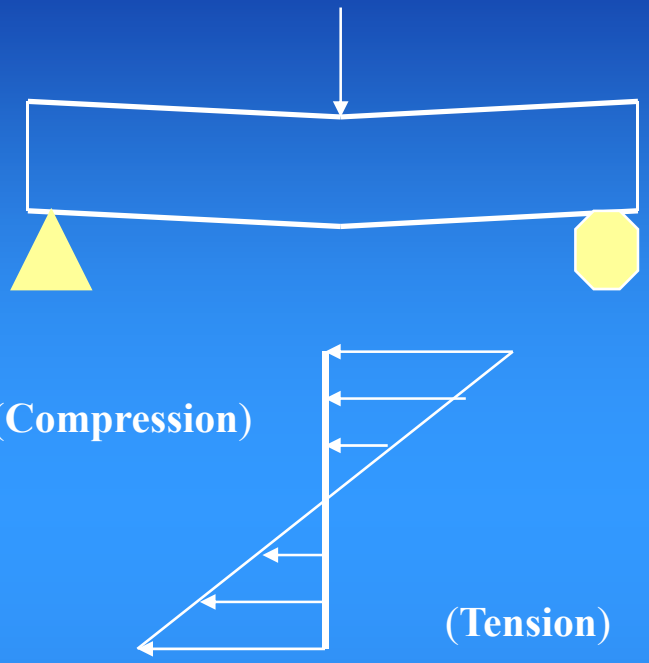


Bridge Mechanics

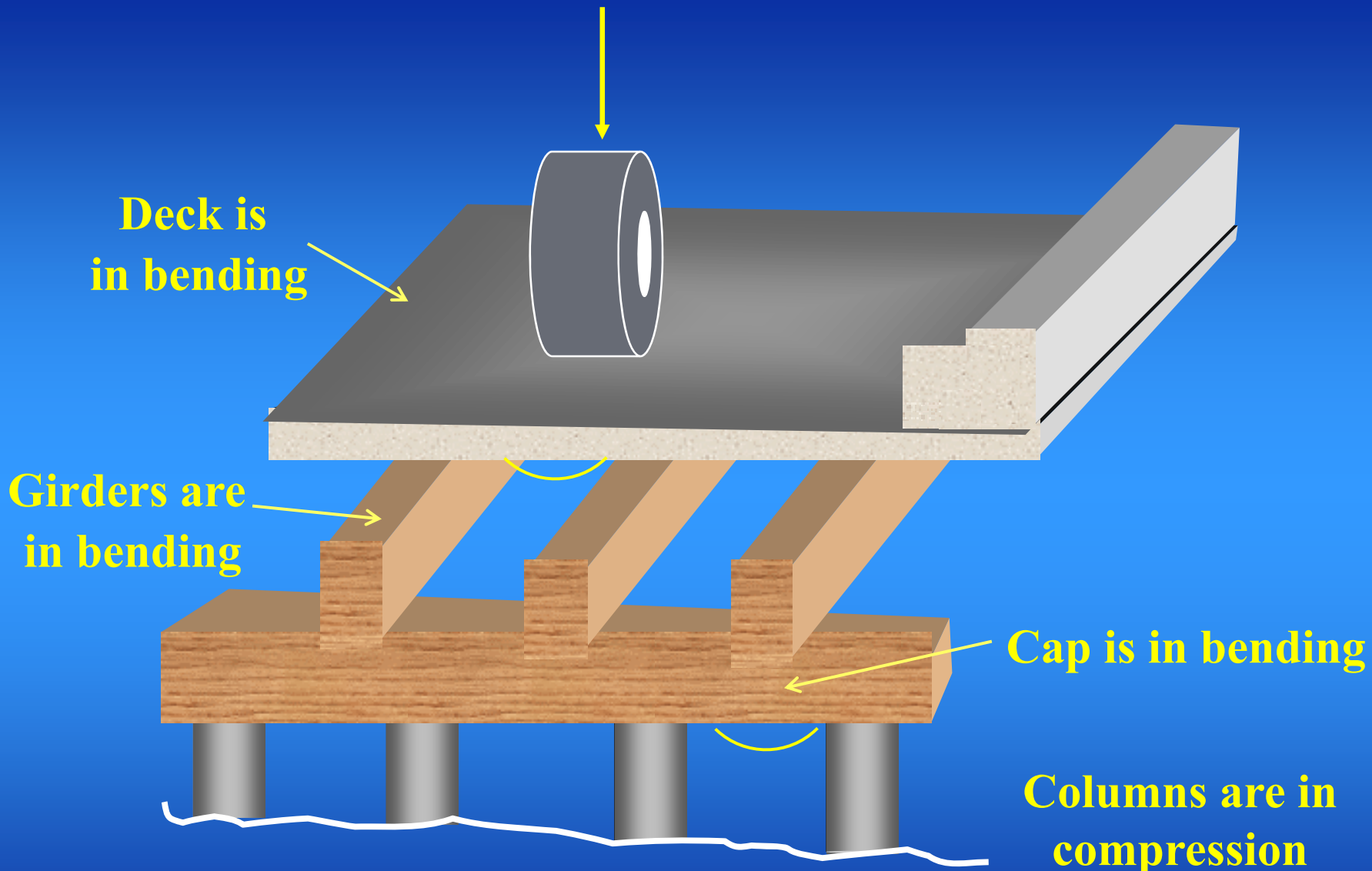


Compression

Tension



Bending

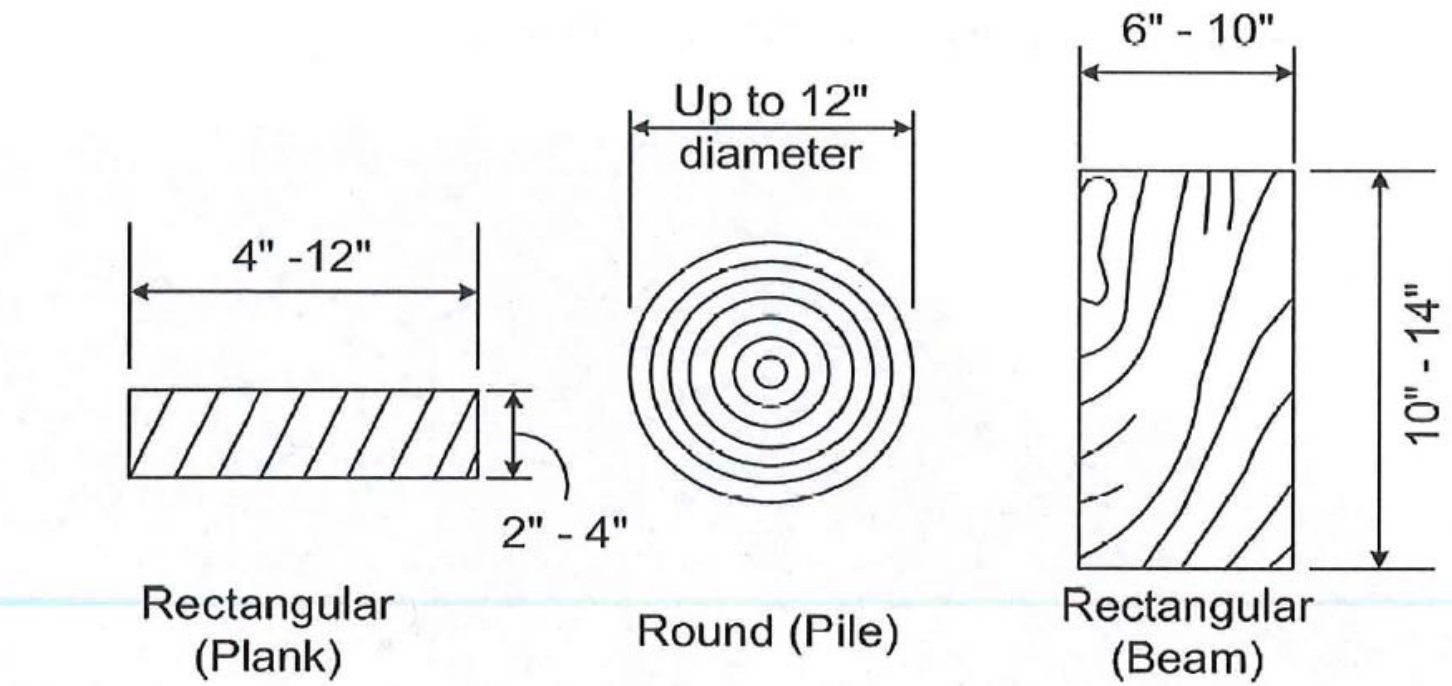

Deck is
in bending
Girders are
in bending
Cap is in bending
Columns are in
compression

Bridge Mechanics

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



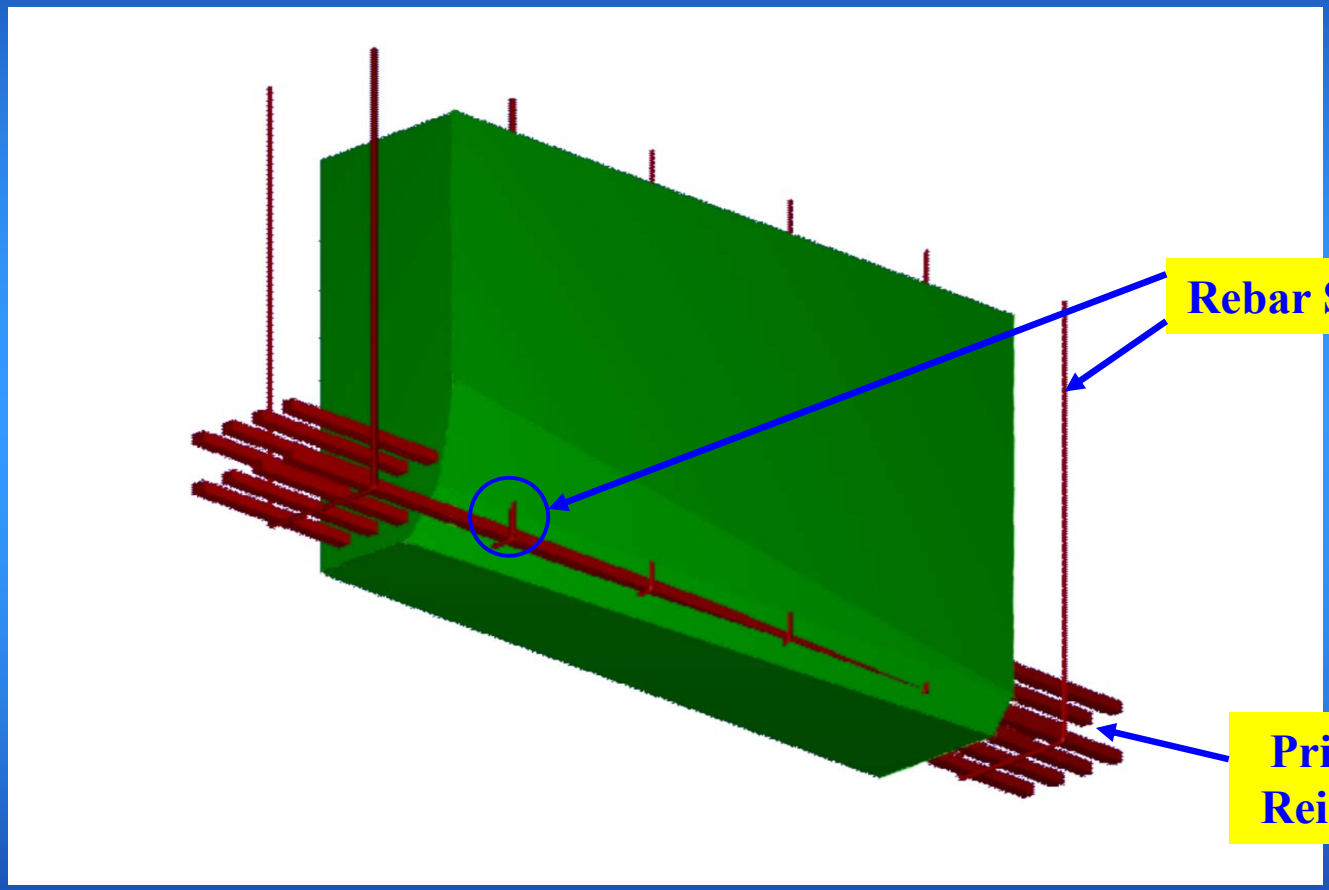
Properties of Bridge Materials (Reinforced Concrete)

- 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

Properties of Bridge Materials (Reinforced Concrete)

- Concrete does not resist tension well without steel or other reinforcement.

Typical Reinforced Concrete Girder



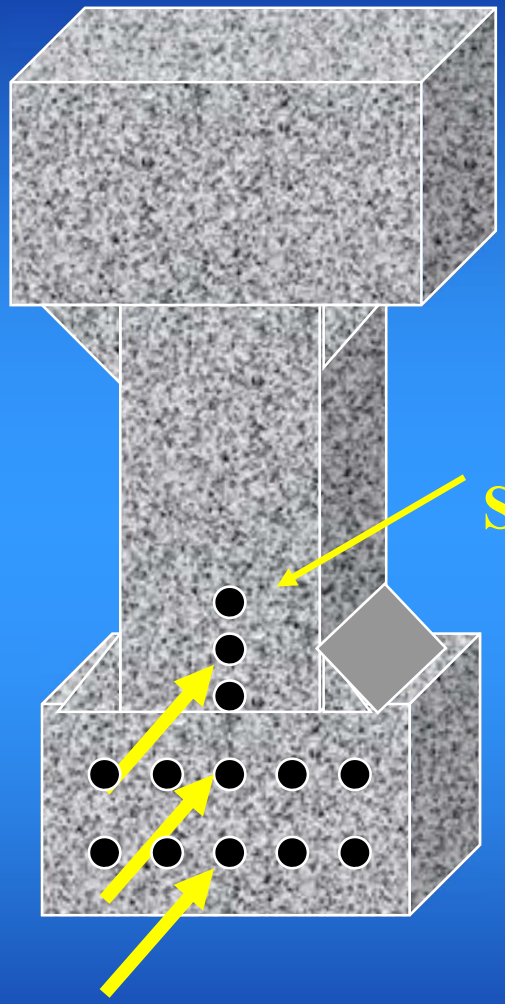
Reinforced Concrete Section

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)

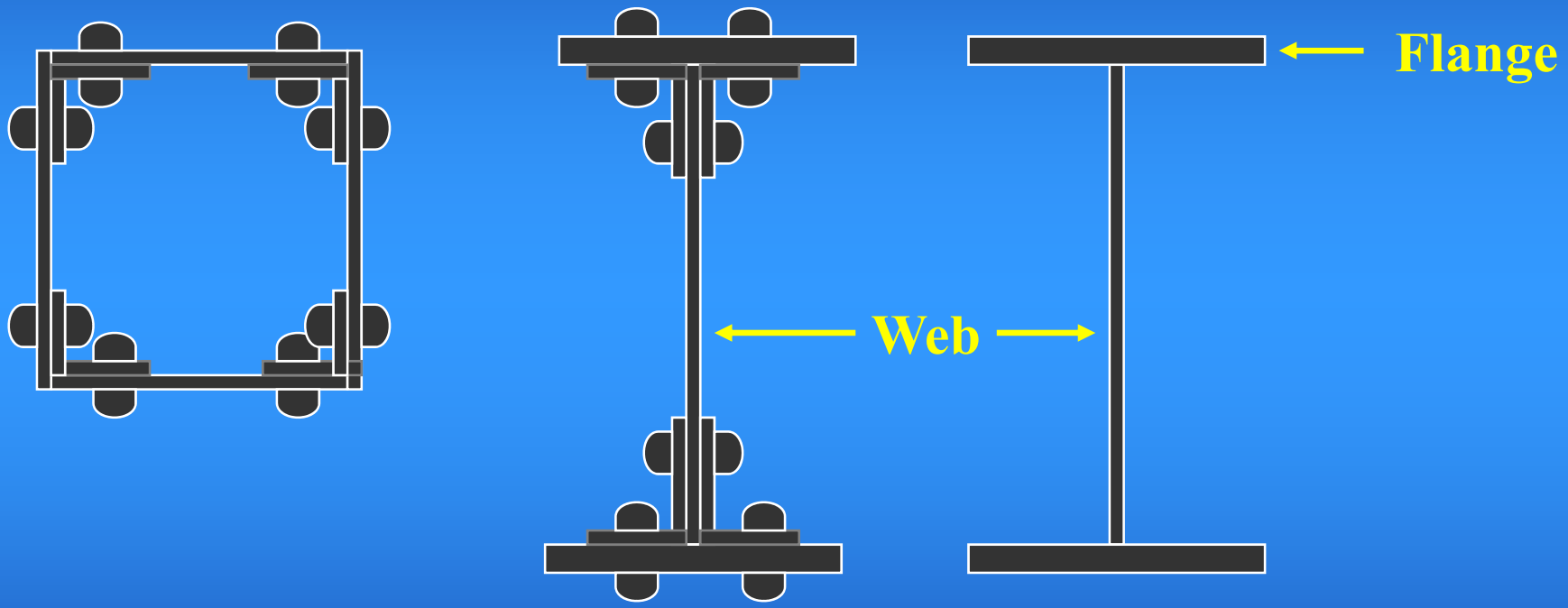
- Stronger and more fire resistant than wood.
- Has compressive and tensile strength and elasticity.
- Resists shock and vibration
- Various shapes for various uses

Properties of Bridge Materials (Steel)

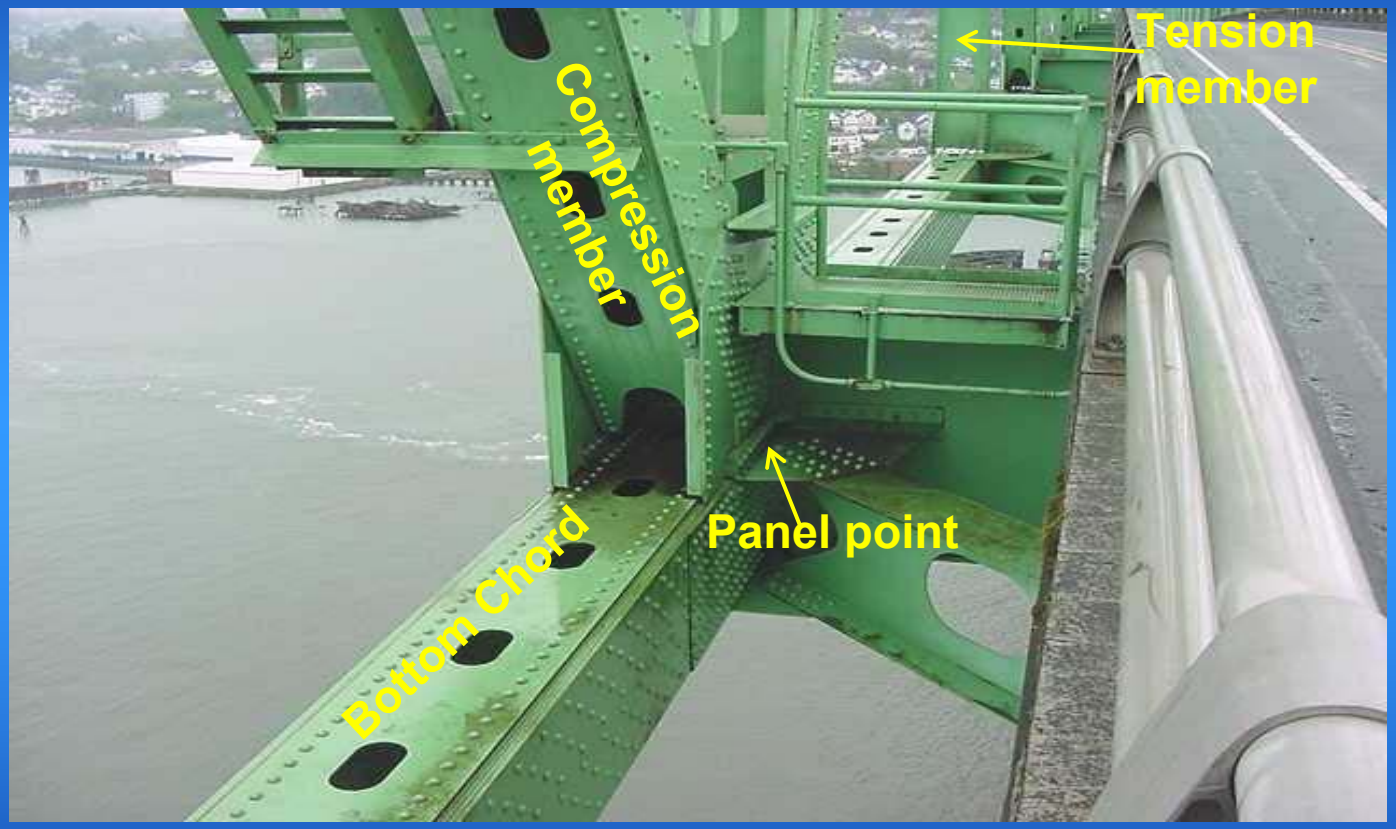
- Because of its high strength per unit weight, Structural Steel members are usually very slender. Thus buckling becomes a serious problem.

- Member Connections can also be a problem for steel structures.

Typical Structural Steel Sections



Structural Steel Members



Comments or Questions?