Jun 9th, 4:50 PM - 5:10 PM

Factors to Consider When Selecting a Structure for an AOP Design

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Considerations for Structure Selection

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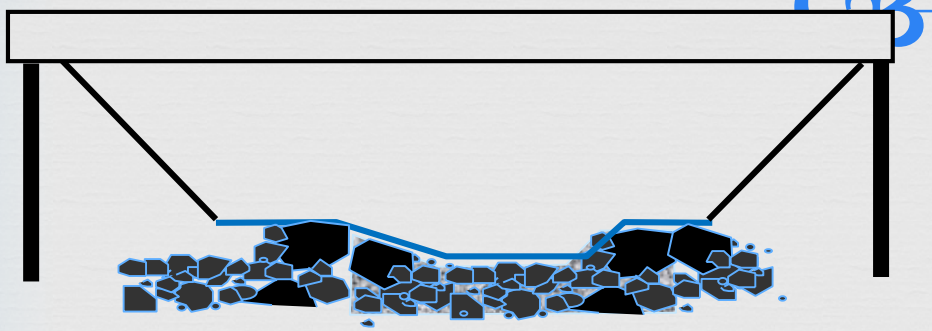
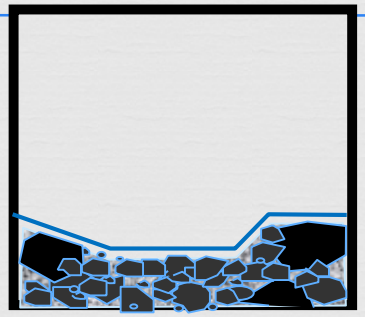
Acknowledgements

- Contributors to Forest Service Stream Simulation Guide and Training
- Bob Gubernick
- Photos

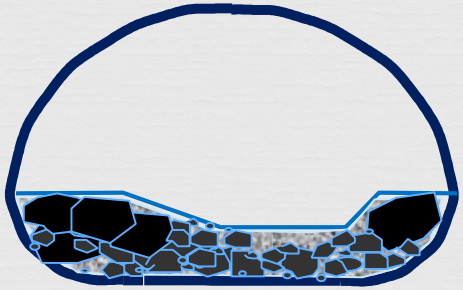
Purpose



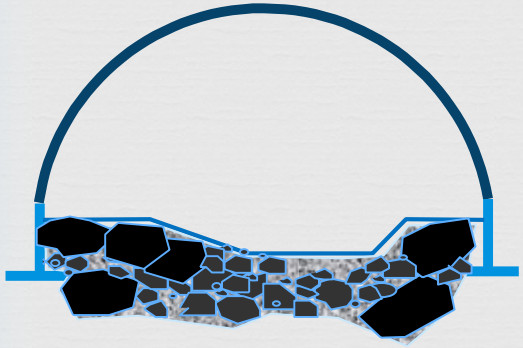
Bridge



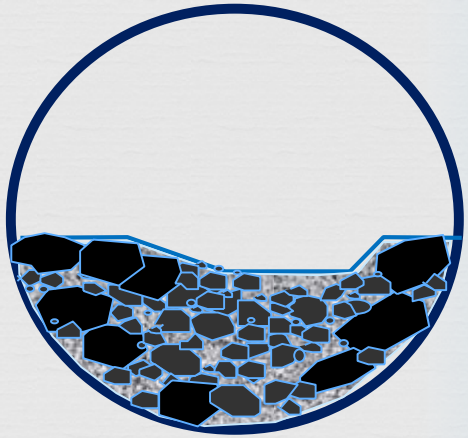
b. Box



c. Pipe Arch



d. Bottomless Arch



e. Embedded Round

Outline

- Cost
- Stream Factors
- Road Factors
- Construction Concerns

Cost

- Not always just the cost of the structure materials.
- Need to consider:
  - Backfill materials
  - Installation Equipment
  - Safety Features

Bankfull Width

- Round Structure
  - Solid pipe maximum
    - 12′-14′
  - Structural Plate
    - 51′
    - But how much fill inside do you need

Bankfull Width

- Pipe Arch
  - 20 ft
- Ellipse
  - 40 ft

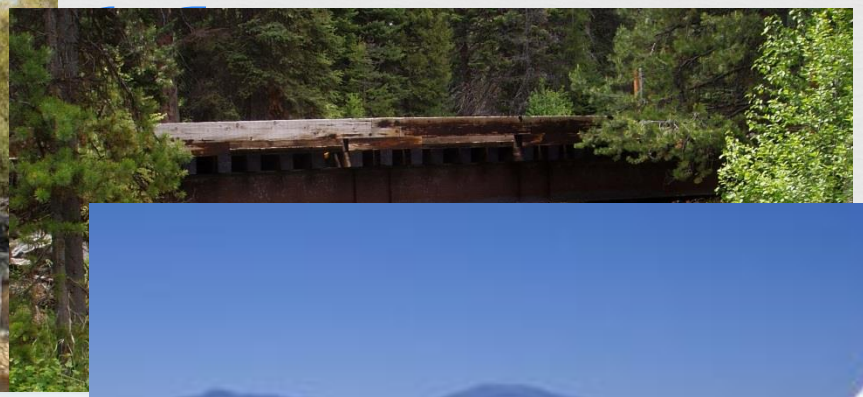
Bankfull Width

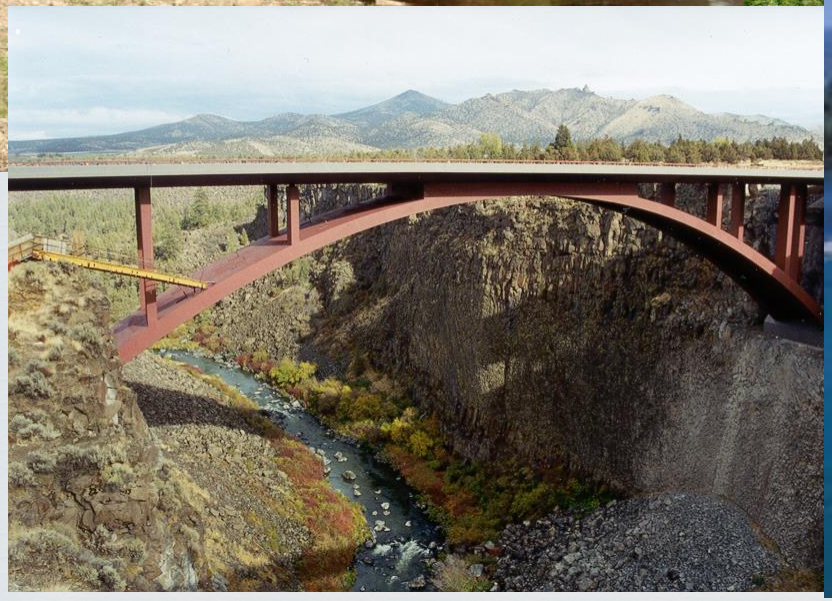
- Bottomless Arch
  - Steel
  - Up to 83’

Bankfull Width

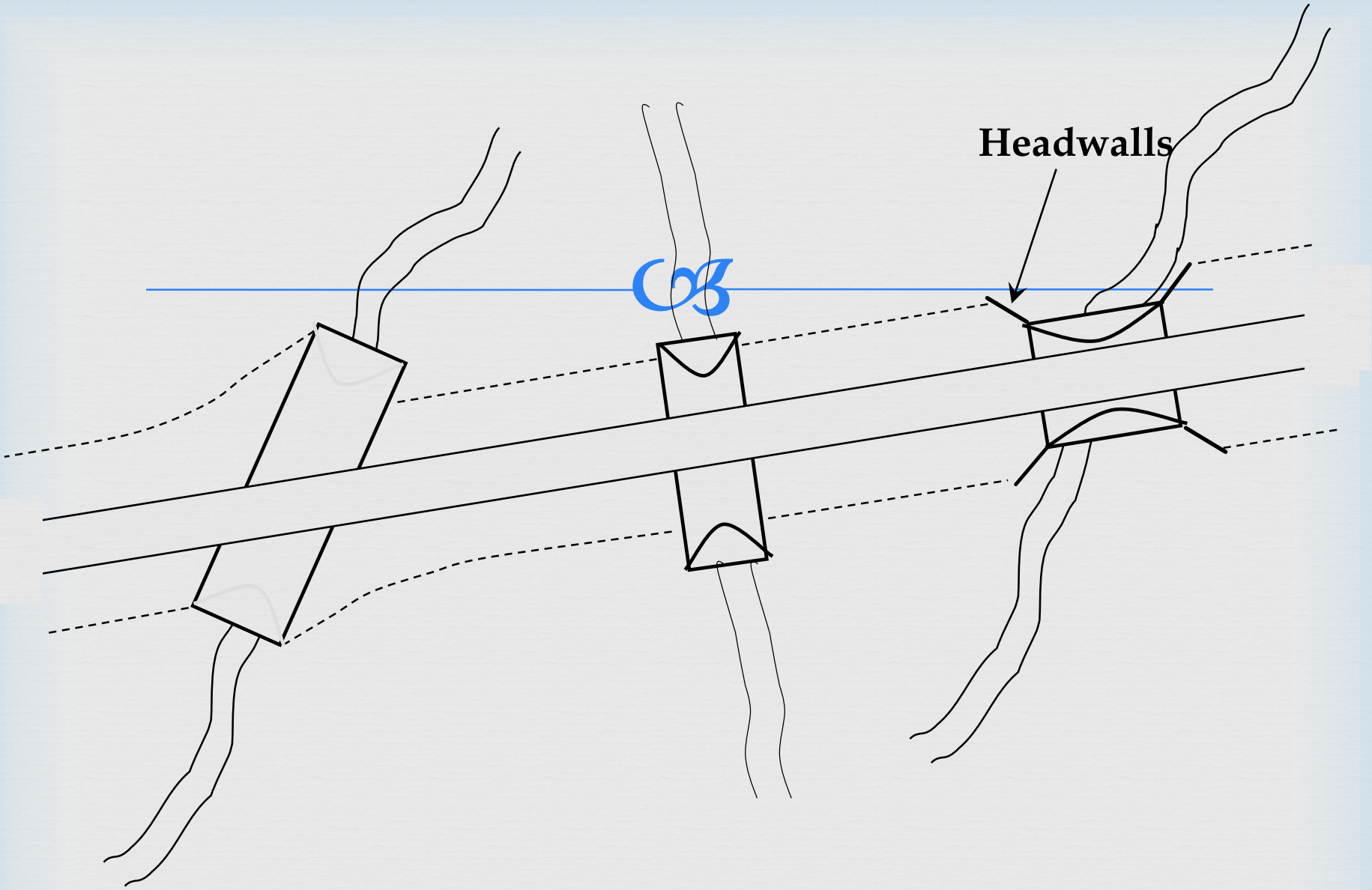
- Bottomless Arch
  - Concrete
    - Up to 35 ft

Bridges





Horizontal Alignment


Headwalls

Entrenchment Ratio

Entrenchment Ratio

Etnrenchment Ratio

Entrenchment Ratio

Vertical Alignment

- How much cover is there?

Clearance Limitations

Adequate Cover

But not too much…

Gradient

- Gradient
  - Embedded pipes
  - Baffles

Hydraulics

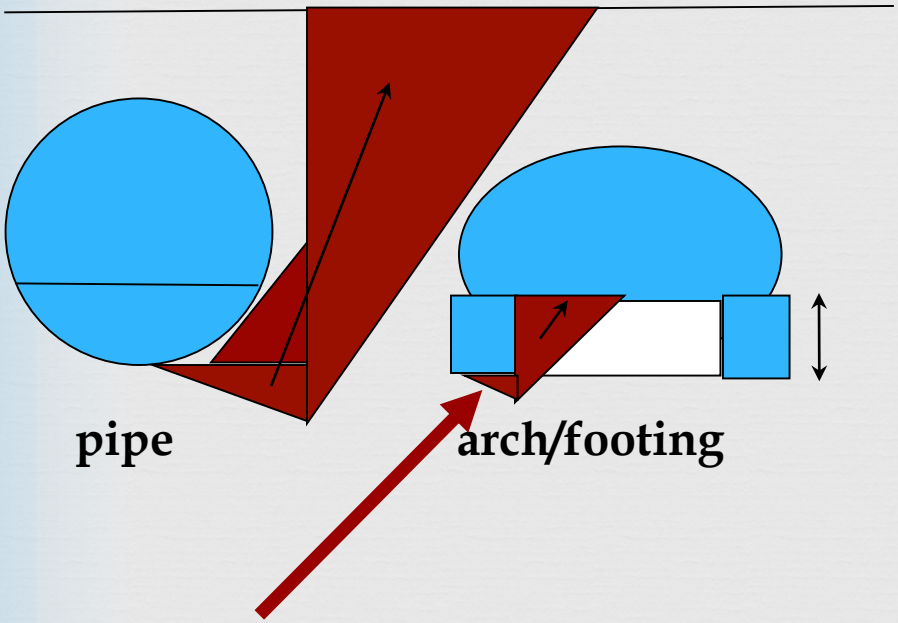
- How much cross-sectional area is needed?
- $Q=1/n*S^{1/2}*R^{2/3}*A$

Hydraulics

- 10 ft span X 4 ft rise single radius arch
  - 33.2 SF
- 10 ft span X 4 ft rise box shape
  - 41.3 SF
- 24% increase by changing shape
- Nearly doubled cost of the structure
  - $233/ LF vs $430/ LF

Debris

Bearing Capacity



- Bearing Capacity of pipe is 2-4* open bottom arch.
- Pipes must fail through entire height of fill – seldom a concern. Settlement is a more likely phenomena.
- It is imperative to prevent scour below the footing design depth. – long profile

Zone of vulnerability, A minimum embedment depth is required to develop foundation bearing capacity in soil.

Soil and Climate

- Soil and Climate Conditions (life of structure)
  - pH
  - Acid rain
  - Moisture

"Normal" Corrosion & Abrasion in a Galvanized Steel Culvert

Abnormal Corrosion Galvanized Steel backfill/groundwater properties

Table from Oregon DOT

Material	Location East or West of Cascades	Water & Soil pH	Soil Resistivity (ohm-cm)	Service Life
Galvanized Steel	East	4.5 – 6.0	1500-2000	30
	East	>6 – 7	1500-2000	35
	East	>7 – 10	1500-2000	40
Galvanized Steel	West	4.5 – 6.0	1500-2000	15
	West	>6 – 7	1500-2000	20
	West	>7 – 10	1500-2000	25
Aluminum	East or West	4.5 - 10	>1500	75
Aluminized Steel	East	5 – 9	>1500	65
	West	5 - 9	>1500	50
Concrete	All Locations	4.5 – 10	>1500	75+
Polyethylene	All Locations	4.5 – 10	>1500	75

Road Considerations

Road Use

- Traffic Level
  - What is amount/type of use? public/private?

Photo by Luke Nichols/Daily Sun Staff

Surfacing

Road Width and Alignment

- Lane Width
- Curves

Safety

- Safety
  - Are you creating on unusual hazard in the road
  - Guardrails
  - Curbs

SHPO

Photos by Jim Kozik, USDA Forest Service, Region 8

Construction Considerations

- Timing
  - WHEN is the in-stream work window
    - Winter
    - Peak recreation
    - Fire Season
    - Hunting Season

Construction Time

- How Long is the window
  - Pre-cast
  - Cast in place
  - Modular

Access

- Access:
  - Can you get it there?
    - Horizontal/Vertical Alignment
    - Load Ratings

Access

- Access
  - How far does it have to come?
    - Materials
      - Pre cast
      - Structural Fill
    - Equipment
      - Cranes
      - Concrete Pumps

Conclusions

- Many factors affect the ‘best’ structure for a given site:
  - Stream
  - Road
  - Construction
  - Cost


Any
Questions?