This was presented on April 20th, 2020 and contains outdated information.
For the most up-to-date content, check out the "Final Report"

Honduras Pedestrian Bridge

William Hellman, Caroline Janssen, Miranda Mangahas, Nathan Miller, and Cole Siegenfeld

OUTLINE

- **BACKGROUND**
- **PRE-DESIGN**
  - Hydrological Assessment
  - Geotechnical Assessment
- **DESIGN**
  - Bridge Choice
  - Superstructure
  - Substructure
- **CLOSING ASSESSMENTS**
  - Community Assessment
  - Environmental Assessment
  - Cost Assessment

BACKGROUND

Where it all began

LOCATION

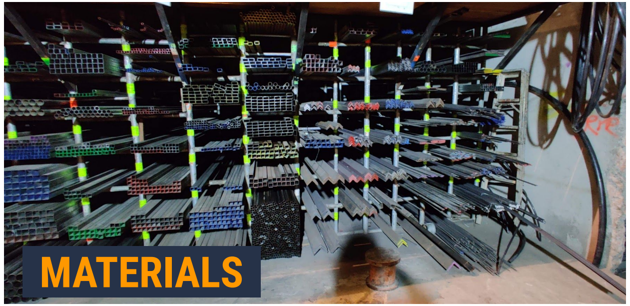
Bacadillas, Honduras

- Sponsor: Predisan
- 12 communities served
  - 3,165 people
- Partner with Lipscomb

CONTEXT

- **Connect** the Bacadilla community to the Predisan medical clinic in Honduras
- Consider the **needs** and **desires** of the community members
- Design a **durable, sustainable, economical, feasible, easily constructible**, and overall **beneficial** bridge

SITE VISIT



SITE VISIT


DE UAPS BACADILLA
LA MANI
LAS CAMILAS
LAGUNAS DEL UYASTE
BACADILLA
EL PUENTE
AGUAS PRECIOSA
LAGUNAS DE SAN JOSE
EL POTRERO

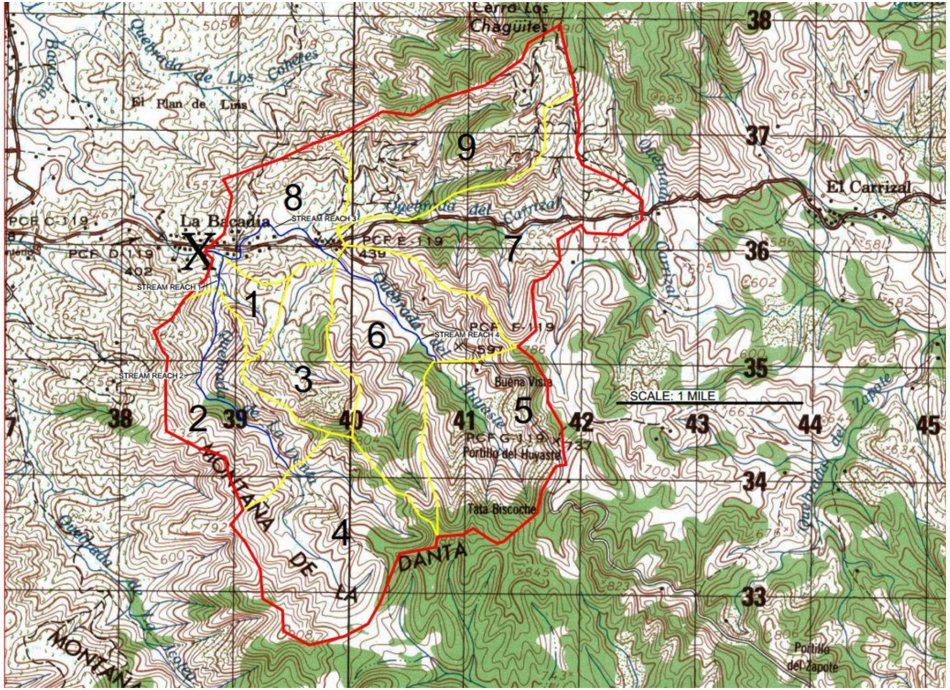
PRE-DESIGN

Gotta design before you design

Hydrological Assessment

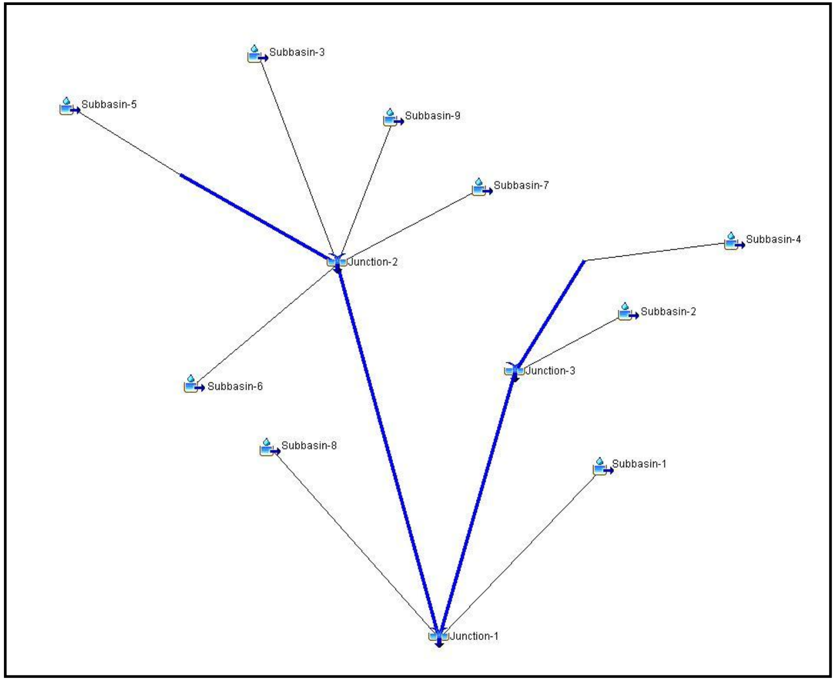
GOAL: Determine Minimum Bridge Height

METHOD: HEC-HMS



- Watershed delineation
  - 9 subbasins
  - 4 stream reaches

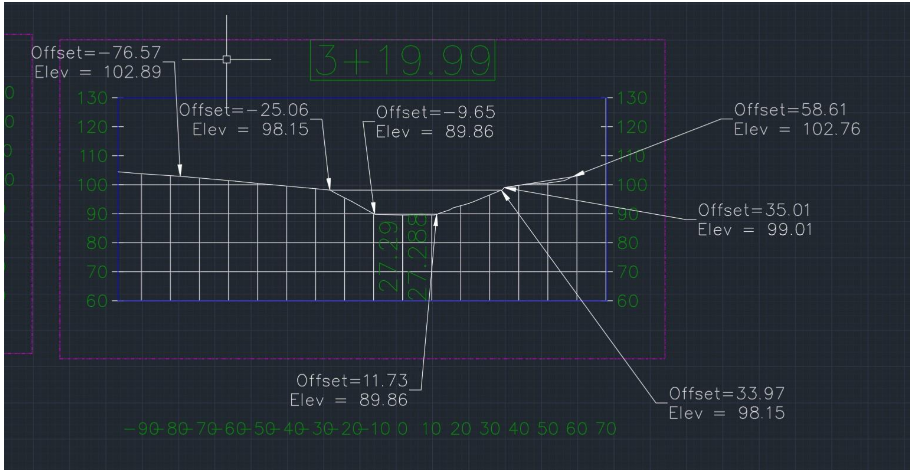
METHOD: HEC-HMS



- Conceptual layout
- Analysis Methods
- Determine output flow rate from rain event
  - Hurricane Mitch, 1998

METHOD: Manning's Equation

$$Q = VA = \left(\frac{1.49}{n}\right) A R^{\frac{2}{3}} \sqrt{S}$$



RESULTS

- Community member testimonies
- Conservative estimate of 101.4’
- Bridge deck elevation set at 104.5’
- Foundation locations

CN	Q (cfs)	Height (ft)	Elevation (ft)
65	1321.4	8.08	98.48
70	1500.0	8.87	99.27
75	1566.2	9.14	99.54
79	1651.5	9.45	99.85
85	1758.5	9.79	100.19
90	1825.4	9.98	100.38

Geotechnical Assessment

SUBSURFACE EXPLORATION

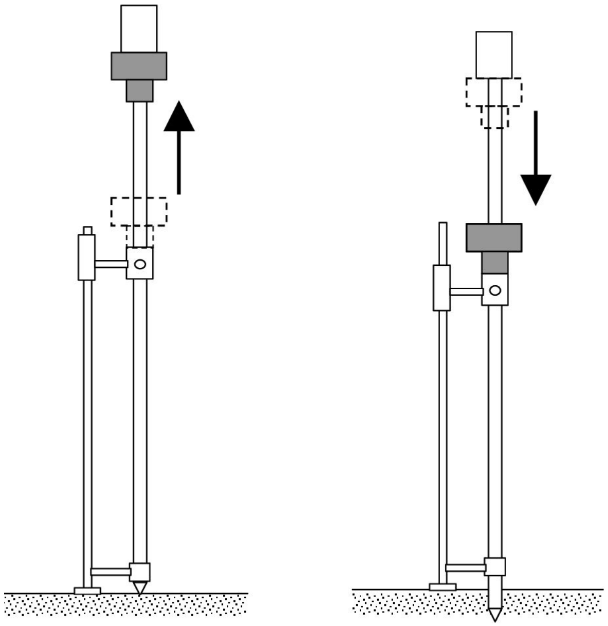
Auger Testing

- 4 Boring Samples
  - 3 on clinic side
  - 1 on road side

Boring	Auger Refusal Depth (ft)
B-1	2.00
B-2	4.00
B-3	1.83
B-4	1.00

Dynamic Cone Penetration Test

- Modified version due to missing cone
- Calibration to standard penetration test values was not accomplished



AUGER SAMPLE ANALYSIS

- Ultimate Bearing Capacity: 2000 psf
- Sieve Analysis and Atterberg Limits Tests
  - Sample 1: poorly graded sand
  - Sample 2: poorly graded sand with silt

DESIGN

"Designers are meant to be loved, not to be understood."
- Margaret Oscar

Bridge Choice

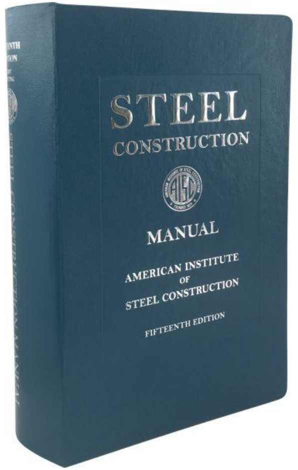
- **Suspended** and **Suspension**
  - Steel Cables
    - Sourcing and Cost
  - Freeboard Clearance
    - Bridge Sag
  - Foundation Spacing
    - Roadside Restrictions

STRINGER SELECTION

Truss → **Stringer**

BEAM SELECTION

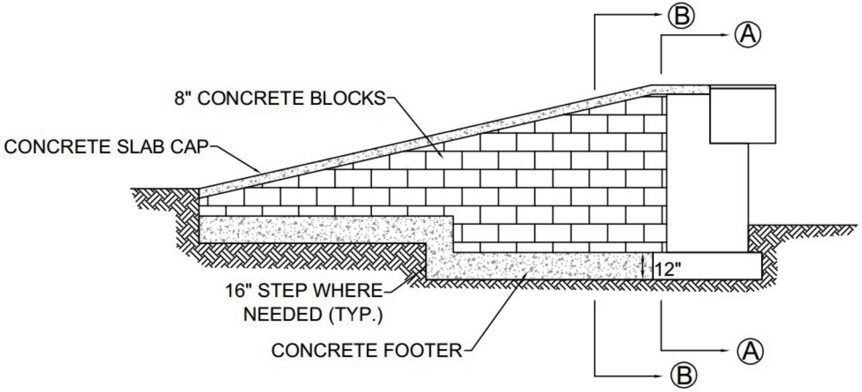
- W24x68 Grade 50 Steel Beams
- Assumptions:
  - 80’ span length
  - Dead Loads:
    - Decking - 30 plf
    - Railing - 40 plf
    - Steel - 70 plf
  - Live Loads:
    - 255 plf
      - 25, 200 lb people
      - motorcycles

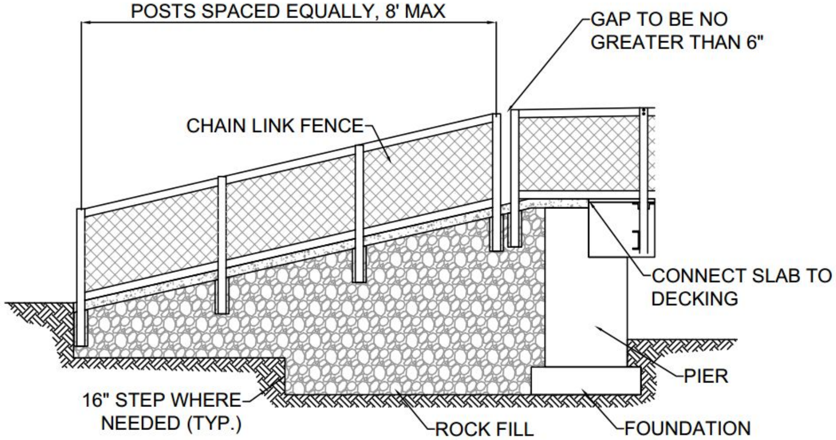


Superstructure

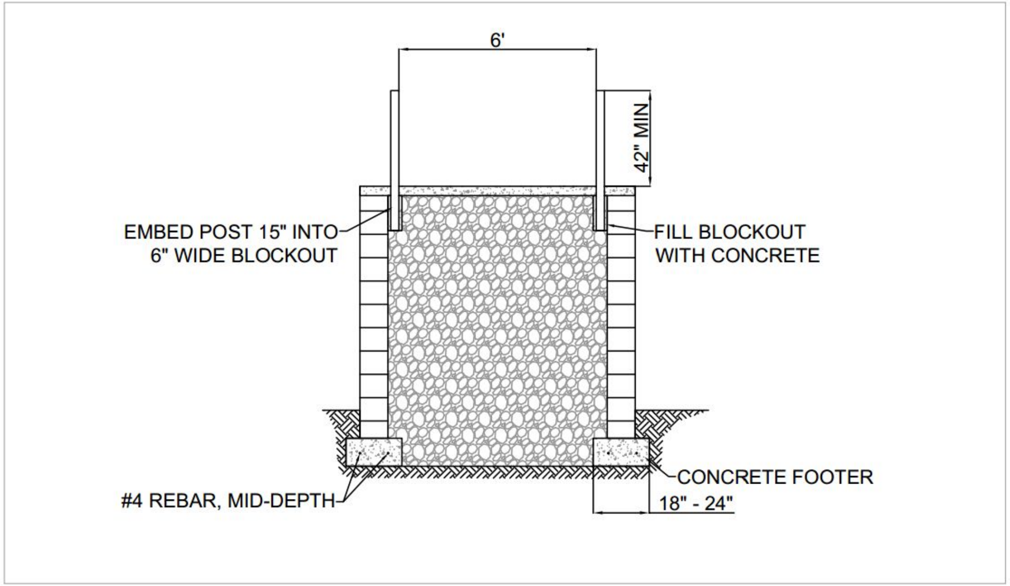
APPROACH RAMPS

- Maximum slope 5:1 (20%)
- 23’ ramp near clinic
- Shorter near road

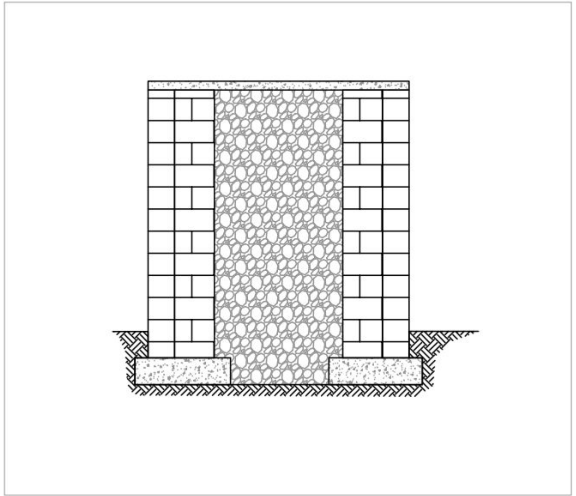




APPROACH RAMPS

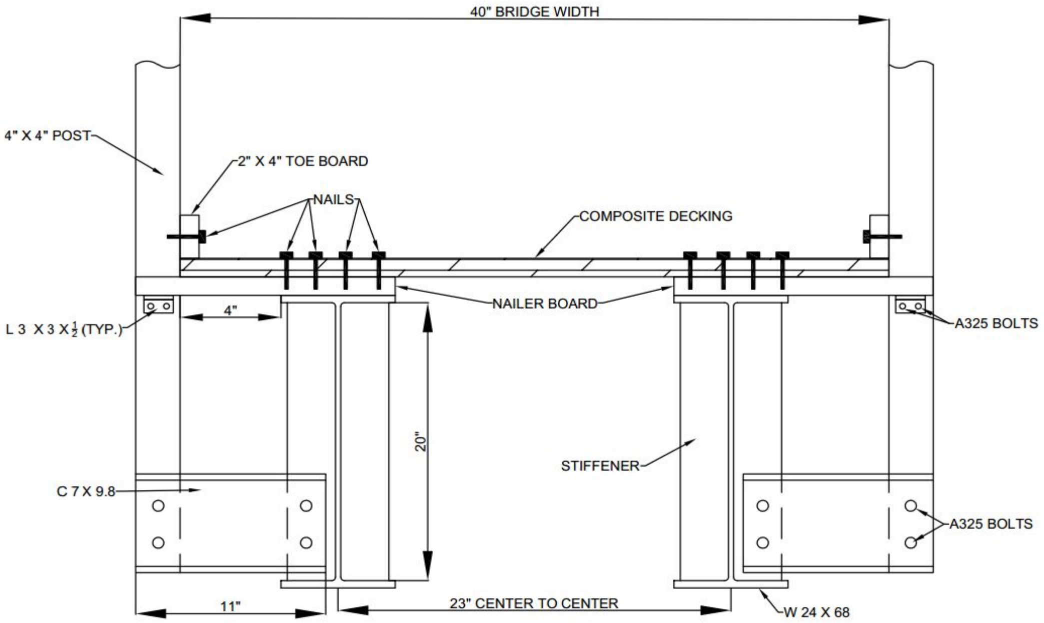


SECTION BB



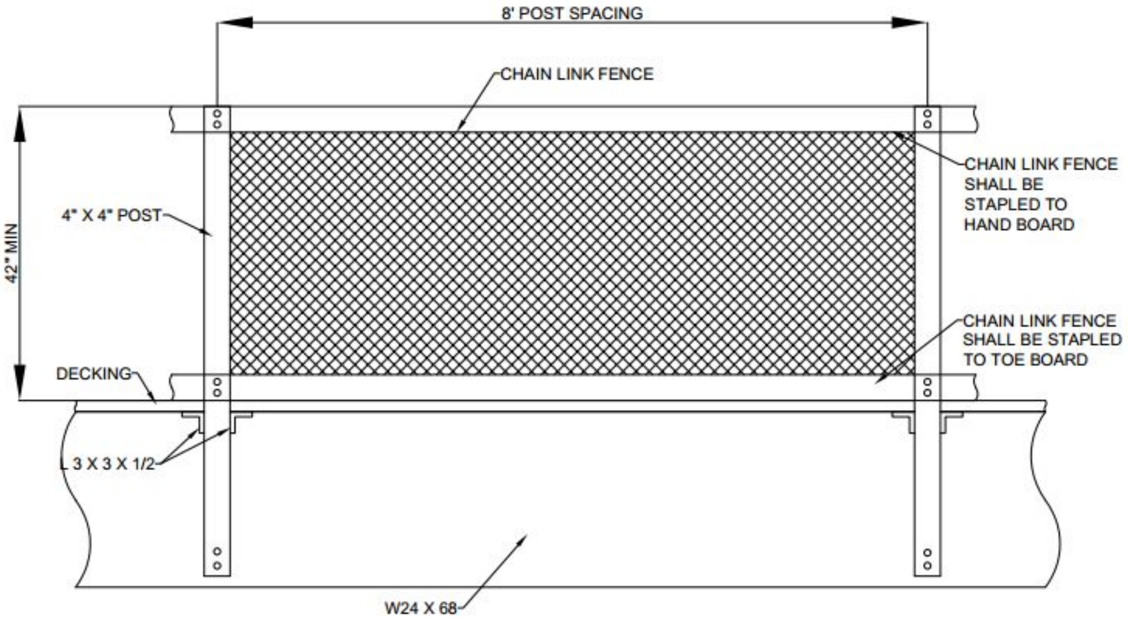
SECTION AA

DECKING & RAILING



- Material Options
  - Composite Decking
  - Wood
- Rails Designed for 750 lb
- Chain Link Fence on Side

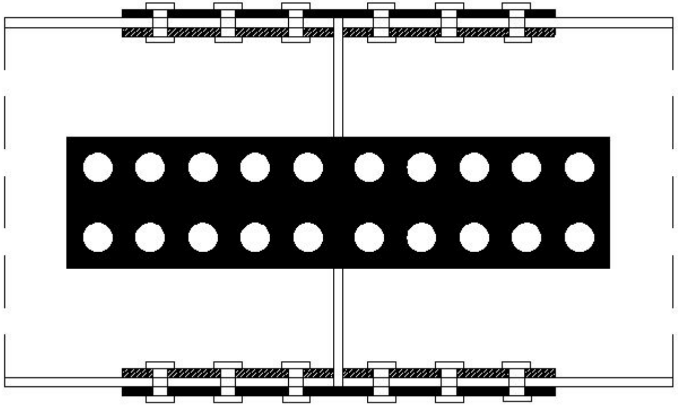
DECKING & RAILING (cont.)

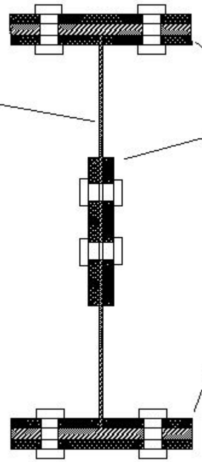


SPLICES

2 Rows of 3 Bolts for each flange splice

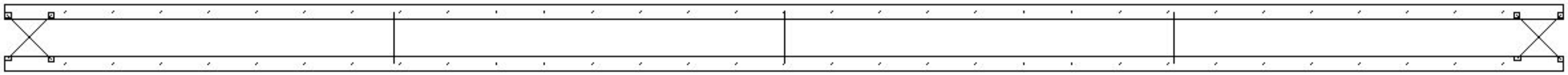
2 Rows of 5 Bolts for each web splice





CROSS-FRAMES

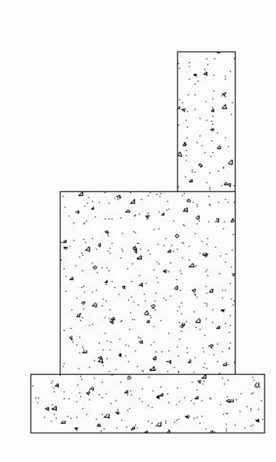
- Steel Channel Sections (C4x4.5) spaced at 20ft
- Steel Angles (L4x4x3/8) crossed at ends for additional lateral support

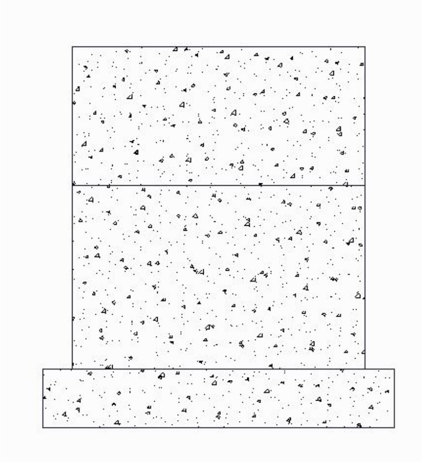


Substructure

SUBSTRUCTURE SPECIFICATIONS

- Bearing on soil (2000 psf)
- Geometry of Piers
- Depth Requirements
- Rebar Sizing and Placement

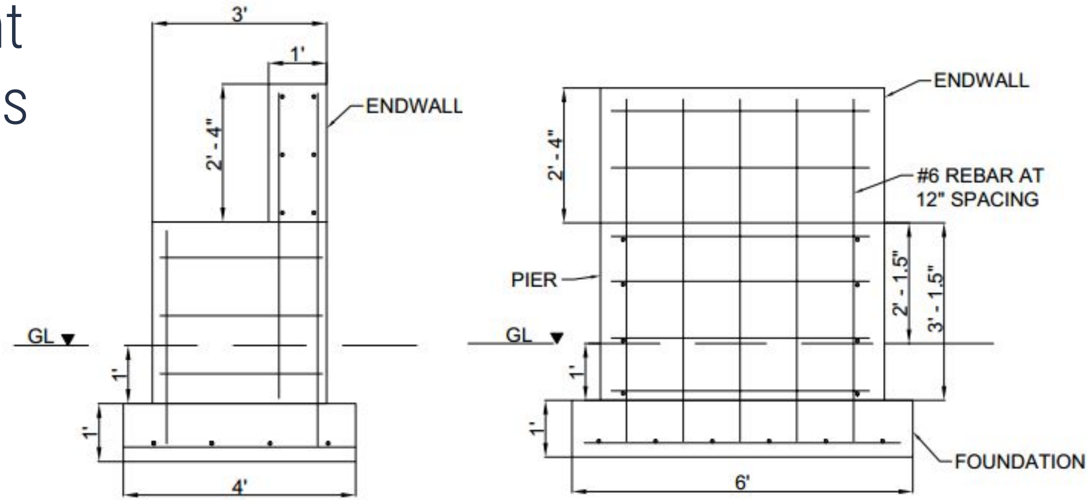




SUBSTRUCTURE CALCULATIONS

- Our bridge is relatively light
- Minimum footing thickness & minimum area of steel

- 1 foot thick footing
- 3/3.5 foot tall piers
- ~200 ft of rebar



CLOSING ASSESSMENTS

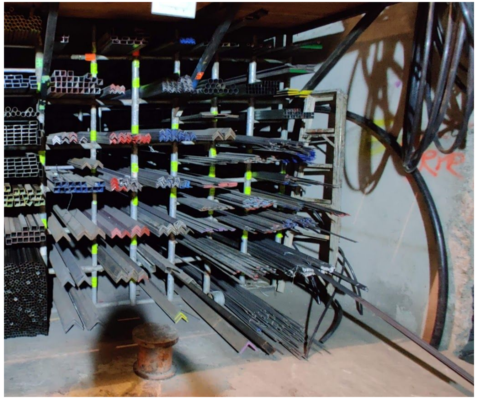
Community Assessment

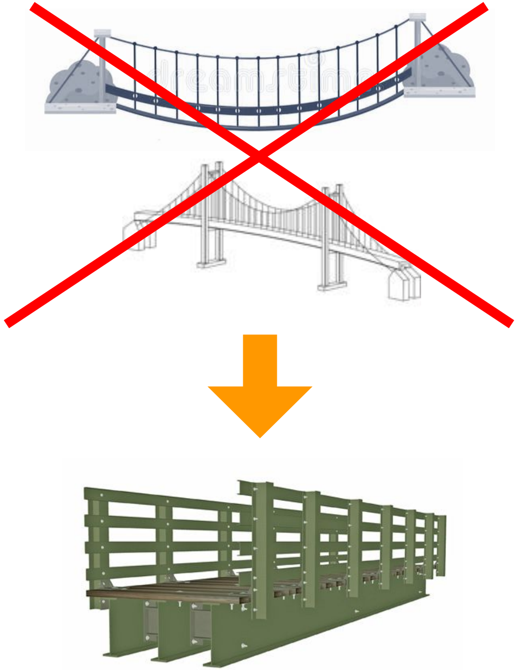
COMMUNITY ASSESSMENT

1) Is this solution right for the community?

2) Is the community invested?

3) How will the design change to adapt to community needs?





Environmental Assessment

ENVIRONMENTAL ASSESSMENT

Steel Carbon Costs

- Approximate 12-tonnes of steel
- 22-tonnes of Carbon (unrecycled)
- 5.6-tonnes of Carbon (recycled)
- Most recycled material
- Minimize carbon emissions

ENVIRONMENTAL ASSESSMENT

Minding the Local Ecosystem

- Manage erosion, water runoff, and sedimentation
  - Utilize perimeter control barriers
  - Minimize disturbed area
  - Store and stockpile materials away from the construction site

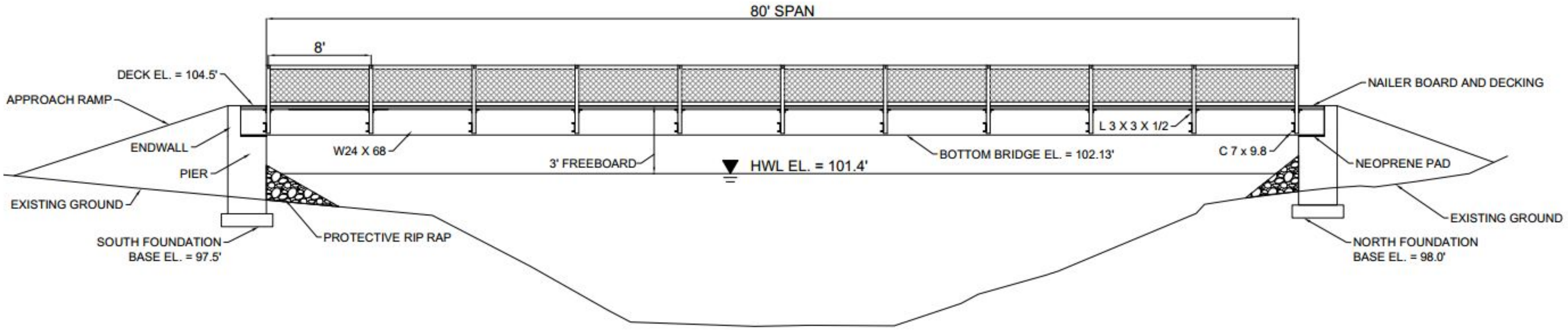
Cost Assessment

COST ASSESSMENT

- Cost Assumptions (In-Place):
  - Structural Steel: $1.25/lb
  - Concrete: $4.82/cubic-ft
  - Rebar: $1.00/lb

- Total Cost Estimate: **$18,500**
  - Structural Steel: $15,000
  - Concrete: $2,250
  - Rebar: $900

CONCLUSION


80' SPAN
8'
DECK EL. = 104.5'
APPROACH RAMP
NAILER BOARD AND DECKING
L 3 X 3 X 1/2
ENDWALL
W24 X 68
BOTTOM BRIDGE EL. = 102.13'
C 7 x 9.8
PIER
3' FREEBOARD
HWL EL. = 101.4'
NEOPRENE PAD
EXISTING GROUND
EXISTING GROUND
SOUTH FOUNDATION
BASE EL. = 97.5'
PROTECTIVE RIP RAP
NORTH FOUNDATION
BASE EL. = 98.0'

SPECIAL THANKS

- John Hastings and Scott Wilson
- Predisan Health Ministries
- Dr. Lori Troxel and Bowen He
- Vanderbilt Civil Engineering Department
- Lipscomb University Civil Engineering Department
- Dr. LeBoeuf & Dr. Byers

THANK YOU!

Questions?

Cool Questions to Ask

- *How did you ensure effective collaboration with the Lipscomb team?*
- *Could you expand more on the cost assessment?*
- *Were there any particular people you met on the site visit who impacted you most?*
- *What would have happened if you had placed the bridge at a lower height?*
- *I love rebar. Could you tell me more about the rebar in the foundation?*

Pedestrian Bridge Standards

13.8—PEDESTRIAN RAILING

13.8.1—Geometry

The minimum height of a pedestrian railing shall be 42.0 in. measured from the top of the walkway.

A pedestrian rail may be composed of horizontal and/or vertical elements. The clear opening between elements shall be such that a 6.0-in. diameter sphere shall not pass through.

When both horizontal and vertical elements are used, the 6.0-in. clear opening shall apply to the lower 27.0 in. of the railing, and the spacing in the upper portion shall be such that an 8.0-in. diameter sphere shall not pass through. A safety toe rail or curb should be provided. Rails should project beyond the face of posts and/or pickets as shown in Figure A13.1.1-2.

$$P_{LL} = 0.20 + 0.050L \qquad (13.8.2\text{-}1)$$

where:

L = post spacing (ft)

The application of loads shall be as indicated in Figure 13.8.2-1, in which the shapes of rail members are illustrative only. Any material or combination of materials specified in Article 13.5 may be used.

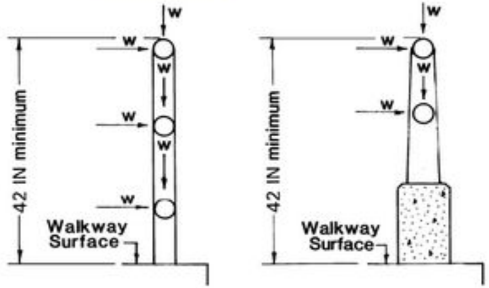


Figure 13.8.2-1—Pedestrian Railing Loads—To be used on the outer edge of a sidewalk when highway traffic is separated from pedestrian traffic by a traffic railing. Railing shape illustrative only.

The design wind load for chain link or metal fabric fence shall be taken as 0.015 ksf acting normal to the entire surface. The wind load need not be applied simultaneously with live load.

Splice Design

Bolt Count Overrides

	Count Override Status	Bolt Count - Calculated	Bolt Count - User Specified	Valid Override
Top Flange Bolt Count Override	Spreadsheet Calculated	6		DNA
Web Bolt Count Override	User Specified	8	10	OK
Bottom Flange Bolt Count Override	Spreadsheet Calculated	6		DNA

Design Check Status

NOTICE: DO NOT MODIF'

Flange Splice

	Factored Yield Resistance Check - Tension	Net Section Fracture Check - Tension	Check $A_n \leq 0.85\ A_g$ AASHTO 6.13.5.2	Block Shear Rupture Resistance	Bearing Resistance
Top Flange - Outer Splice Plate	OK	OK	OK	OK	OK
Top Flange - Inner Splice Plate	OK	OK	OK	OK	OK
Bottom Flange - Inner Splice Plate	OK	OK	OK	OK	OK
Bottom Flange - Outer Splice Plate	OK	OK	OK	OK	OK

COST ASSESSMENT

	Category	Quantity	Cost/Unit	Total Cost
SUMMARY	Overall			$18,447.64
	Structural Steel	11923.75 lbs	$1.25/lb	$14,900.95
	Concrete	467.01 cubic-ft	$4.82/cubic-ft	$2,250.89
	Rebar	889.24 lbs	$1.00/lb	$889.24
	Masonry	300 blocks	$1.00/block	$300.00
	Superstructure Cost			$15,721.51
	Substructure Cost			$2,619.57