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Civil and Environmental Engineering Services

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PROPOSED

LAFAYETTE COLLEGE

CEERC

Civil & Environmental Engineering Research Center

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Report 9

Pedestrian Bridge

Site

Former Hummel Lumber Supply at 900 Bushkill Drive

City of Easton, Northampton County, Pennsylvania

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Pedestrian Bridge Analysis Table of Contents

FIGURES

SECTION I: PROPOSED FEATURES

A bridge from Fischer Field to the future CEERC would allow pedestrians to travel safely from main campus to the new building. This bridge would be design so that plant operation vehicles and public safety vehicles could also use the bridge. The bridge will be open air, but covered so that it will not need to be cleared in the event of snowfall.

SECTION II: BRIDGE ANALYSIS

II.1 Dead Loads:

		Unit weight
1.	HSS 9"x7"x5/8"	59 lb/ft
2.	HSS 5½" x5½"x3/8"	25 lb/ft
3.	Glass	160 pcf
4.	Concrete Decking	50 psf

II.2 Live Loads:

		Uniform
1.	AASHTO LRFD for Pedestrian Bridges	90 psf

II.3 Wind Load:

1. AASHTO, Articles 3.8 and 3.9: 38.3 psf

II.4 Vertical Uplift:

1. AASHTO LRFD for Pedestrian Bridges 20 psf

II.5 Snow Loads:

1. Snow Loads determined by Bethlehem, PA 30 psf

II.6 Ice Loads:

1. NYDOT Sign Design 20 psf

SECTION III: BRIDGE DESIGN

III.1 Preliminary Bridge Design

The bridge will be designed to meet both AASHTO and ADA standards. The bridge will span 120 ft and be 40 ft above the road. The bridge will be connected to the future parking garage on one side and Fischer Field on the other.

The bridge is going to have a round shape as oppose to a standard truss or arch bridge. What made this bridge difficult to design was the long span and unusual shape. The three designs that were modeled in SAP2000 changed the orientation of the cross bracing, but kept the dimensions the same.

The first design involved all the longitudinal cross bracing being parallel to each other, sloping upward. A visual is shown in Figure III.1. The resulting forces on the longitudinal cross bracing were extremely high with a 390 k*ft moment and axial forces in the 300 kips, the resulting moment diagram is shown in Figure III.2. Using the 14th Edition AISC Steel Construction Manual L-shapes, I-Beams, round HSS tubes and rectangular HSS tubes were analyzed for these forces. The I-beam that would have been used was W21x68, which is a deep section that would not allow glass to be used. There weren't any L-shapes or round HSS tubes large enough to carry the loads and the rectangular tube that was determined to be adequate was an HSS 16"x12"x1". Using material this large would have resulted in very little open space on the bridge. The bridge would have essentially been a metal tube.

The second design that was tested involved parallel, horizontal bracing. A visual is shown in Figure III.3. The resulting forces on this bridge were about 350 kips axial and 45 k*ft moment, the resulting moment diagram is shown in Figure III.4. This design required small material than the first design, but the material that would have been used still left little room for glass.
Since the longitudinal cross bracing material was determined to be inefficient for the design, material for the transverse ring was not analyzed.

Section III.2: Final Design

The third design involved lattice bracing. A visual is shown in Figure III.5. This design resulted in 300 kips axial force, in both compression and tension, and 20 k*ft in moment on the longitudinal cross bracing, the resulting moment diagram is shown in Figure III.6. This design was chosen because it had the lowest resulting forces and would require the least amount of material.

Using the 14th Edition AISC Steel Construction Manual, L-shapes, I-Beams, round HSS tubes and rectangular HSS tubes were analyzed. The I-Beam that would have been used for the longitudinal cross was determined to be a W18x35. None of the L-shapes were large enough to carry the loads. Because of the axial load, the round tube that was determined to be adequate was an HSS 14"x0.312". The rectangular material to be used was determined to be HSS 9"x7"x5/8". The rectangular tube was chosen to be used because it allowed for the most window room. These materials leave about a four-foot space for glass to be put in to cover the bridge and create windows and a covering.

The transverse tube bracing was then analyzed. The resulting forces on were 100 kips axial and 3 kip*ft moment. For ease of connection, a square tube will be used for the transverse ring. A square HSS 5½"x5½"x5/8" was determined to be adequate for the forces found.
The transverse ring will be constructed by cutting the square HSS tube into sections and welding them in between the rectangular HSS tubes. The lattice will be made by cutting the rectangular

HSS tubes that slope up at the full length, cutting the bars that slope downward at a shorter length and then welding the bars together. Details of this can be seen in Figure III.7. Construction of the lattice rings can take place offsite. The rings can then be trucked in and lifted into place by a crane.

The bridge will be connected to the parking garage and Fischer Field by a moment resisting, concrete tunnel block. The decking support will be a concrete slab that is designed to support pedestrians, bikes and plant operations golf carts. The glass in between the bracing is able to withstand the snow loads for the Easton area. This will provide the bridge with a covering and ensure that no snow removal will be necessary. An elevation view of the bridge can be seen in Figure III.8.

FIGURES AND TABLES

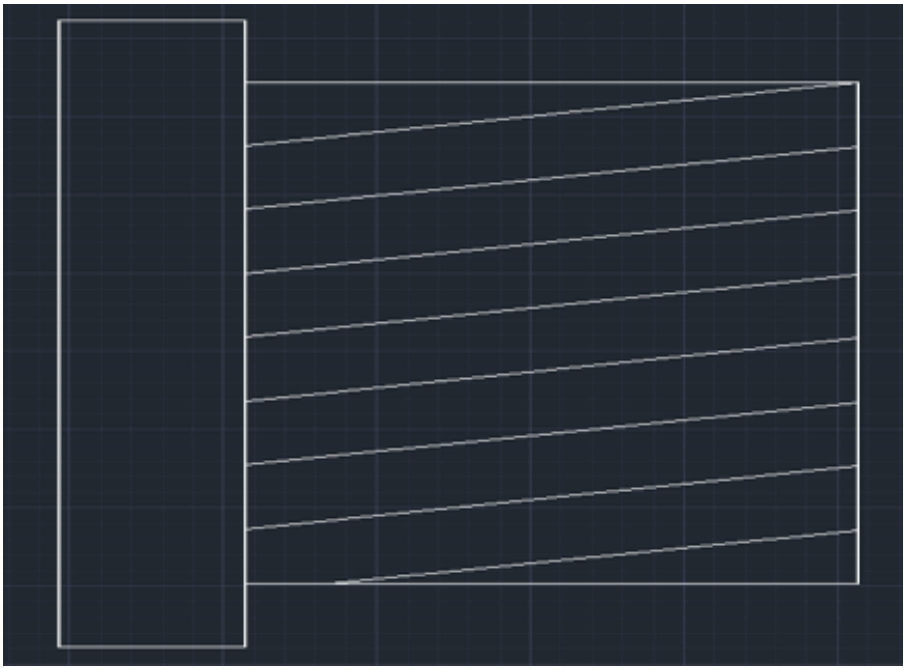

Figure III. 1. Bridge section with sloped cross bars.

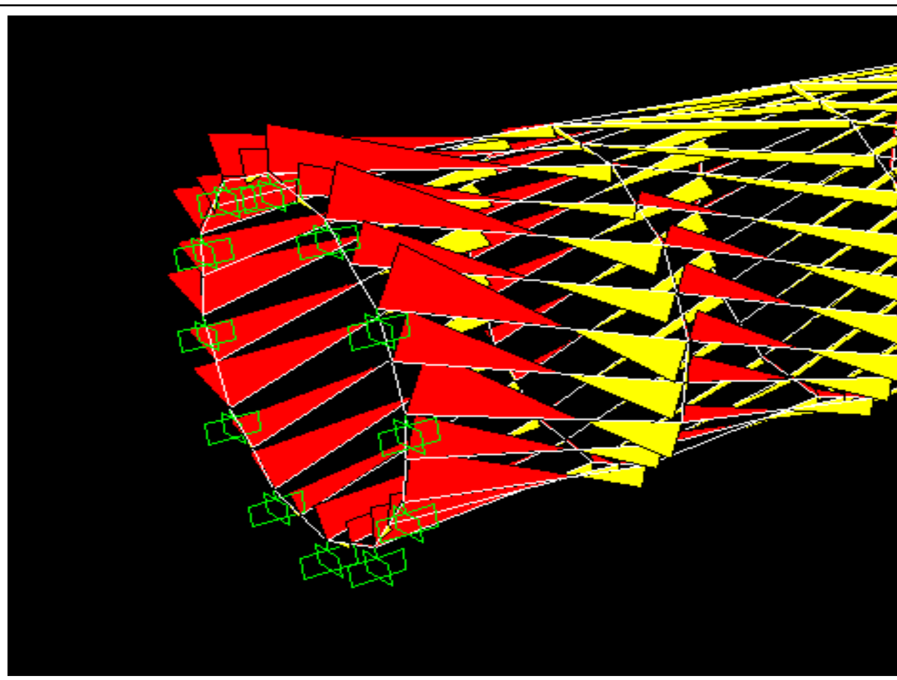

Figure III. 2. Moment diagram for sloped cross bar bracing.

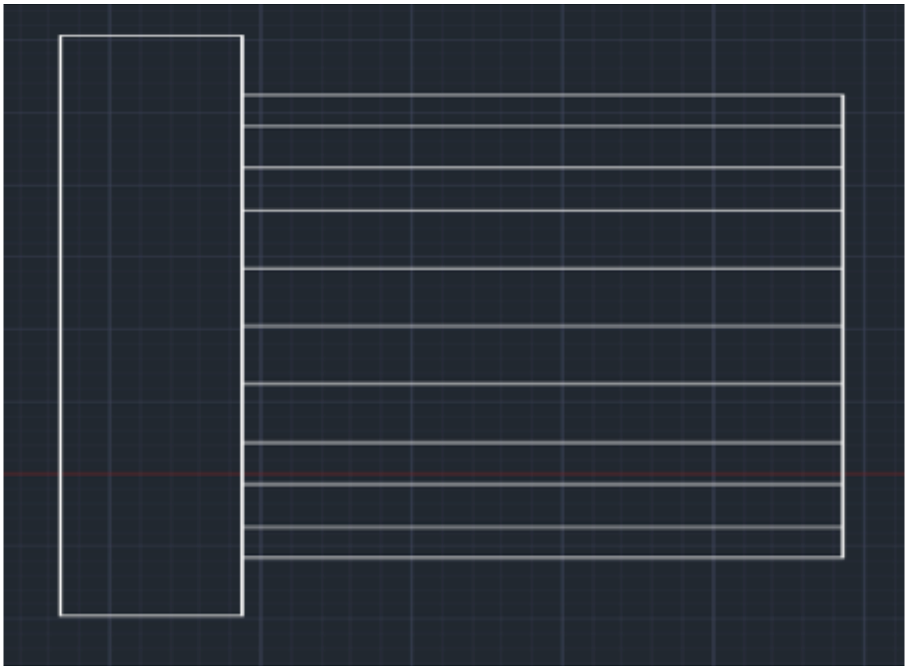

Figure III. 3. Bridge with horizontal cross bracing.

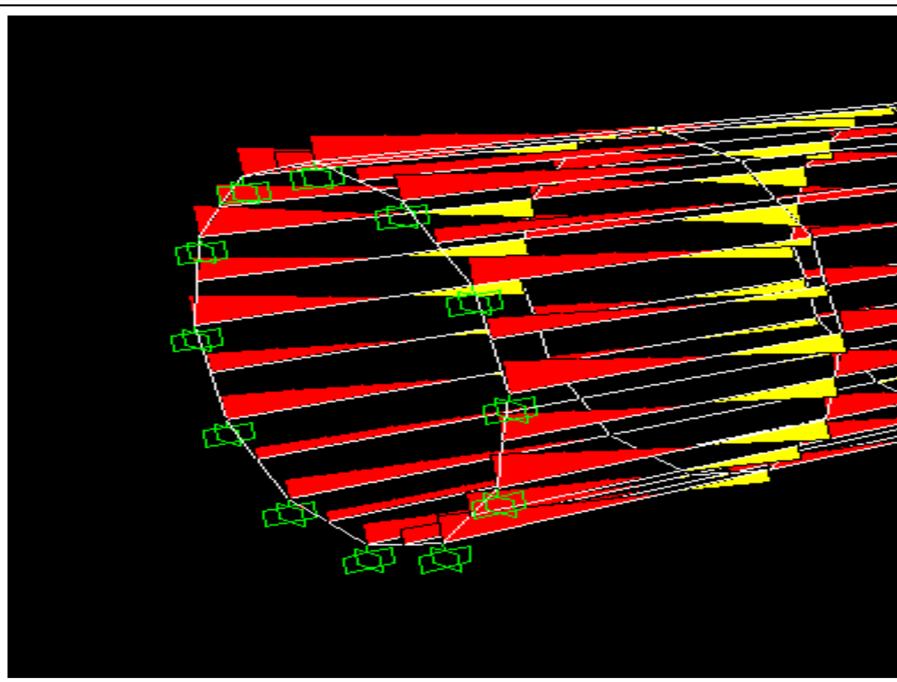

Figure III. 4. Horizontal bracing moment diagram.

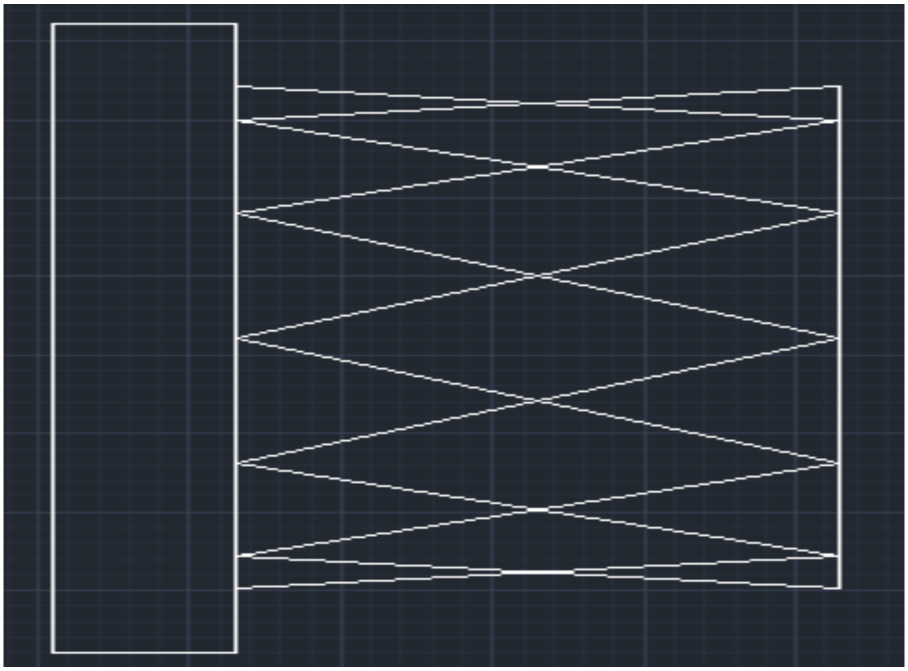

Figure III.5. Bridge section with lattice bracing.

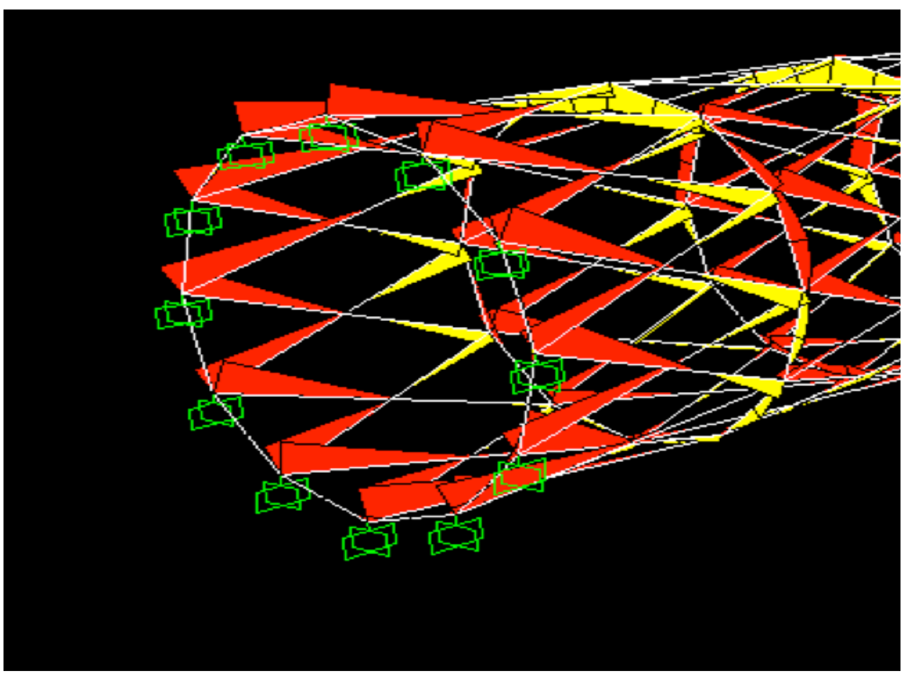

Figure III.6. Lattice Bracing moment diagram.

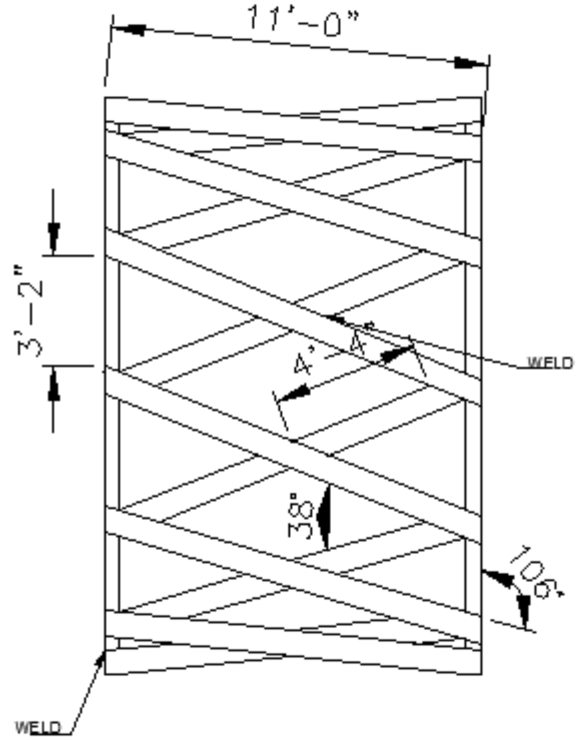

Figure III.7 Lattice detail

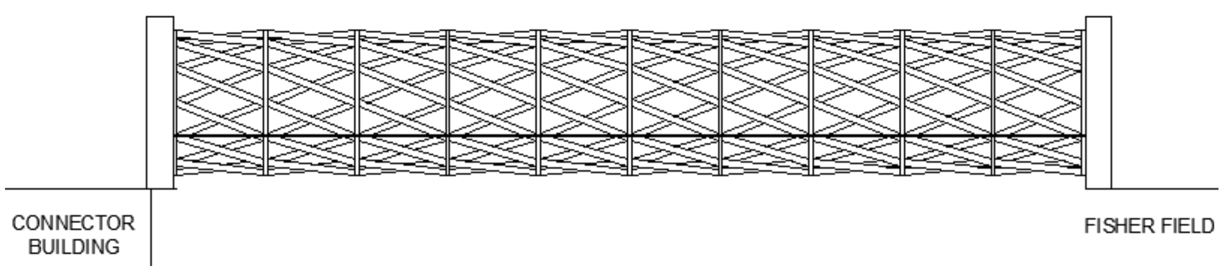

Figure III.8. Elevation view of the bridge.