Overhead Pedestrian Bridge Illumination Study

Problem

The overhead pedestrian bridge that crosses over W. North Avenue is a unique architectural feature that signifies the presence of Coppin State University in the community. The bridge connects the current campus to the new campus. Coppin State University has planned to build at a minimum four more buildings in the new part of campus in future years. The bridge will experience even more traffic once the new parking garage on the other side of the bridge is completed. The Health and Human Services Building contains outreach programs that will service the community which include a daycare center and a clinic. Currently this structure is lit in a dull industrious fashion.

Solution

The goal of the lighting redesign is to create a prestigious symbol for the college. Everyone who drives down W. North Avenue will be captivated by the new lighting scheme. The bridge literally connects old campus to new campus and signifies the college's effort to rebuild the area surrounding new campus. The luminaires selected blend into the structure to hide the source of the light. The redesigned lighting scheme highlights the prominent architectural and structural features of the building while shining a beacon of light into the community.

Methodology

The fixtures and layout were chosen to produce a certain illuminance level, while accentuating the architectural features of the bridge. The illuminance levels were designed according to the IESNA Lighting Handbook, which recommends that an exterior active walkway of a building should maintain a horizontal illuminance of 5 footcandles and a vertical illuminance of 3 footcandles. These light levels are important to reach for safety, security and facial recognition. The fixtures are manually controlled and time controlled to turn on at 4 pm and off at 7am.

The new fixtures were then circuited to the respective panel board (LPN2) which is 480/277 volts. The current circuit (number 4) was then redesigned. Emergency fixtures with emergency ballasts were utilized in the redesign process the same way as the original design. The emergency ballasts have the ability to become battery operated when the power goes off. The last step was to analyze the cost and maintenance of the new design.

Resources & Tools

AGI Lighting Software
Alexis Kreft – Electrical/Lighting 5th Year Student
AutoCAD
Gardco – Fixture Manufacturer
Illumination Engineering Society of North America (IESNA) Handbook
Microsoft Excel
National Electric Code written by the National Fire Protection Agency

Lighting Impacts

Existing Conditions

The existing lighting design is depicted in Figure 1, Figure 2 and Figure 3. Forty pendant mounted fixtures are mounted in the center of the ceiling. The existing fixtures can be seen from the road below and do not highlight the truss system and the unique architecture.

Figure 1: Interior View of Existing Lighting Design

Figure 2: Exterior View of Existing Lighting Design

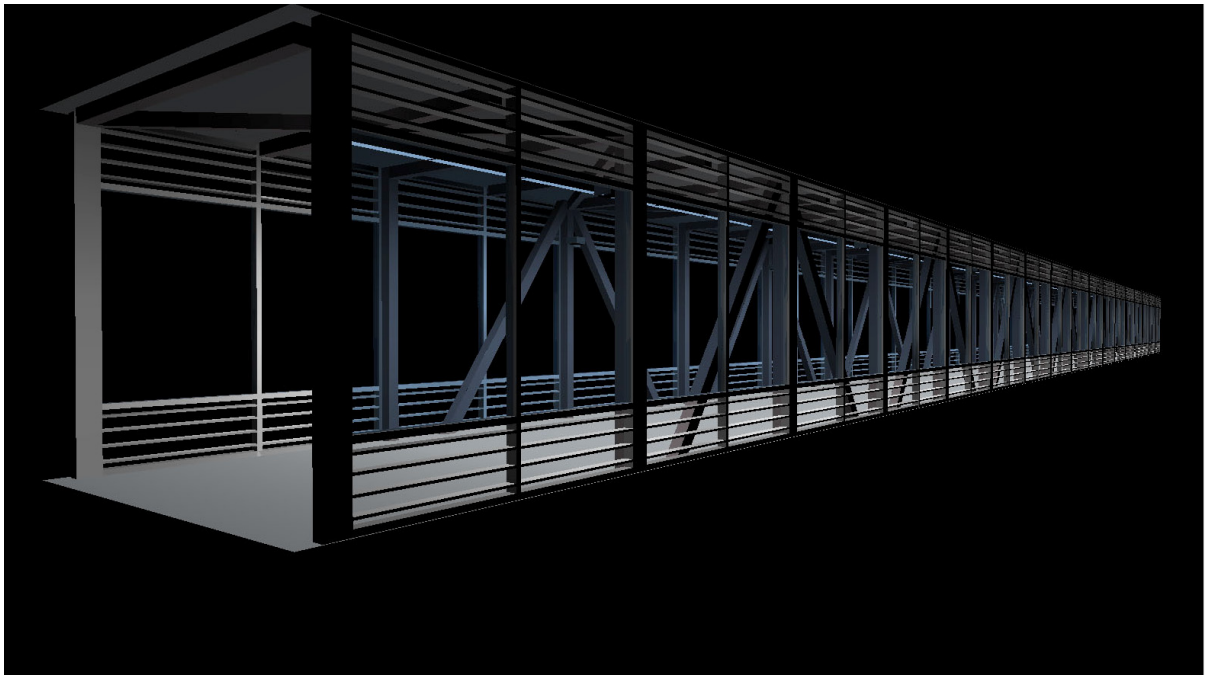


Figure 3: Exterior View of Existing Lighting Design

Figure 4 illustrates the existing illuminance levels in a pseudo color rendering. The color scale, seen on the left, represents the illuminance in footcandles. The current design focuses most of the light on the floor.

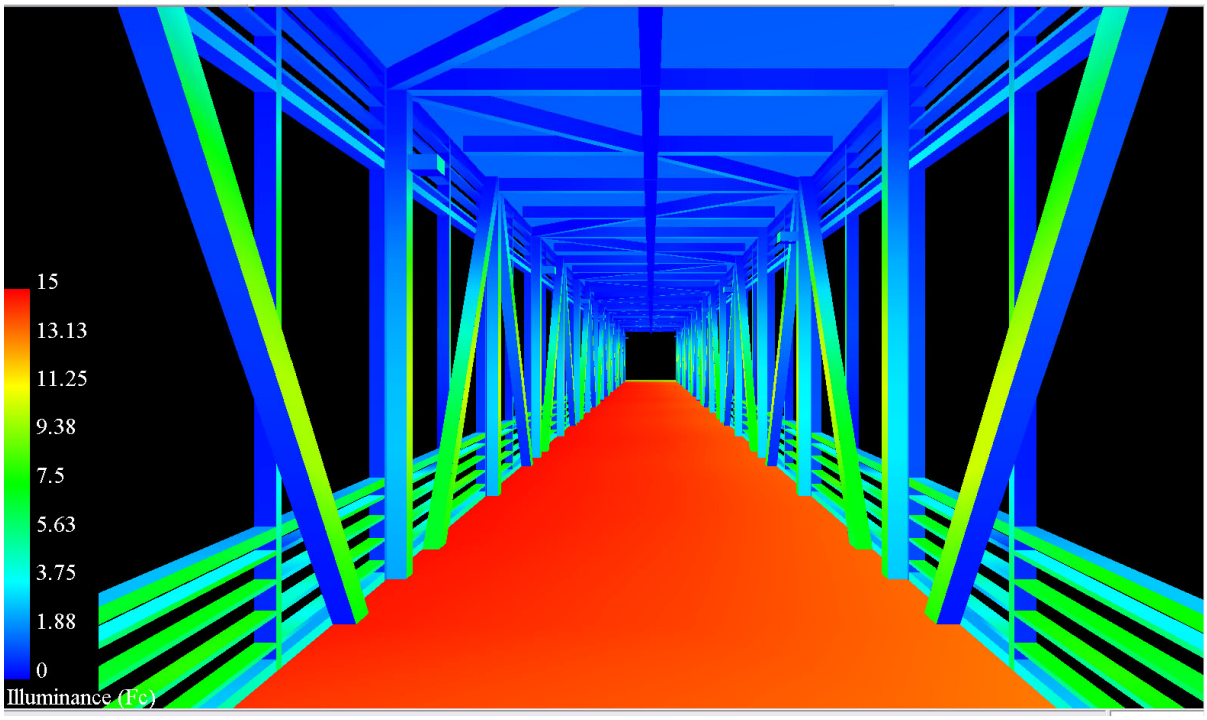


Figure 4: Interior Illuminance Levels

Redesigned Conditions

The selected fixtures were chosen because they blend into the space and provide the illusion that the source of light is unknown. From most angles the fixtures cannot be seen. In places where the fixtures can be seen, they are painted the same light gray color as the truss system. The down light in Figure 5 is mounted on the ceiling every twenty feet. Figure 6 is the up/down light mounted on the wall every ten feet on alternate sides. The cut sheets for these fixtures can be found in Appendix D. Table 1 provides the details of each fixture. Figure 7, Figure 8, and Figure 9 illustrate the new design of the bridge.

Figure 5: Down Light

Figure 6: Up/Down Light

Table 1: Light Fixture Schedule

Label	Description	Catalogue NO.	Lamp			Ballast		Voltage	Fixture Qty.
			NO.	Type	Watts	Type	Lamps		
FF-1	Diecast Aluminum, Ceiling Surface Mounted Downlight	Gardco Lighting-300/O/CR/50MH /277/NP	1	50W MH	50W	Electronic	1	277	7
FF-2	Diecast Aluminum, Wall Surface Mounted Downlight	Gardco Lighting-301/O/W/50MH/ 277/NP	1	50W MH	50W	Electronic	1	277	16

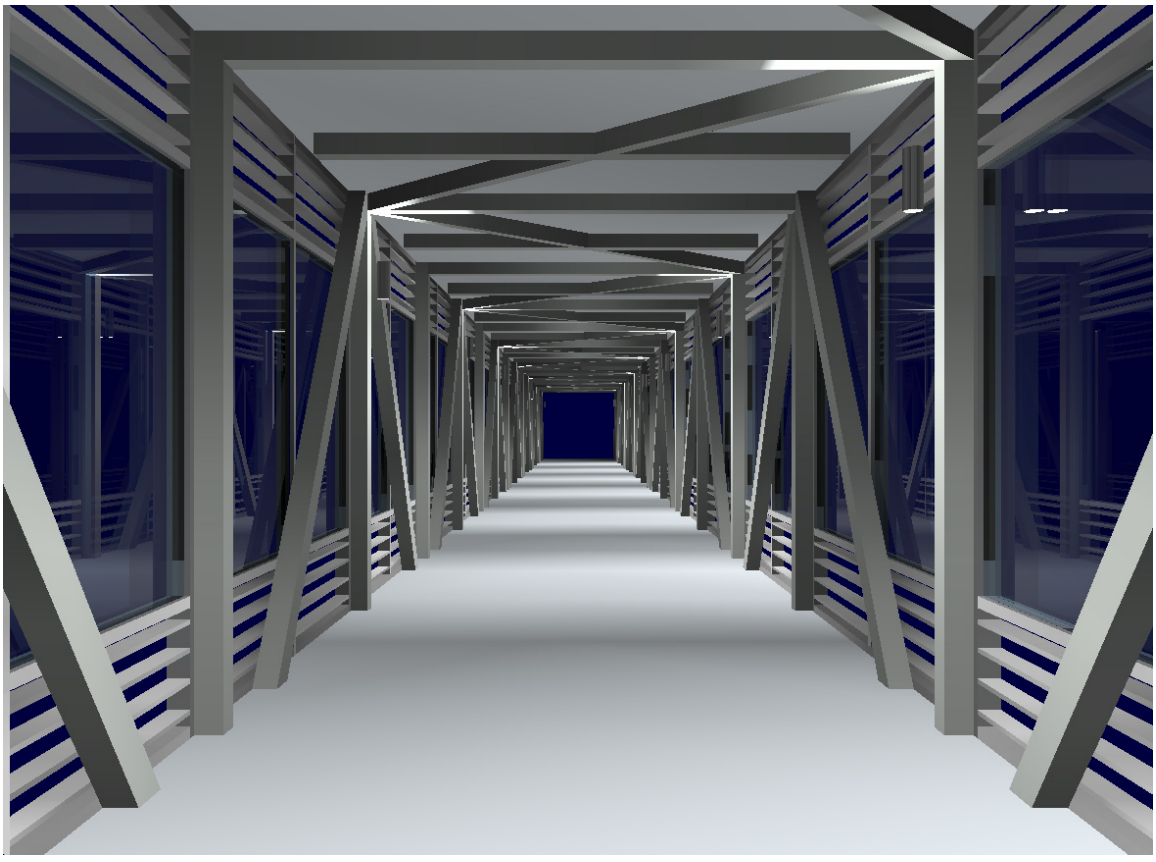


Figure 7: Interior View of Redesigned Lighting Scheme

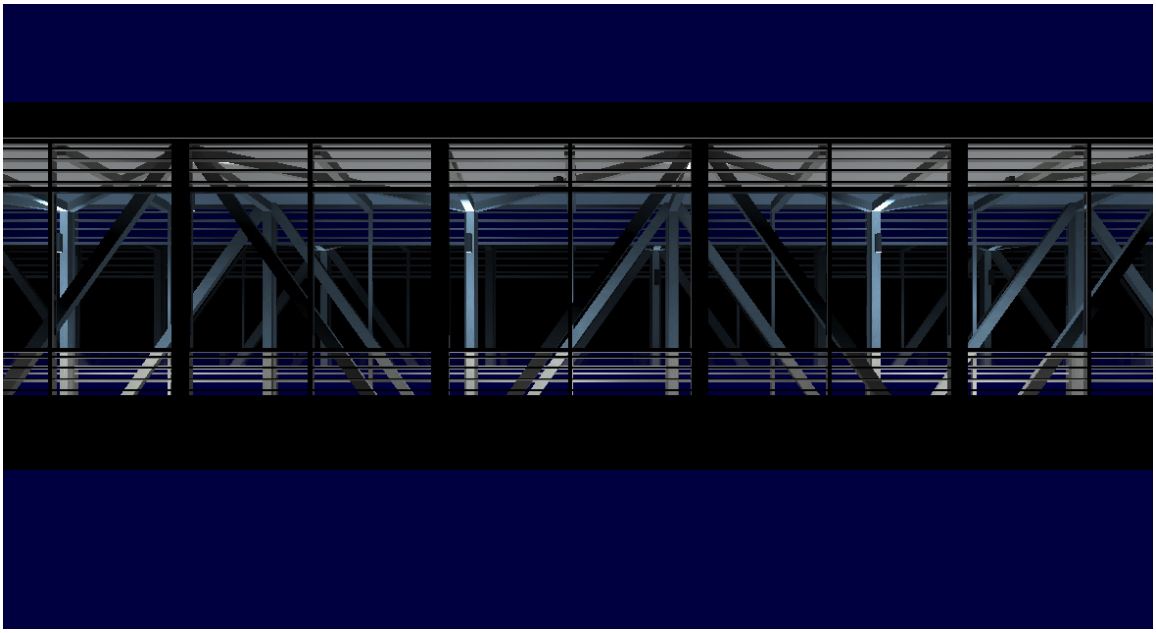


Figure 8: Exterior View of Redesigned Lighting Scheme

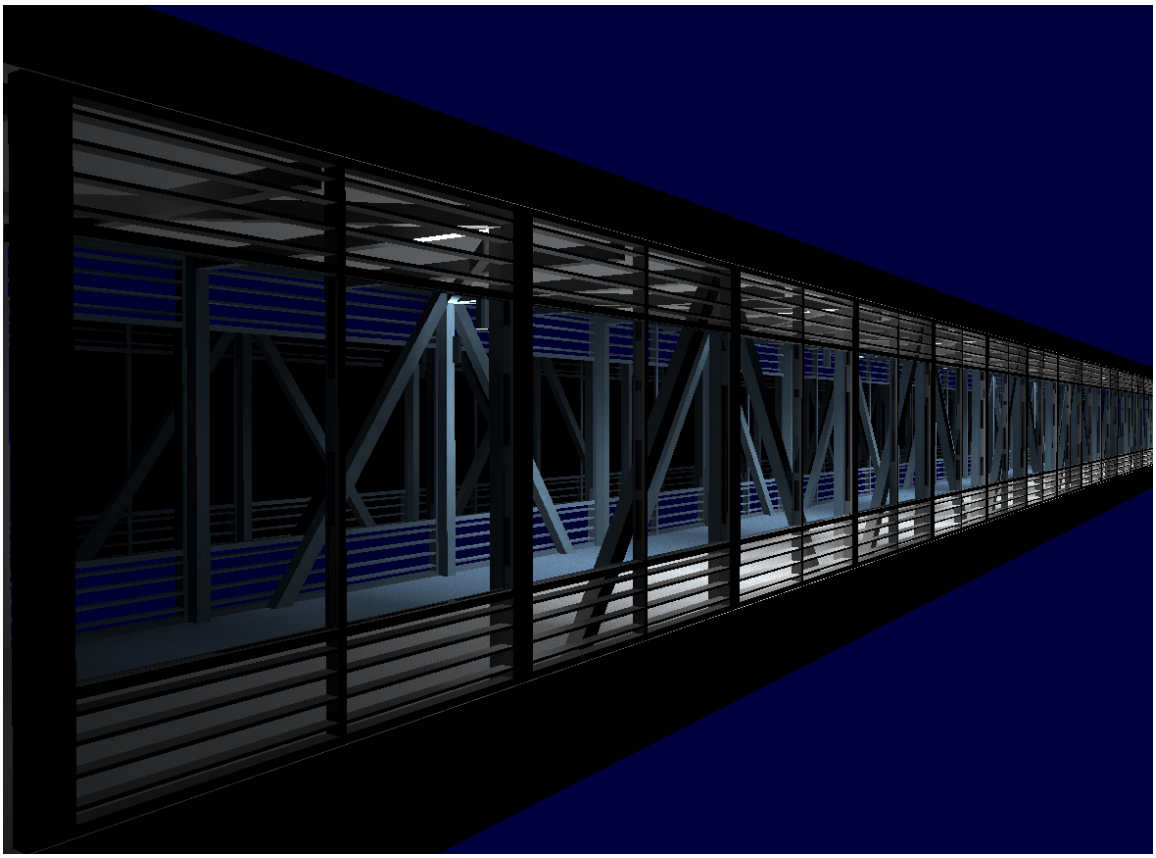


Figure 9: Exterior View of Redesigned Lighting Scheme

Figure 10 illustrates the redesigned illuminance levels in a pseudo color rendering. The color scale, seen on the left, represents the illuminance in footcandles. The redesigned space highlights the structure of the bridge. The average illuminance value is 6.18 footcandles with a maximum value of 11.6 footcandles.

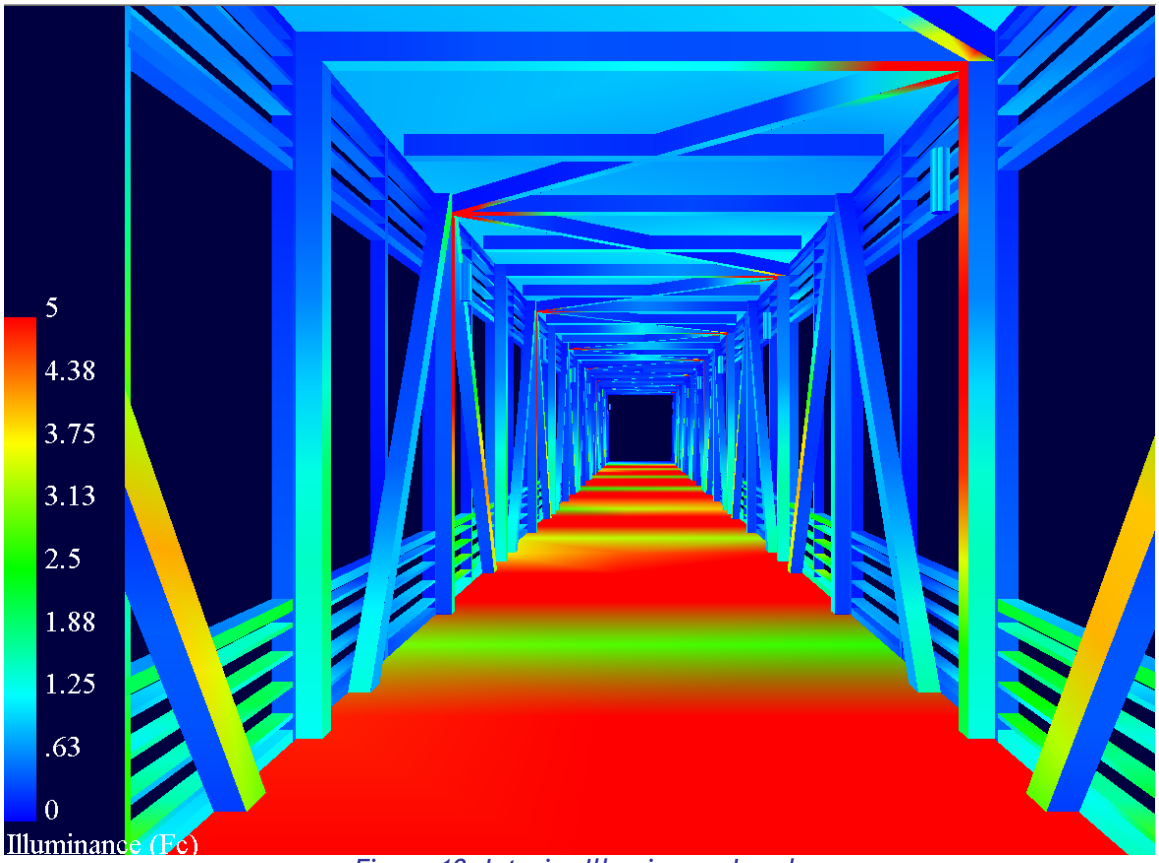


Figure 10: Interior Illuminance Levels

Calculation Points

Light Loss Factors

In order to produce an accurate pseudo color rendering (Figure 10) in AGI light loss factors (LLF) need to be taken into consideration for each fixture. Table 2 illustrates the LLF for each luminaire.

Table 2: Calculated Light Loss Factors

Luminaire Label	Maintenance Category	LLD	LDD	RSDD	BF	Total LLF
FF-1	IV	0.7	0.85	-	0.98	0.5831
FF-2	III	0.7	0.88	-	0.98	0.60368
Assume: 24 month cleaning interval and a clean environment.						

Power Density

ASHRAE 90.1 recommends an allowable power density for active building entrances to be less than or equal to $3W/ft^2$. The power density of the redesigned bridge is 0.586 W/ft^2 which is 80% below the allowable. Table 3 depicts calculation of the redesigned power density.

Table 3: Power Density of Redesign

Label	Qty	Watts	Total Watts
FF-1	7	52	364
FF-2	16	52	832
		Total:	1196
		Sq Ft:	2040
		Power Density:	**0.586275**

Electrical Impacts

After redesigning the lighting layout, the new electrical system had to be taken into consideration. The lighting was circuited to panel board LPN2. Circuit 4 ,a 20A single pole 277V system, was then redesigned. According to National Electric Code (NEC) a 20A single pole should only be circuited to 80% of its maximum ampacity. Therefore, only 16A should be on one circuit. In order to calculate the allowable total wattage on one circuit the following equation was used.

16A x 277V x 1 (Power Factor) x 0.8 (for growth) = 3,600 Watts

The total wattage for all luminaires was found to be 1,196 watts. This was found by multiplying the number of fixtures (23) by the amount of watts (52). Since 1,196 watts is less than 3,600 watts all of the fixtures can be circuited together. Figure 11 is a panel board displaying the new lighting load on circuit 4. The circuit breaker is 30A and the feeder requires (3) #10 wires in ¾" rigid PVC conduit. The main distribution feeder was sized for an over-current protection device based on design load from panel. The circuited layout plan of the bridge is depicted in Figure 12.

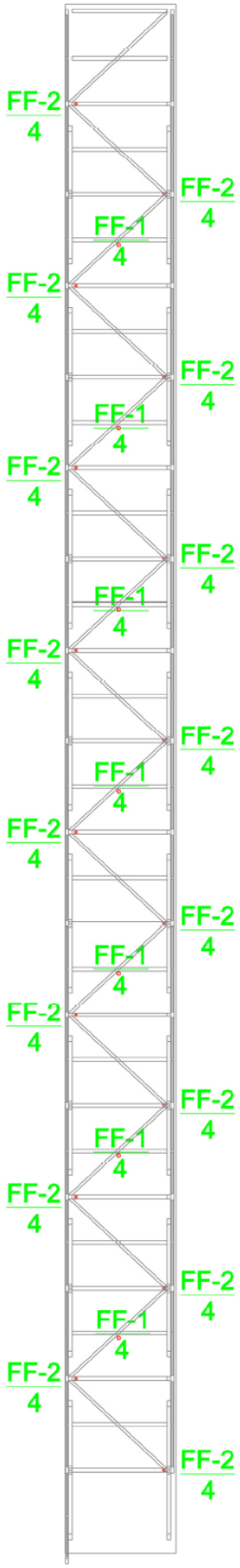
PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W	PANEL TAG: LPN2	MIN. C/B AIC: 10K
SIZE/TYPE BUS: 150A	PANEL LOCATION: Room 212	OPTIONS: PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN: 150A/3P C/B	PANEL MOUNTING: SURFACE	FOR PANELBOARD 1L1B

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting	Offices	2900	20A/1P	1	*			2	20A/1P	1800	Corridor	Lighting
Lighting	Offices	2100	20A/1P	3		*		4	20A/1P	1196	Bridge	Lighting
Lighting	Exterior	500	20A/1P	5			*	6	20A/1P	1100	Cove	Lighting
Lighting	Control Panel	2900	20A/1P	7	*			8	20A/1P	0	0	Lighting
Lighting	Control Panel	2900	20A/1P	9		*		10	20A/1P	0		
Spare		0	20A/1P	11			*	12	20A/1P	0		
Spare		0	20A/1P	13	*			14	20A/1P	0		
Spare		0	20A/1P	15		*		16	20A/1P	0		
Spare		0	20A/1P	17			*	18	20A/1P	0		
Spare		0	20A/1P	19	*			20	20A/1P	0		
Spare		0	20A/1P	21		*		22	20A/1P	0		
Spare		0	20A/1P	23			*	24	20A/1P	0		
Spare		0	20A/1P	25	*			26	20A/1P	0		
Spare		0	20A/1P	27		*		28	20A/1P	0		
Spare		0	20A/1P	29			*	30	20A/1P	0		
Spare		0	20A/1P	31	*			32	20A/1P	0		
Spare		0	20A/1P	33		*		34	20A/1P	0		
Spare		0	20A/1P	35			*	36	20A/1P	0		
Spare		0	20A/1P	37	*			38	20A/1P	0		
Spare		0	20A/1P	39		*		40	20A/1P	0		
Spare		0	20A/1P	41			*	42	20A/1P	0		

CONNECTED LOAD (KW) - A	7.60	TOTAL DESIGN LOAD (KW)	23.09
CONNECTED LOAD (KW) - B	6.20	POWER FACTOR	1.00
CONNECTED LOAD (KW) - C	1.60	TOTAL DESIGN LOAD (AMPS)	28

Figure 12: Circuited Layout Plan of Bridge



Conclusion & Recommendation

It is recommended that the redesigned lighting scheme be utilized for the overhead pedestrian bridge at Coppin State University. The redesigned power density is slightly lower than original design's power density so the cost of electricity for lighting the bridge will remain the same. Although the exact costs of the existing and redesigned fixtures could not be determined the number of fixtures is reduced from 40 to 23. The added benefit of creating an architectural feature that symbolizes the college's community service greatly outweighs any costs that will be incurred.