

# San Francisco – Oakland Bay Bridge East Span Lighting Project



# Bay Bridge Plan View





## Project Background

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- Oct. 17, 1989, on the Eastern Span of the Bay Bridge, a section of the westbound lanes collapsed onto the eastbound lanes as a result of a 6.9 magnitude earthquake
- The earthquake is well-remembered due to its occurrence during the warm-up broadcast prior to Game 3 of the 1989 World Series between the two Bay area teams – the Oakland A's and the San Francisco Giants
- After the quake, seismic evaluations of both east & west spans were conducted and it was determined the east span would need to be replaced.
- A short 24 years later, the new Eastern Span of the Bay Bridge opened to the public on 9/2/2013.



## Project Scope

- Illuminate the Roadway: 2 separate bridges - Eastbound & Westbound



## Project Scope

- Architectural Illumination of the Tower, Main Cable & Suspension Cables



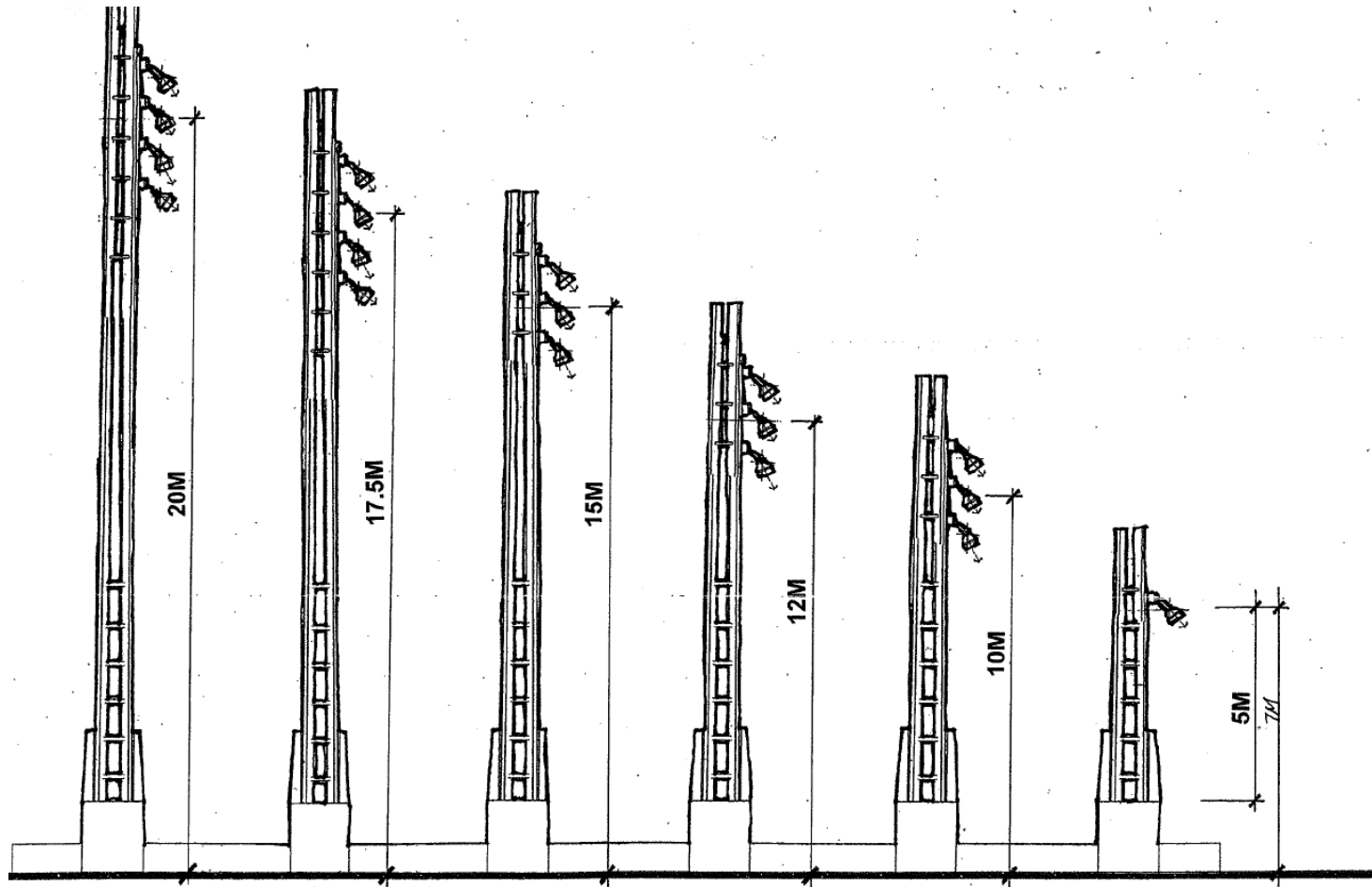


## Project Scope

- Provide fixtures that integrate into the bridge's architecture
- Create architecturally desired effects with the lighting

# Original Architectural Concepts

Create a 'crescendo effect' with the poles and fixtures leading to the Self-Anchored Suspension Bridge





# Original Architectural Concepts

- Create a 'crescendo effect' leading to the Self-Anchored Suspension Bridge
  - Gradually increasing pole heights.
  - Gradually increase the # of fixtures per pole.
  - Marker Light atop each pole to highlight elevation increase.
- Highlight the main & suspender cables and towers to stand out as an icon in the middle of the bay.
- Illuminate the roadway utilizing a one-directional floodlight style aiming logic with a vertical crossarm configuration.
- Utilize metal halide light sources
  - At the time the conceptual designs were developed, LED was not a viable light source option
  - Keep in mind, bridge design began in the 1990s.

# Lighting the Roadway

- Illuminate the Roadway: 2 separate bridges - Eastbound & Westbound





# Lighting the Roadway

- Illuminate the Roadway: 2 separate bridges - Eastbound & Westbound
  - Poles mounted to the left side of drivers for each direction of traffic & fixtures aimed the direction of traffic flow
  - First step was to demonstrate we could uniformly light the road deck but illustrate our concerns with spill/glare.
  - Build trust with the Bay Bridge design team.

# Lighting the Roadway



# Lighting the Roadway





# Lighting the Roadway



# Lighting the Roadway



# Lighting the Roadway





# Lighting the Roadway

- First major design challenge: Working with the architectural team to define a fixture size.

# Lighting the Roadway

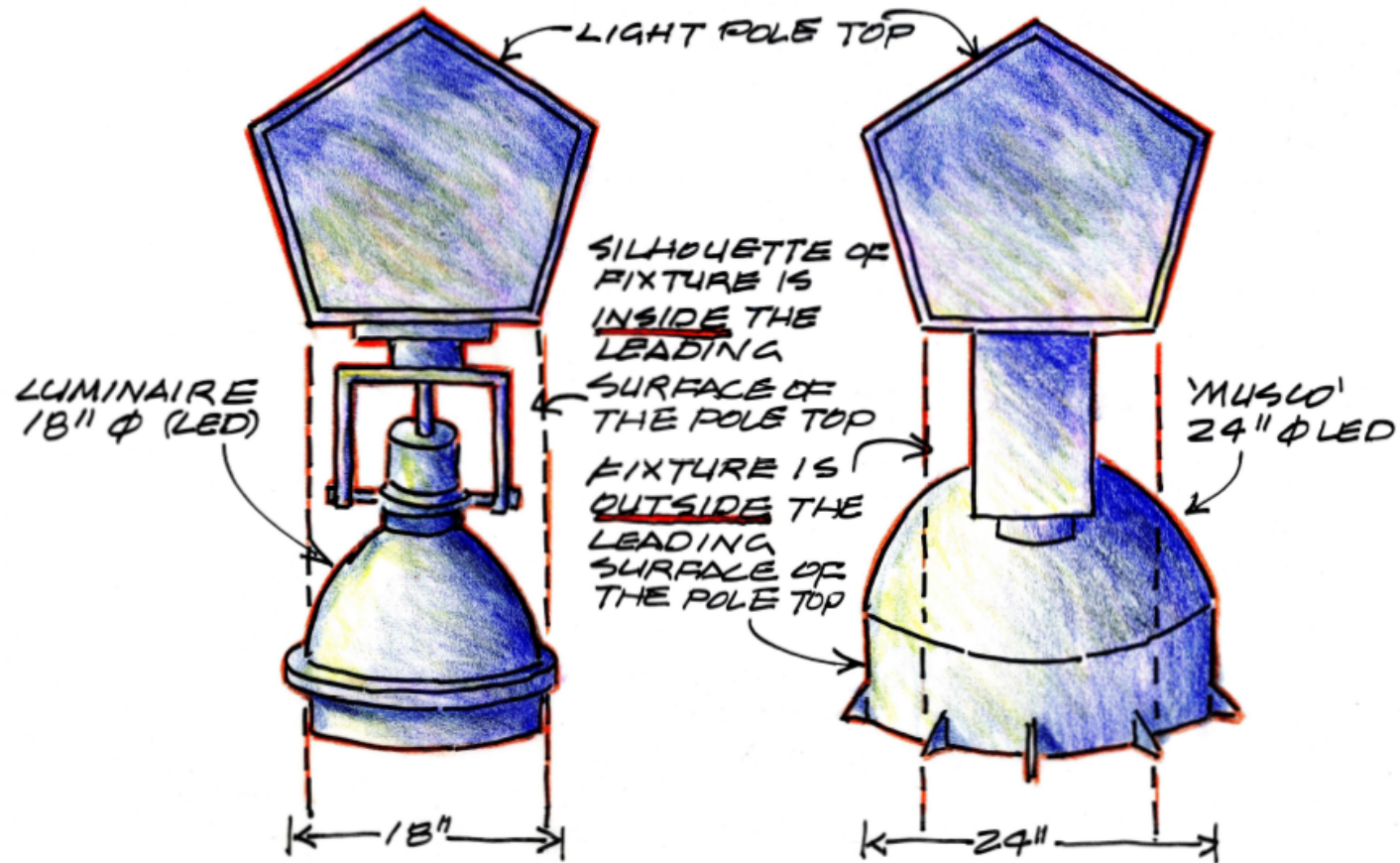


# Lighting the Roadway



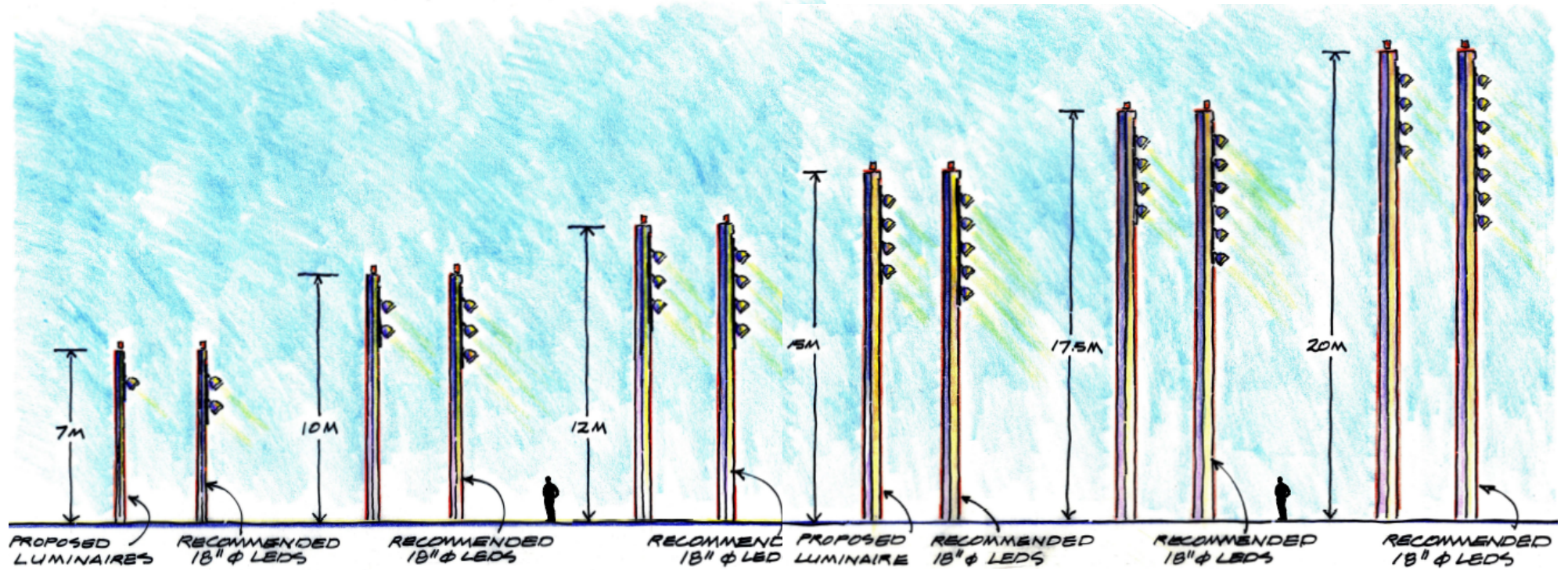


# Lighting the Roadway



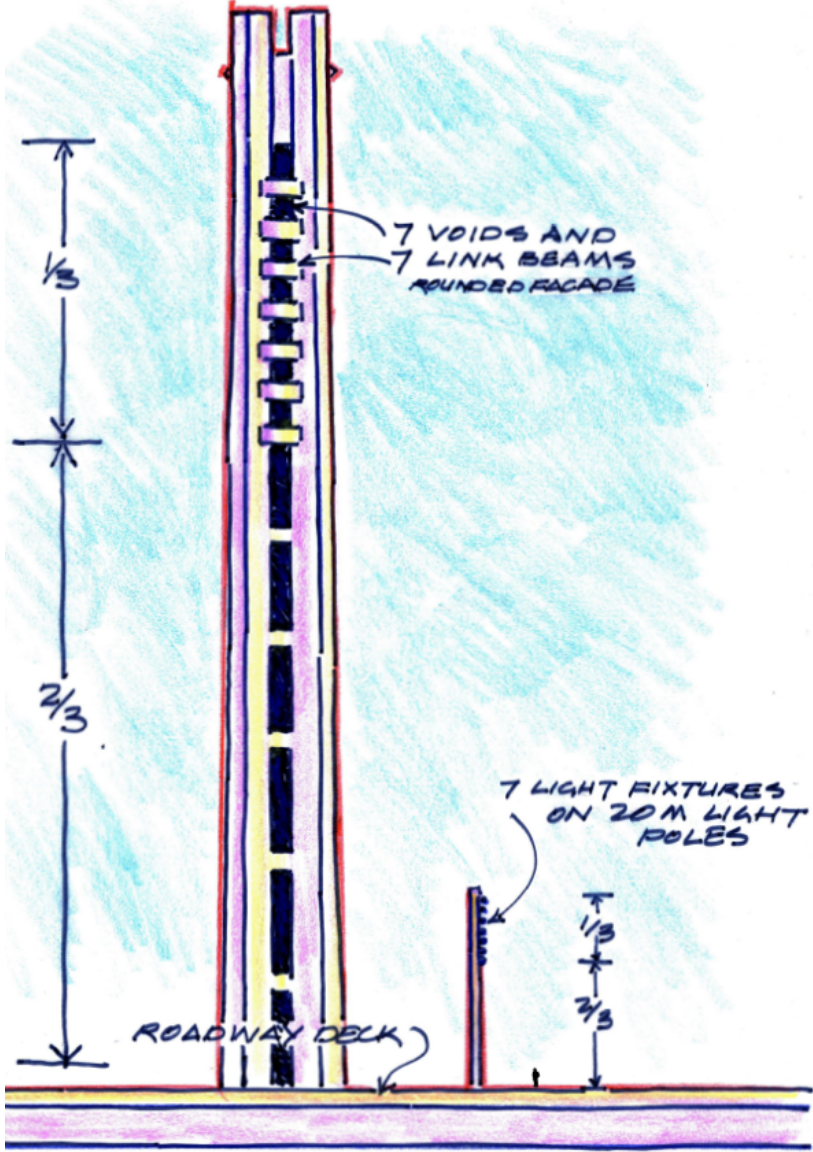
COMPARISON OF FIXTURE SILHOUETTE AT TOWER TOP "TYPICAL"

# Lighting the Roadway





# Lighting the Roadway



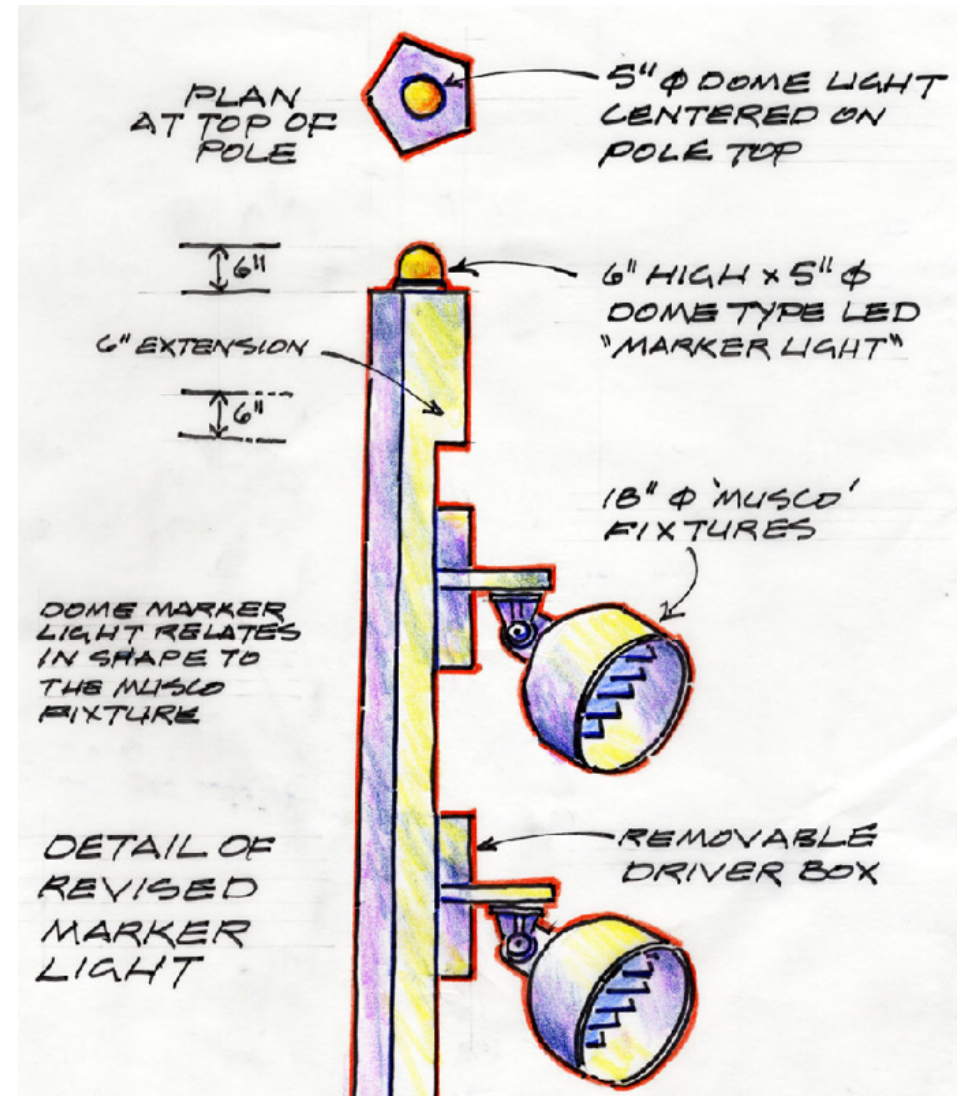


## Lighting the Roadway

- Simultaneous to all of the architectural design taking place, we were still determining what LED would be needed to achieve the illumination levels.
- As the architectural design was being defined, Cree presented a new LED to us – the XM-L, which would achieve our desired results.
- This LED is what allowed us to finalize on the smaller fixture size.
- Of course, the LED wasn't in production yet, but based upon past experiences with Cree, we all took a leap of faith.

# Lighting the Roadway

- The final piece was to add the Marker Light to the pole top.



## Lighting the Roadway

- For design verification, in addition to computer simulated calculations, Musco built a full scale section of bridge roadway at our HQ in Oskaloosa, Iowa.
- Substantial internal visoring was added to each fixture to mitigate glare to drivers traveling in the opposite direction.





# Lighting the Roadway



# Lighting the Roadway





# Lighting the Roadway





# Lighting the Roadway



## Lighting the Cables, Tower, & SAS Roadway

- With the fixture roadway light fixture defined, the architects expressed their desire to use the same fixture housing for most other lighting requirements.
- To achieve other lighting requirements, internal modifications were made to increase the light output for:
  - Illuminating the main and suspension cables
  - Illuminating the tower
  - Illuminating the roadway on the Self Anchored Suspension Bridge area where poles do not exist.
- Musco also designed and fabricated all of the mounts for these fixtures.

# Lighting the Cables, Tower, & SAS Roadway

- Cable Lighting was achieved by:
  - Doubling the number of LEDs within the fixture & using a spreader lens technology to keep a narrow vertical beam angle, but widen the beam horizontally.
  - Light fixtures were attached at the base of the suspender cables to illuminate the bottom side of the main cable and the lower  $\frac{1}{2}$  of the suspender cable.



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  - Light fixtures were also attached at the top of the suspender cables to brackets supported by the main cable for illumination of the upper  $\frac{1}{2}$  of the suspender cables.



# Lighting the Cables, Tower, & SAS Roadway



# Lighting the Cables, Tower, & SAS Roadway





# Lighting the Cables, Tower, & SAS Roadway





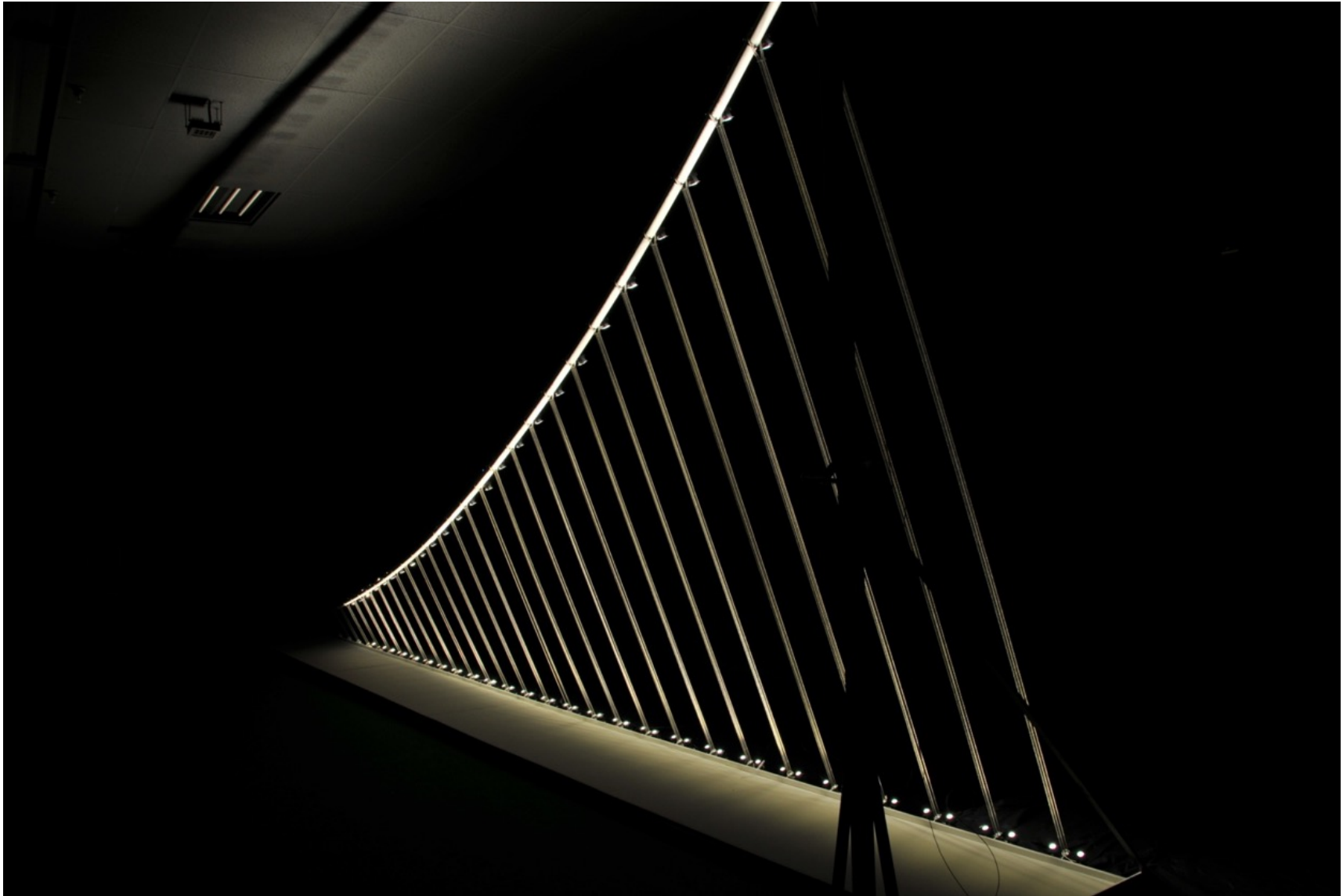
## Lighting the Cables, Tower, & SAS Roadway



## Lighting the Cables, Tower, & SAS Roadway



## Lighting the Cables, Tower, & SAS Roadway





# Lighting the Cables, Tower, & SAS Roadway

- SAS Roadway Lighting
  - Notice there are no poles on most of the SAS portion of the bridge.



## Lighting the Cables, Tower, & SAS Roadway

- SAS Roadway
  - Notice there are no poles on most of the SAS portion of the bridge.
- To light the roadway in this area, we again had to mount fixtures to the main cable.

# Lighting the Cables, Tower, & SAS Roadway





# Lighting the Cables, Tower, & SAS Roadway



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## Lighting the Cables, Tower, & SAS Roadway





# Lighting the Cables, Tower, & SAS Roadway

- Lighting the Tower
  - Hybrid of fixtures were used.
    - Pole mtd. Fixtures for lower elevations of tower:
      - Target was close so not as many lumens required.
      - Fixtures had internal visoring to mitigate unwanted glare for traffic.
    - Cable lighting fixtures for upper elevations of tower where more punch was needed to get light to the top.

# Lighting the Cables, Tower, & SAS Roadway



# Lighting the Cables, Tower, & SAS Roadway





# Lighting the Cables, Tower, & SAS Roadway



# Energy Savings

## Hourly Energy Analysis

<u>Target Area</u>	<u>Orig. Specified System</u>	<u>LED Solution</u>	<u>Resultant Savings</u>
Roadway	239.8kW	109.2kW	<b>130.6kW (54%)</b>
Marker Lights	43.7kW	3.5kW	<b>40.2kW (92%)</b>
Cable Up/Down Lts.	76.6kW	29.9kW	<b>46.7kW (61%)</b>
Cable Mtd. Roadway	22.0kW	11.8kW	<b>10.2kW (46%)</b>
Tower Lights	<u>37.4kW</u>	<u>11.7kW</u>	<b><u>25.7kW (69%)</u></b>
	419.5kW	166.1kW	<b>253.4kW (60%)</b>



  
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*Lighting*  
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