San Francisco – Oakland Bay Bridge East Span Lighting Project
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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.
• 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
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
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  – 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
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
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.
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.
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 ½ of the suspender cable.
Lighting the Cables, Tower, & SAS Roadway
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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 of the main cable and the lower ½ of the suspender cables.
- Light fixtures were also attached at the top of the suspender cables to brackets supported by the main cable for illumination of the upper ½ of the suspender cables.
Lighting the Cables, Tower, & SAS Roadway
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- **SAS Roadway Lighting**
  - Notice there are no poles on most of the SAS portion of the bridge.
• 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
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- 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
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## Energy Savings

### Hourly Energy Analysis

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