SPS Bridge Decks
Self-Performing Installation of Short Span Bridges
SPS Technology
Terminology and History

Structural Composite
- two steel plates bonded to a solid elastomer core
- continuous elastomer support to steel precludes local buckling
- SPS 8-25-8: expresses the sandwich elements thickness in mm

History
- developed in 1993
- over 450 projects & 3 million ft² in service in 30 countries
- used in ships, bridges, stadium and buildings
- approved by major global regulators
<table>
<thead>
<tr>
<th>Project</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carnegie Hall - Floors</td>
<td><img src="Carnegie_Hall_Floors.jpg" alt="Image" /></td>
</tr>
<tr>
<td>Dawson Bridge - Deck</td>
<td><img src="Dawson_Bridge_Deck.jpg" alt="Image" /></td>
</tr>
<tr>
<td>Georgia Tech - Terraces</td>
<td><img src="Georgia_Tech_Terraces.jpg" alt="Image" /></td>
</tr>
<tr>
<td>Stratford Edge - Floors</td>
<td><img src="Stratford_Edge_Floors.jpg" alt="Image" /></td>
</tr>
<tr>
<td>Martin Branch Bridge - Deck</td>
<td><img src="Martin_Branch_Bridge_Deck.jpg" alt="Image" /></td>
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<td>London Olympics - Terraces</td>
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</table>
SPS Technology - Offshore Applications

- Pontoon Protection
- Side Shell Protection
- Pipe Racks
- Helideck
- Ship Security Solution
- Deck Strengthening

April 2017
What are SPS Bridge Decks?

SPS Bridge Deck

- a composite deck made of two steel plates, a solid polyurethane core and a steel perimeter bar
- deck made composite with steel girders through continuous longitudinal bolting
- asphalt or light-weight wearing surfaces possible
- TL-4 crash tested barrier
- AASHTO Innovation Initiative – TxDOT Experience
SPS Bridge Decks
Polyurethane Core

General
- elastomer supplied as two separate components (polyol, isocyanate)
- characteristics guaranteed by BASF Elastogran in partnership with SPS

Design
- sufficient modulus of elasticity to prevent local buckling of steel faceplates
- operating temperature range from -40°F to 248°F (-40°C to 120°C)
- fatigue insensitive bond and core demonstrated by laboratory testing

Quality Assurance
- Positest used to measure bond strength
- injection overseen by qualified injection engineer accredited by IE
### SPS Bridge Decks

**Typical Panel Dimensions and Weight**

<table>
<thead>
<tr>
<th>Deck Type</th>
<th>Metric (Approximate)</th>
<th>Girder Spacing</th>
<th>Weight¹ (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPS 5/16”-1”-5/16”</td>
<td>SPS 8-25-8</td>
<td>5’ to 6’</td>
<td>37</td>
</tr>
<tr>
<td>SPS 3/8”-1”-3/8”</td>
<td>SPS 10-25-10</td>
<td>6’ to 7’</td>
<td>41</td>
</tr>
<tr>
<td>SPS 1/2”-1”-1/2”</td>
<td>SPS 13-25-13</td>
<td>7’ to 8’</td>
<td>51</td>
</tr>
</tbody>
</table>

¹Based on the smaller girder spacing and a panel length of 30’ with 1” x 4” perimeter bars

**Typical Length**

20’ to 40’

**Typical Width**

5’ to 8’

**SPS Panel**
## SPS Bridge Decks
Comparison with Concrete Bridge Decks

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Concrete Deck</th>
<th>SPS Deck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>100 to 113 psf</td>
<td>37 to 51 psf</td>
</tr>
<tr>
<td>Deck Thickness</td>
<td>8&quot; to 9&quot;</td>
<td>1-5/8&quot; to 2&quot;</td>
</tr>
<tr>
<td>Weather Sensitivity During Installation</td>
<td>Weather dependant</td>
<td>Less weather dependant</td>
</tr>
<tr>
<td>Deck Durability</td>
<td>Deck may need to be replaced during its service life due to shrinkage cracking, reinforcement corrosion</td>
<td>Minimum deck life of 100+ years achieved by panel metallization. Protected against de-icing salts and chemicals</td>
</tr>
</tbody>
</table>
SPS Bridge Deck Fabrication Process

- parametric CAD modules
- dedicated production line
- automated production
- CNC driven manufacturing
- fast efficient fabrication

- excellent dimensional tolerances
- adaptable geometry
- climatic control conditions
- maximum integration of details

Fabrication of SPS Bridge Deck Plates for Dawson Bridge

- blasted plate with perimeter bars
- drain detail
- countersunk bolt holes drilled
- vacuum lift

- elevated casting bed
- elastomer injection
- vent funnels and restraint
- stacking and delivery
• AASHTO hosted a webinar as part of SPS Innovation Initiative Award in 2015

Benefits of SPS Bridge Decks
Prefabrication and Modular Construction

- Accelerated Bridge Construction
- Staged Construction - Single Lane
- Prefabricated Deck-to-Girder
- Full-Span Bridge Module
- Integrated Deck-to-Tub Girder
- Prefabricated Sidewalk Panels
Benefits of SPS Bridge Decks Construction

- Efficient Transportation
- Lightweight Equipment
- Reduced Site Congestion
- Immediate Load Carrying Capacity
- Single Trade
- All Steel Construction
Benefits of SPS Bridge Decks
Typical Bridge Details

- Asphalt Wearing Surface
- Lightweight Wearing Surface
- Deck Mounted TL-4 Guardrail Post
- Steel Curb
- Drain Insert
- Standard Expansion Joint Seal
Benefits of SPS Bridge Decks
Typical Bridge Details Continued

Longitudinal Camber

Crossfall - Crowned SPS Panels

Crossfall - Sloped Bearing Plates

Weathering Steel

Factory Applied Paint

Metallized Panels
Benefits of SPS Bridge Decks

1. AASHTO Approved
2. Crash Tested TL-4 Barrier
3. Fatigue Insensitive Bond and Core
4. Composite Action
5. Design Guidelines
6. IE Technical Support

SPS Bridge Deck Design Guidelines
15 November 2018
US CUSTOMARY UNITS

"...the revolutionary Sandwich Plate System is a new generation building material bringing shipbuilding and civil engineering to the Breakfield of a new era..." - Lloyd's Register
Crash Barrier Performance
Pendulum Tests

- pendulum tests by Texas Transportation Institute (TTI) 2005
- crash barriers on SPS achieved TL-4 performance level
- SPS deck undamaged
## SPS Bridge Decks

### ABC Opportunities

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>SPS Value / Attributes / Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deck Weight</strong></td>
<td>• SPS bridge deck is 50% to 70% lighter than an equivalent concrete deck</td>
</tr>
</tbody>
</table>
| **ABC / Schedule**   | • **Light Weight Deck**  
|                       |   • lighter superstructure allows for innovative construction methods  
|                       |   • existing abutments can be reused without strengthening (minimize bridge closures)                                             |
|                       | • **Modular Construction**  
|                       |   • transforms construction to onsite assembly  
|                       |   • preassembled deck-on-girder sections readily erected and assembled  
|                       |   • staged construction can be readily accommodated                                                                        |

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**Mettlach Bridge (Germany)**  
one month to re-instate each lane

**Dawson Bridge (Canada)**

“Lightweight composite steel plate and elastomer deck shaves months off project schedule and millions off budget.” – Modern Steel Construction, March 2011
## SPS Bridge Decks
Deficient Bridges, Constructability and Durability Opportunities

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>SPS Value / Attributes / Benefits</th>
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</table>
| **Deficient Bridges** | • elimination of traffic load restrictions; increase vehicle capacity (posted bridge)  
• elimination of superstructure strengthening of historical bridges; bridge life extension  
• reduces pier, abutment and foundation costs  
• additional pedestrian and cycling capacity |
| **Constructability** | • lighter cranes can be used  
• reduced number of trucks for transportation (particularly remote sites)  
• immediate load carrying capacity  
• all steel construction erected by single trade simplifying site logistics  
• eliminates wet work (no concrete closure pours)  
• reduces site congestion; reduces staging area |
| **Durability** | • designed for 100+ year design life  
• infinite fatigue resistance  
• watertight deck; water management details incorporated  
• industry standard coatings provide a protective barrier |

- **Mettlach Bridge (Germany)** — increased traffic load capacity
- **Pont Rouge (Luxembourg)** — deck life extension; staged construction; increased load capacity
Bridge History

- steel, seven panel, pin-connected Pratt through-truss bridge spanning 103’
- built in 1898
- located in the town of St. Marys, Ontario Canada

Bridge Prior to Rehabilitation

- previous deck was asphalt over wood with pressure treated sidewalks
- salt water ingress due to winter salting was corroding the superstructure
- load limit of 5 tonnes was imposed
- bridge had been closed for 2 years due to safety concerns
Why SPS Bridge Decks?

- provided a light-weight deck (38psf) for load restricted truss
- provided a solid deck with galvanized steel curbs and drains to control salt water runoff
- improved structural integrity and increased longevity of bridge
- maintained historic look and feel of bridge
Scope of Work

- provided nine SPS 8-25-8 bridge panels with cut-outs for drains
- panels were provided with a three-coat paint system on bottom and edge surfaces
  - zinc-rich primer (3.5mils); epoxy intermediate (3.9mils); polyurethane finish (2.0mils)
- primer only for the top surface to control flash rusting
- HDG bent plate steel curbs with a finishing paint coat
- transverse steel splice plates
Superstructure

- floor beams were replaced one at a time (W12x45)
- remaining superstructure was repaired and repainted
- original stone abutments and wing walls were re-pointed
- new stringers (W10x39) were predrilled to match hole pattern of SPS deck
SPS Bridge Decks - Water Street Bridge
SPS Panel Delivery

Transportation

- entire bridge deck delivered in one truck load (~ 30tons)
- nine SPS 8-25-8 panels covering 1630ft$^2$
SPS Panel

- small cranes required to off-load panels
- one operator and two ground personnel used to off-load
- maximum panel weight = 3.5tons
Panel Installation

- panels fitted to new stringers
- one operator and four ground crew
- simple machinery used, in this case the GC had a small crane at its disposal
- cumulative time for panel placement was 1 day
Panel Bolting

- bolting was completed in 3-1/4 days working 8 hour days
- crew consisted of 2 pairs of workers (one above and below) and one foreman
- 1506 panel bolts with perfect match-fit to stringers within 1/8" bolt hole tolerance
Panel Welding

- deck can be track welded for faster installation
- GC chose to weld by hand (2 welders, 2 days)
Curb Installation

- waterproofing membrane installed under steel curbs
- neoprene pad placed under curb to provide watertight seal
- refurbished post and rails bolted through curb and deck to stringer
Wearing Surface

- light-weight wearing surface (RS Clare Bimagrip) with nominal thickness of ~ 3/8"
- factory applied top surface primer was blasted off
- waterproofing membrane was applied over clean deck surface
- refurbished post and rails bolted through curb and deck to stringer
SPS Bridge Decks - Water Street Bridge
Completed Structure
## SPS Bridge Decks
Proven Performance, Schedule/Constructability Benefits, Longevity, Quality

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Attributes / Benefits / Reduced Risk</th>
</tr>
</thead>
</table>
| **Schedule (ABC)**   | • shorter and predictable schedule  
• weather independent  
• traffic disruption, site congestion and environmental contamination are minimized  
• staged construction readily accommodated |
| **Constructability** | • lifting locations built into panels  
• light-weight equipment (telehandler) can be used to move plates  
• plates are easily stackable -> increases site safety and reduces staging area  
• single trade for deck and superstructure  
• immediate load-carrying capacity (construction loads, light-weight lifting equipment) |
| **Durability**       | • designed for 100+ year design life  
• infinite fatigue resistance  
• watertight deck  
• water management details incorporated  
• industry standard coatings provide a protective barrier |
| **Maintenance**      | • weathering steel can be specified eliminating the need for coating maintenance  
• topside of bridge deck is coated using industry standard methods to provide a protective barrier against standing water as required for weathering steel  
• in case of accidental or extreme load events, damaged panel can be easily removed and replaced |
| **Rideability**      | • solid deck provides smooth riding surface  
• asphalt and light-weight wearing surfaces readily accommodated |
| **Quality Assurance**| • factory quality construction production (independent of weather conditions)  
• excellent dimensional accuracy  
• high quality finishes |
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503-545-6600

Rolando Moreau – Engineering Bridge Lead
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613-569-3111 x 5028

www.ie-sps.com
<table>
<thead>
<tr>
<th>Coating Layer</th>
<th>Location</th>
<th>Specified Nominal Thickness (μm)</th>
<th>Manufacturer</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; Zinc Rich Epoxy Primer&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Top side only</td>
<td>90</td>
<td>Dimetcote 302 H</td>
<td>Green</td>
</tr>
<tr>
<td></td>
<td>Bottom and edges</td>
<td>90</td>
<td>Amercoat 68HS</td>
<td>Red</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; Epoxy Intermediate</td>
<td>Bottom and edges</td>
<td>100</td>
<td>Amercoat 385</td>
<td>Light grey</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt; Polyurethane Finish</td>
<td>Bottom and edges</td>
<td>50</td>
<td>Amercoat 450H</td>
<td>Dark grey (PC848)</td>
</tr>
</tbody>
</table>

<sup>1</sup> The primer was removed from the top surface of the SPS panel in the field in order to receive the wearing surface

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<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; Hot-dip galvanized</td>
<td>-</td>
<td>75</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; Epoxy Prime Coat (applied in two coats)</td>
<td>Top and vertical sides</td>
<td>100</td>
<td>Shervin Williams Macropoxy 646</td>
<td>-</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt; Aliphatic Polyurethane Top Coat</td>
<td>Top and vertical sides</td>
<td>75</td>
<td>Shervin Williams Acrolon 218 HS</td>
<td>Dark grey (PC848)</td>
</tr>
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SPS Bridge Decks - Water Street Bridge
Additional Slides – Expansion Joint

3/4" CTSK HEAD BOLT TYP. (BY OTHERS)
LIGHT-WEIGHT WEARING SURFACE (BY OTHERS)
WATERPROOF MEMBRANE (BY OTHERS)

ASPHALT (BY OTHERS)
GRANULAR 'A' BACKFILL (BY OTHERS)
350 x 10 STEEL PLATE (BY OTHERS)

MC250 x 42.4 (BY OTHERS)
W250 x 58 STRINGER (BY OTHERS)

EXISTING STONE MASONRY

200 x 200 x 30 LAMINATED BEARING AND WEDGE PLATE (BY OTHERS)

SPS CONNECTION AT ABUTMENT
64.1' / SCALE = 1:5