SPS TECHNOLOGY

Structural Composites Engineered for the 21st Century

Bridges

The Sandwich Plate System (SPS®) is a structural composite material used for bridge decks that is up to 70% lighter than reinforced concrete. A high precision component manufactured offsite, makes it easy and quick to install.

SPS comprises two metal plates bonded with a polyurethane elastomer core. It delivers a high strength to weight ratio making it an excellent alternative to both cast-in-place or pre-cast reinforced concrete. Bridge deck panels, typically 1-5/8" to 1-3/4" thick, are installed using standard steel working practices.

The design of SPS is simple. SPS panels are isotropic and naturally stiff in all directions. Standard design procedures are used to tailor the geometry and performance of SPS to each particular bridge.

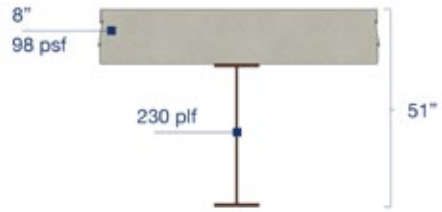
The use of SPS results in lighter bridge decks which are simple and safer to construct and are built to more predictable and shorter schedules as installation is not weather dependent.

Bridge applications

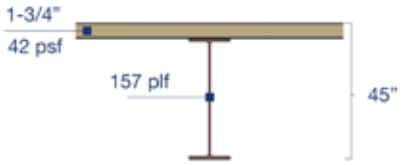
SPS bridge decks: New bridge, bridge expansion and replacement deck

SPS bridge decks facilitate bridges with lighter girders, longer spans, fewer piers and reduced piling which reduce total project costs and schedules.

Pre-cast / Cast-in-place concrete



Sandwich Plate System (SPS)



Design

SPS is a bolted solution with minimal site welding required. SPS panels are adaptable to multiple configurations – cambered girders, constant cross-section and vertical or horizontal curves. The crown of the road can be matched at both ends creating a seamless transition between existing road and new deck with new asphalt overlaid. This allows existing surface runoff designs to be respected. Other typical bridge geometries, including skew, super-elevations, crossfall and camber, can also be readily accommodated.

Enhanced architectural elegance is achieved with lighter, thinner decks.

SPS bridge decks are fabricated to factor quality construction with excellent dimensional control associated with steel structures (not concrete) and flatness that gives excellent rideability. Wearing surfaces can be conventional asphalt on top of a waterproof membrane or a thin polyurethane wearing surface which is particularly valuable for weight constrained movable bridges. Standard details, including deck-girder connections, drains, guardrails, crash barriers, abutments and curbs, are integrated into the design.

Weight

SPS bridge decks are up to 70% lighter than concrete and are fully compatible with existing bridge components and wearing surfaces. Standard design procedures are used to tailor the geometry and performance of each SPS bridge deck.

Reduction in deck dead load for deficient bridges assists with life extension, elimination of traffic load restrictions and increased load capacity while minimizing or eliminating the need for reinforcement. In new build projects, lighter girders, lighter piers and fewer piles per pier are required.

Installation

SPS panels are bolted to supporting beams and behave compositely in positive and negative bending.

Simple, prefabricated plates facilitate sections (girders and deck plates) being pre-assembled. SPS bridges are quick to build with more predictable schedules as installation is not weather dependent. Installation programs can be designed so that bridges remain open to traffic.

An SPS bridge deck is an all steel solution which can be installed by the same crew as the steel frame. The deck offers immediate load carrying capacity once the corners of the panels are bolted to the top flange of the supporting beams.

Due to the size and weight of SPS panels, truck transport, movements on site and size of crane required are all reduced facilitating a safer site and lower costs.

Working from both ends of the bridge, up to 6,500sf of SPS panels can be installed per day. On average, schedules are reduced by 15-20% with 15-25% overall net cost savings.

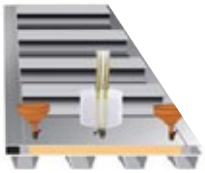
SPS orthotropic bridge deck strengthening

SPS can be used to strengthen existing orthotropic steel bridge decks without replacement. The existing deck is used as one plate of the new composite, which stiffens the deck, reduces fatigue stresses and increases distribution of wheel loads across

1 **Remove** existing wearing surface

2 **Weld** perimeter bars to deck and weld top plate to form air-tight cavities

3 **Inject** elastomer into cavities and allow to cure



4 **Apply** new wearing surface

Design

SPS can be used to strengthen existing orthotropic steel bridge decks. The existing deck is used as one plate of the new composite, which stiffens the deck, reduces fatigue stresses and increases distribution of wheel loads across stiffeners.

Bridge projects can be completed in sections to minimise traffic disruption and reinstatement can be undertaken from above or below.

Benefits

This in-situ repair leads to enhanced fatigue resistance, extends service life, can improve load capacity and achieve a weight neutral deck. SPS reduces project schedules and maintains traffic flow which minimises disruption to the users.

Installation

Simple, fast process.

Strengthening is a four stage process that combines in-situ steel work with elastomer injection in a predictable and repetitive procedure that can strengthen over 2,200sf of bridge area per day, per crew, without closing the bridge.

Details and wearing surfaces

Material options

SPS panels are manufactured in a wide range of steel alloys which include standard structural steel, weathering steel, vanadium steel for high strength or stainless steel for enhanced corrosion protection.

Ancillary features

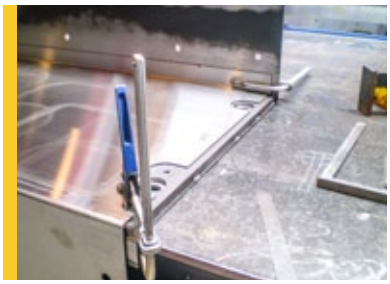
All standard ancillary features – crash barriers, curbs, street lights, drains, medians, expansion joints – can be used with attachment holes pre-drilled in the factory to allow rapid installation in the field, increased accuracy and improved quality control.

Wearing surfaces

An asphalt or lightweight wearing surface (5/16” to 2/5” thick) can be applied to SPS bridge decks. Both wearing surface types use a waterproofing membrane to protect the deck against corrosion.

For more information contact: **bridges@spstechnology.com**

Benefits and performance



The economics

SPS reduces costs, shortens construction schedules, limits risks and reduces life cycle costs. A shorter, more predictable timetable is achievable through prefabricated modular bridge components which are erected and assembled by a single trade. SPS can minimise or eliminate the need for reinforcement of deficient bridges which leads to overall net savings. Bridge life cycle costs are reduced as SPS is designed for 100+ years, compared with a concrete deck which will need to be replaced during the service life of the bridge.

Weight savings

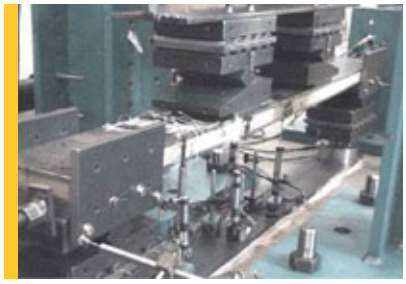
SPS bridge decks are up to 70% lighter than the concrete equivalent, which allows large preassembled deck on girder sections to be erected or lighter cranes to be used. Lighter decks allow for increased vehicle, pedestrian and cycling capacity for existing deficient bridges while minimizing or eliminating superstructure reinforcement.

Panel fabrication

SPS panels are designed in 3D CAD BIM allowing for design and construction teams to integrate the deck design with the rest of the structure. The panels are made using CNC cutting equipment directly off CAD drawings; to deliver a factory finished product with high dimensional accuracy. The production process allows for quality control of all panels prior to shipping which significantly reduces the risk of in-field errors. SPS panels are produced to match the procurement schedule of the bridge superstructure.

Crash performance

Crash barriers on SPS bridge decks have achieved a TL-4 performance level as verified by pendulum tests conducted at the Texas Transportation Institute. Standard DOT guardrail systems (deck or side mounted) are easily accommodated.



Fatigue life

The bond strength and core material are fatigue insensitive and have an infinite fatigue life as verified by the University of Alberta and Virginia Tech. SPS bridge decks are designed for infinite fatigue life in accordance with the applicable bridge design code.

Corrosion protection

SPS bridge decks are designed for 100+ year design life. The topside of the bridge deck is protected with a waterproofing membrane and a wearing surface. The underside is protected by industry standard coatings such as epoxy paints, thermal zinc or aluminium spray metallization. If applicable, weathering steel can be specified in design.

Deckwater management details such as drains, curbs and drip-lips are incorporated into the design to control runoff.

Shorter construction

Over 1,300sf of SPS bridge panels can be delivered to site per truck. This is two and a half times more than pre-cast concrete slabs. Cast-in-place concrete would require four truck loads to achieve the same area. Fewer deliveries simplifies logistics, congestion and improves health and safety.

Reduced transport

Over 120m² of SPS bridge panels can be delivered to site per truck. This is two and a half times more than pre-cast concrete slabs. Cast-in-place concrete would require four truck loads to achieve the same area. Fewer deliveries simplifies logistics, congestion and improves health and safety.

Health & safety

SPS components require fewer workers for movement and handling. SPS panels provide an immediate working platform for erection of subsequent panels and for material storage. Prefabrication and modular construction reduces site congestion and waste as building is done off-site.

Dynamics

SPS is tailored to provide the required dynamic performance that satisfies acceleration limits associated with footfall-induced vibrations (pedestrian bridges) and vibrations due to vehicular loads (roadway bridges).

Reuse/recycling

SPS plates can be re-commissioned. All SPS elements are developed for 100% re-use. At the end of a structure's life the SPS elements can be demounted (simply unbolted) and, unlike concrete, re-used in another project. If SPS panels are not re-used, the two components (steel and elastomer) can be fully re-cycled. Combining this, with reduced material in the bridge's superstructure and foundations, SPS decks provide substantial sustainability advantages over concrete decks.

Approval

SPS technology is supported by over 22 years of research and development carried out in close cooperation with independent institutions and regulators. The material characteristics of SPS are well documented and include static and dynamic behavior, vibration damping and impact resistance.

Leading research institutions in North America, Europe and Asia have completed full-scale load and fatigue testing on SPS structures with approvals received.

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Case studies

Cannelville Road Bridge, USA

A new 52' 6" bridge, with a 100 year service life, was successfully installed in just 26 days. With an integrated SPS bridge deck this two vehicle lane modular prefabricated bridge arrived to site on two semi-trucks. Each section was located onto the abutments in just 10 minutes. The bridge was funded by the FHWA AID program, the aim of which is to find an alternative to address the aging bridge inventory.

"The design of the girders paired with the SPS deck, permitted our crews to completely replace the old structure in record time. From bridge and abutment demolition to new abutments and superstructure, this bridge was open to traffic in 26 days. Remarkable."

Dan Rogovin, President and CEO, US Bridge

"One hundred year bridges should be the standard. We need to be innovative and not afraid to try new ideas."

Doug Davis, County Engineer for Muskingum

Dawson Bridge, Canada

The Dawson Bridge opened in 1912, is a 5 span truss bridge that forms an important link across the North Saskatchewan River running through the center of Edmonton, Canada. The structure had weakened with age and a load limit had been imposed. The existing deck was a combination of concrete and wood. Replacing the deck with concrete and removing the load limit would have required a substantial strengthening of the truss superstructure.

20,000sf of SPS bridge deck panels were installed over a short summer period in parallel with renovation of the main trusses. Using SPS panels 3 months were saved on the entire project schedule and the full load capacity was reinstated for this historic bridge without major structural reinforcement.

"Lightweight composite steel plate and elastomer deck surface saves months of project schedule and millions of budget."

Modern Steel Construction, March 2011

Pont Rouge, Luxembourg

The widening and strengthening of this bridge, locally known as the 'Pont Rouge', was undertaken by SEH Engineering GmbH, our German SPS bridge licensee.

As a main arterial route into the city centre, it was imperative to keep the bridge fully operational throughout the project. With SPS, the Pont Rouge was transformed from six vehicle lanes into a mixed use bridge fulfilling modern day requirements. Six feet were added to its width using a total of 24,110sf of SPS panels.

The bridge now accommodates four SPS strengthened vehicle lanes and two newly installed tram lines; plus a two-way cycle lane and pedestrian walkways on either side which are accommodated on the newly installed SPS panels.

Mettlach Bridge, Germany

This suspension bridge, constructed in 1951, crosses the River Saar, Mettlach, Germany. Spanning 354ft, the bridge has two lanes and was originally built with a steel-concrete composite deck. The bridge had its load carrying capacity reduced due to wear and corrosion of the cables and cross girders but was required to an upgrade to current code.

The existing deck was replaced with SPS which weighed just 220 tons rather than 550 tons as per the original concrete deck. This gave 330 tons savings of dead load which relieved stress in the suspension cables allowing the bridge to accommodate increased traffic loads and meet modern-day requirements.

Martin Branch, USA

In 2008 SPS was used to rapidly replace TxDOT's Martin Branch Bridge; a remote two lane 3-span rural road bridge. The work took place over a weekend with no need for any concrete work. The SPS panels were delivered to site as half-width bridge modules integrated with longitudinal girders. Each bridge span consisted of two bridge modules spanning 50ft long by 13ft wide.

In 2014 Sandwich Plate System was selected for the AASHTO Innovation Initiative Award based on a nomination by TxDOT for the successful installation and follow-on testing of the completed bridge project over several years.

Link-span Bridge, UK

Red Funnel's East Cowes link-span bridge was reinstated and strengthened using SPS. The wearing layer was first removed, after which the 118ft long steel bridge deck was prepared. Perimeter bars were welded to the deck to create 35 cavities of 4/5" depth. 5/16" steel top plates, with a factory applied wearing surface, were then welded to the perimeter bars to form air-tight cavities before the injection of the elastomer core. There was no disruption to scheduled services.

"To maintain an outstanding service to our regular customers was our key priority. SPS was the only way to keep the bridge open and achieve a first class permanent repair. IE had gone to extreme lengths to ensure that all logistical challenges had been considered and resolved before the start. Red Funnel would thoroughly recommend SPS for link-span repair to any operator."

Commodore Mark Slawson OBE, Fleet and Technical Director, Red Funnel

Ma Fang Bridge, China

The orthotropic steel deck of this high volume road bridge in Zhaoqing Sihui City in Guangdong Province was suffering from fatigue. SPS was used to carry out a lane by lane strengthening and allowed the bridge to remain open to traffic throughout the project. Steel work and surface preparation was undertaken by a local contractor with SPS conducting the elastomer core injections. A total of 5,510sf of bridge was reinstated during the Christmas to New Year period 2009.

Water Street Bridge, Canada

A lightweight SPS bridge deck was a key component in a project to rehabilitate the historic Water Street Bridge in St Mary's, Canada. The 103ft long by 16ft wide bridge, originally built by the Stratford Bridge Company for $2,000, had been closed for two years due to safety concerns. The bridge's original deck was wooden with an asphalt wearing surface and a five ton load limit. Winter salting had accelerated corrosion of the steel super-structure and led to closure. The new SPS deck was made up of just 9 panels and arrived on the back of just one truck.

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