SPS Design & Construction Solutions

samaras SYSTEMS

bridges

Intelligent Engineering's Sandwich Plate System (SPS®) is a structural composite material used for bridge decks that is up to 60% 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 45mm 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 predicable schedules as installation is not weather dependent.

ie intelligent engineering

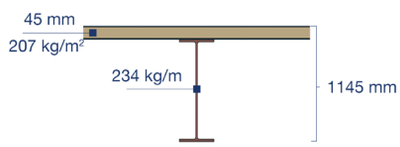
Bridge applications

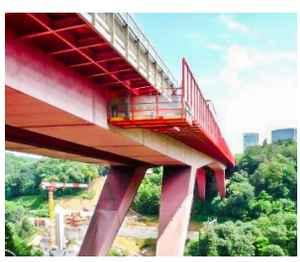
SPS bridge decks: New bridge, bridge expansion and replacement deck

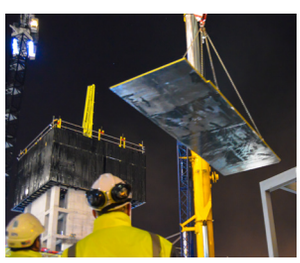
SPS Bridge decks facilitate lighter bridges with lighter girders, longer spans and fewer piers and reduced piling. They substantially reduce total project costs and schedules.

Pre-cast / Cast-in-place concrete

Sandwich Plate System (SPS)







Design

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.

The flat (below L/1500), accurate (made to a +0mm -3mm tolerance) panels can be delivered to site with factory applied wearing surface. The wearing surface can be conventional asphalt on top of a waterproof membrane or a thin polyurethane wearing surface. These thin surfaces are particularly valuable for weight constrained moveable 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 allows for life extension, elimination of traffic load restrictions, increased load capacity while minimising or eliminating the need for reinforcement. In new build projects, lighter girders, lighter piers and fewer piles per pier are required.

Installation

The SPS panels are bolted to existing supporting girders and stringers and work compositely with the superstructure (in tension and compression).

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 programmes can be designed so that bridges do not need to be closed to traffic.

An SPS bridge deck is an all bolted 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 girder and stringer.

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 600m² of SPS panels can be installed per day. On average, schedules are reduced by 15-20% with 15-25% overall net cost savings.

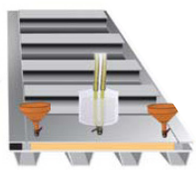
SPS orthotropic bridge deck strengthening

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 stiffeners.

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 surface coating

Design

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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 minimise project schedules an allows remain open during the process to maintain traffic flow and minimise disruption.

Installation

Simple, fast process

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

Details and wearing surfaces

Material options

SPS panels can be manufactured in a wide range of steel alloys. Most are made from weathering steel allowing the deck plates to mirror the corrosion resistant steel work of the superstructure. Decks can also use standard structural steel, vanadium steel for high strength or stainless steel for architectural impact.

Ancillary features

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

Wearing surfaces

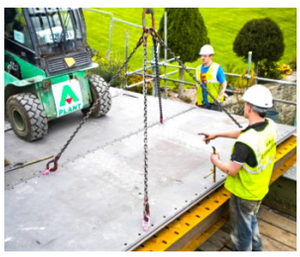
Bridges made from SPS do not suffer from surface cracking associated with concrete decks or the high deck curvatures experienced with orthotropic steel decks. Engineers can now save significant weight by specifying thinner asphalt or more advanced polymer wearing surfaces. Both wearing surface types use a polyurethane membrane to protect the steel deck.

For more information:
bridges@ie-sps.com

Benefits

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 75+ years compared with concrete deck which will need to be replaced during its service life.



Weight savings

SPS bridge decks are up to 60% lighter than concrete equivalent which allows large preassemble 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 minimising or eliminating superstructure reinforcement.

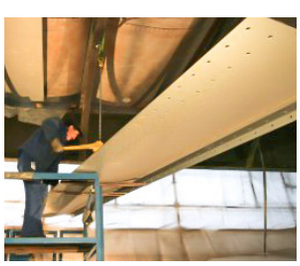
Reduced transport

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.

Approval

SPS technology is supported by over 20 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 behaviour, vibration damping, fire resistance 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.



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 building. 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, provides substantial sustainability advantages over concrete decks.

Dynamics

SPS solutions cover a range of dynamic performances based on the final category specified by the main consultants.

SPS offers the code required sound insulation when combined with typical wearing surfaces.

Performance

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, as well as high speed robotic welding equipment to deliver high finished accuracy. The production process allows for quality control of all panels prior to shipping, significantly reducing the risk of hard to correct in-field errors. SPS panels are produced to match the procurement schedule of the bridge superstructure.

Shorter construction

SPS eliminates the need for wet and associated trades. With SPS concrete casting schedules become irrelevant. Installation is simple and quick to fit and fasten to the supporting structure with fewer lifts. Panels can be preassembled with their secondary beams and, once installed, the SPS panels provide an immediate working platform.

Health & safety

SPS components require fewer workers for movement and handling. The prefabricated SPS panels with all attachments and openings, reduce operations at ground level and at height.

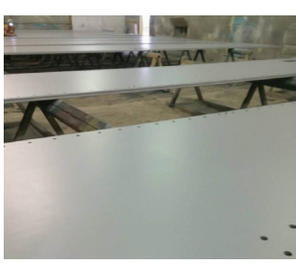
SPS can take full structural load and immediately act as a working platform, material storage and/ or a protective crash-deck. Site activity is reduced through the offsite manufacturing process.

Crash performance

Crash barriers on SPS bridge decks can achieve 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 will have an infinite fatigue life as verified by the University of Alberta. All steel bridge structures will have bolted or welded connections with a lesser fatigue category and, therefore, these will govern the fatigue resistance.



Longevity

SPS bridge decks are designed for 75+ year design life with infinite fatigue resistance. Industry standard coatings, such as paint or spray metallisation, provide a protective barrier. A waterproofing membrane is applied to the top surface of the deck before application of the wearing surface. Other deck water management details, such as drains and drip lips, are readily incorporated into the design.

For more information:
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Case studies

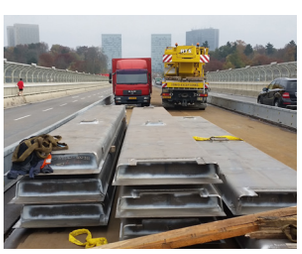
Pont Rouge, Luxembourg

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, the 355m long Grand Duchess Charlotte Bridge carries the N51 across the River Alzette between Kirchberg and Luxembourg, it was imperative to keep the bridge fully operational throughout the project, as bridge closure would have put pressure on other routes into the city.

With SPS, the Pont Rouge was transformed from six vehicle lanes into a mixed use bridge fulfilling modern day requirements.

1.83m was added to its width using a total of 2,240m² of SPS panels. The bridge now accommodates four SPS strengthened vehicle lanes (two in each direction) 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.



“SPS is not only stronger and less expensive than most other carriageway decks, but it is also capable of reducing bridge weight considerably”

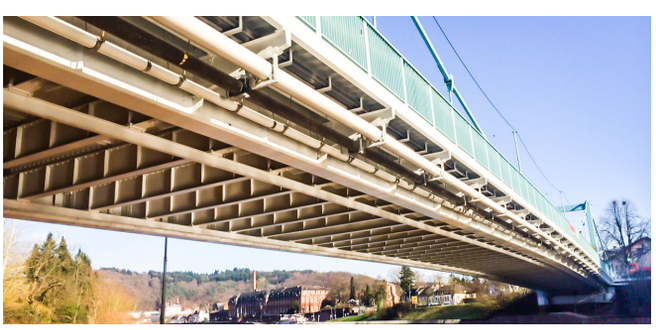
Christof Grieser-Schmitz, SEH Engineering

Dawson Bridge, Canada

The Dawson Bridge is a 100 year old, 5 span truss bridge that forms an important link across the North Saskatchewan River running through the centre 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.

1,826 m² of SPS bridge deck panels were installed over a short summer period in parallel with renovation of 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.

Mettlach Bridge, Germany



This suspension bridge, constructed in 1951, crosses the River Saar, Mettlach, Germany. Spanning 108m, 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 but it was required to carry increased loads due to high traffic.

The existing deck was replaced with SPS which weighed just 200 tonnes rather than 500 tonnes as per the original. This dead load weight reduction relieved stress in the suspension cables allowing the bridge to accommodate increased traffic loads and meet modern day requirements.

Ma Fang Bridge, China

The orthotropic steel deck of this high volume road bridge in Zhaoqing Sihui City in Guangdong Province, China 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 IE undertaking the elastomer core injections. A total of 512sqm of bridge was reinstated during the Christmas to New Year period 2009.

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 36m long steel bridge deck was prepared. Perimeter bars were welded to the deck to create 35 cavities of 20mm depth. 8mm steel top plates, with 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.

"Maintenance of the regular service to the customers was our key priority. Closely followed by minimising disruption to the local population. SPS was the only way to keep the link-span bridge open and achieve a first class permanent repair. Red Funnel would whole heartedly recommend SPS for link-span repair to any operator."

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

Martin Branch, USA

Texas DOT, supported by US Federal Highway Authority, used SPS panels to rapidly replace the deck of a remote two lane 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. The completed bridge comprised three 15m by 2m spans with expansion joints.

U1 Viaduct, Germany

This rivet steel overhead rail bridge, built in 1910, has barrel plates supporting the ballast and these were showing signs of fatigue and cracking. Conventional repairs would have required the removal of the steel plates, rail track, sleepers and ballast, which would have taken considerable time and led to major public inconvenience. SPS allowed Berliner Verkehrsbetriebe (BVG) to avoid closing the bridge for repair. The riveted and curved architectural features of this historic structure were retained.

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