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ConX Space Frame System

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CONX SPACE FRAME SYSTEM

THE NEED

The construction industry is constantly under pressure to deliver higher quality building projects for less cost with shorter schedules and reduced risk. Off-site manufacture is one of the key initiatives being used by contractors to achieve these goals. Sandwich Plate System (SPS) Floors deliver a compelling off-site solution for structural floors. Their composite steel panels provide a similar performance to concrete floors at one quarter the weight, 10 - 15% shorter project schedules and broader benefits such as reduced complexity and the elimination of the majority of wet-work above ground level.

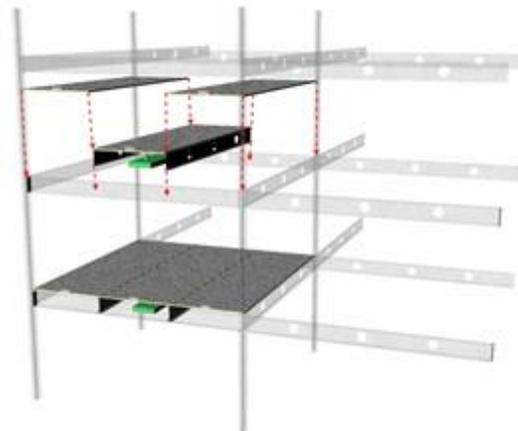


FIGURE 1 CONX SPACE FRAME SYSTEM



FIGURE 2 EXAMPLE OF CONX SPACE FRAME SYSTEM



an SPS 3-30-3 plate (80 kg/m², 36mm thick) for one design and an SPS 5-30-5 plate (110 kg/m², 40mm thick) for the other. A typical concrete floor weighs 400-500 kg/m² and is 130+mm thick. SPS Floor plates have high dimensional accuracy of ±2mm and are flatter than a standard cast-in-place concrete floor (less than 4mm over 3m rather than 8mm for straight edged concrete).

Detailing of SPS Structural Floors

The details shown here are typical details and are taken from the SPS Floors Technical Summary.

Connections to Structural Frame

SPS Floor plates are connected to supporting elements of the structural frame by bolting the SPS plates through perimeter (edge) bars to top flanges of supporting beams at 600mm c/c or less, all along the complete perimeter of each panel. (Welding can also be used but is expected to be a less preferred option for on-site work.)

Attachments

Creating openings and penetrations in SPS Floors uses industry standard techniques and is easier, safer and quicker than in concrete floors. The location of these openings and penetrations, without detriment to structural integrity, is significantly more flexible than in concrete floors. The sealing of any penetrations uses industry standard materials. Bent plates or threaded collars are employed to close the edges of exposed elastomer. These collars eliminate exposure of elastomer and provide a robust boundary for subsequent installation of services into penetrations.

SPS Floor plate systems are homogeneous. This feature allows much greater flexibility in sizing and locating floor penetrations than conventional concrete floor construction methods. Substantial penetrations, up to 800mm x 800mm in plan, or groups of smaller penetrations can be easily and economically achieved on site anywhere within SPS Floor plates and without the need for re-framing at these locations. Larger openings, of unlimited size, can be obtained through the same process, but will require secondary framing at perimeter of the opening. On-site, penetrations can be easily made using cold-cutting processes typically used on-site however the cutting process is both faster and cleaner than with concrete. In pursuit of maximum off-site fabrication, the design of SPS Floors seeks to incorporate as many penetrations and openings in the factory as possible.

Floor Finishes

All conventional floor finishes can be used with SPS Floors ranging from ceramic tiles to raised access floors but can often be installed with greater efficiency. For example, due to the natural flatness of SPS Floors, no intermediate flattening screeds are required. Also, for raised floor systems, pedestal attachments can be prefabricated into the SPS plates.



Structural Characteristics and Performance

SPS Floors are specifically engineered for each application. They can be readily designed to achieve low deflections and vibration Response factors of 4 to 8 with live loads of 1 to 10kN/m² across a wide range of one or two way spans

Static performance

Typically, the dominant design condition for SPS Floors is dynamic performance. Unlike concrete, which uses weight and mass damping to control vibrations, SPS Floors use stiffness. Hence, the static deflection of an SPS Floor under a live load (5kN/m²) is typically greater than span/750 (concrete typically only achieves span/360).

Dynamic performance

With these low deflections and the natural damping provided by the visco-elastic polyurethane core, SPS Floors can readily achieve a Response factor of 4 to 8 depending on intended use. In a recent series of tests on a full-scale mock-up, two independent experts tested SPS Floors for dynamic response and compared them to concrete floors in similar structures. Both experts concluded that the SPS Floors were able to offer a similar performance to conventional concrete floors. A further study by Arup into the dynamics of a commercial office floor using SPS Floors on a steel frame has demonstrated that suitable performance levels can readily be reached, as in the analysis shown to the right:

Integration with the structural frame

When erected and attached to the primary and secondary beams, SPS Floor plates form a rigid horizontal diaphragm that transfers external lateral loads to the lateral load resisting system. This is typically achieved by bolting SPS panels through perimeter (edge) bars to top flanges of supporting beams all along the perimeter of each panel.

Composite action

With these connections, SPS Floors readily achieve composite action with the supporting secondary beams in the same way studs used in composite concrete floor construction. Spacing of bolts is adjusted to achieve desired level of composite action and bending moment capacity. Primary beams in a floor system can also be made partially composite. However additional bolts are required near each secondary beam to transfer the total compressive force between adjacent SPS panels and hence non-composite design of primary beams is preferred. The loads due to composite action with supporting beams or due to diaphragm action are transferred through the bolt to the SPS plate's edge bar and from the edge bar through continuous fillet welds to the metal faceplates of the SPS plates.



Point loads

SPS Floor plates can support significant point loads. For example, on a 100mm x 100mm loaded area, a 3mm thick plate alone can support a point load of 200kN (punching shear at $0.6F_y$). However, since both faceplates of the SPS panel work together with significant loads being transferred by the polyurethane core, SPS panels are able to support significantly higher point loads than this.

THE BENEFITS

Prefabricated SPS Floors are 75% lighter & thinner than concrete floors. Their lower mass reduces the weight and size of the building frames and foundations. Their prefabrication significantly reduces project schedules and project risk. The detailed benefits arise in four broad categories:

- Reduced erected materials: lighter structural elements, shorter vertical elements, smaller foundations, longer spans - fewer structural elements
- Shorter project duration: improved construction activities including tightening finished build tolerances with structural floors immediately square, flat and level
- Improved financials: reduced finance costs, earlier and enhanced revenue opportunities
- Other benefits: improved build-ability, de-risked construction programme, reduced health & safety risk, enhanced sustainability, easier M&E integration, reduced impact on building locale, enhanced architectural options, easier to accommodate future change of use

CASE STUDY

BAA Pier Prototype : Concourse Floors

SPS Floor modules incorporated into prototype for BAA's generic pier

- Full-scale 9m long 27m wide section of pier erected at Heathrow airport
- 4 SPS modules delivered to cover half of prototype wide
- Each module 9m long * 3.6m wide

The prototype demonstrated that significant efficiency savings were achievable:

- 6 trades were removed from site
- Pier structure erection schedule compressed by 60%
- SPS units for each 9m * 27m bay could be erected the day after the lower frame
- Erection of the lower frame and cladding could follow on day after floor erection, using SPS as full strength safe working platform
- Enhanced build quality and reduced H&S risk was also delivered



STATUS

To date, SPS has been used in 5 continents on 110 projects amounting to over 100,000m². While many of these projects have previously been on ships and oil & gas installations, Intelligent Engineering (IE) has more recently developed SPS solutions for the construction market. A significant amount of testing (10,000+ tests) has been completed on the basic component materials, SPS structures and on SPS Terraces by BASF, technical institutions, universities, and independent laboratories under the supervision of independent experts. These tests have included full-scale static, dynamic, fatigue and fire tests.

BARRIERS

Biggest barrier to the widespread use of the SPS Floor technology is the lengthy acceptance process of building codes.

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REFERENCES

1. Intelligent Engineering had provided the information used in this factsheet upon the request of ECT.
2. www.ie-sps.com

REVIEWERS

Peer reviewed as an emerging construction technology

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