Polymer Composites as Construction Materials

Application Summary Sheet 5

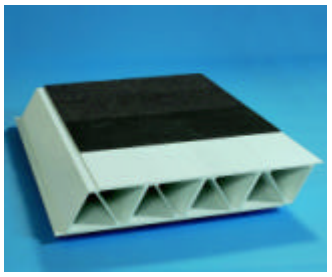
Title: Bridge Decks (see also *Bridges*)

Target Audience: Bridge designers, structural and civil engineers, bridge specifiers, architects

Keywords: Bridge, deck, sandwich profile, replacement, refurbishment, load reduction, floors

Overview of application / summary

FRP bridge decks comprise profiled sections and sandwich panels, spanning transversely or longitudinally between supporting elements (such as steel beams) or suspended from tension cables. Several variants have been developed. Most comprise of pultruded multi-cell sections which are glued or bolted together to form a compound structure. For example, the ACCS system (Advanced Composites Construction System) uses pultruded multi-cell box section with connecting toggles and gluing; Superdeck system uses bridge truss sections with hexagonal shear keys; ASSET system (Advanced Structural System for Tomorrow's infrastructure) uses a two-cell prismatic profile.



Asset bridge deck with lightweight covering

Bonds Mill Lift Bridge with ACCS deck

Construction is usually pultruded glass fibre reinforced polyester or vinylester, although some types are hand-laminated. Decks are prefabricated and craned onto bearings as a single unit leading to considerable savings in installation time. Principal advantages are durability and lightness. The biggest deck spans are up to 10m. Variants capable of 40 tonne loads are available. Wear

surface or top surface is polymer concrete (often applied before installation) and asphalt.

Markets: New bridges, replacement of deteriorated reinforced concrete decks damaged by de-icing salts.

Examples of deck systems:

ACCS, Superdeck, DuraSpan, Strongwell, EZ Span, Manitobia, Superdeck, Kansas System (honeycombed core), Hardcore System, ASSET system.

Impact of Application

Financial:

Lower installation costs through prefabrication and lightness of elements, leading to reduced road/rail occupation and disruption charges, lower crane requirements

Lower through life cost through higher durability and reduced maintenance requirements.

In refurbishment projects, ability to use existing support structure and foundations.

Environmental:

Efficient section, reduction in use of materials, alternative to steel and reinforced concrete.

Social:

Reducing installation time results in lower traffic disruption

In refurbishment projects, ability to replace decking in a heritage bridges, increasing capacity through dead-load reduction, whilst conserving the outward appearance.

Engineering:

Advantages

Lightweight (replacement decks, heritage bridges, lift bridges, cable stayed and suspension bridges, swing bridges, increasing capacity, decrease in foundation loads)
Lightweight - ease and speed of handling, cranage and transport leading to lower disruption and reduced need to curtail traffic etc. and allows use lower capacity lifting gear.
Speed of installation (eg concrete curing) leading to reduced disruption, through road closures etc.

Durability - waterproof and corrosion resistant (eg from de-icing salts)
Freeze-thaw resistant
Ability to accommodate service conduits.

Robustness:

High - applications backed up by authoritative research, component and full scale testing.

Future developments and estimated time-scale:

Higher capacity systems, longer spans (under development)
Decking systems for the floors of buildings, stadiums etc (under development)

For example: Project ASSET (Advanced Structural System for Tomorrow's infrastructure) lead by Mouchel, is an innovative structural system based on advanced composite profiles. Laboratory tests are underway in Spain in readiness for the installation of a prototype highway bridge in Oxfordshire during mid-2002 to carry vehicles of up to 40 tonnes. Mouchel's design incorporates mating and overlapping sections so that lengths of the two-cell profile can be factory-bonded together side-by-side to form a high-strength deck structure, repeatable in 300mm widths and able to carry concentrated wheel loads. The system can also be used for floors in buildings.

Where to get further information

Products:

Duraspan™ Composite Bridge Deck (Fiber Reinforced Polymer)
Martin Marietta Composites
www.martinmarietta.com

Research:

Development Of An Advanced Composite Decking System For New-Build
Dr. John Hodgson, Dr. Sam Luke, L Canning,
Structural Faults and Repairs 2001.

The Analysis, Design and Optimisation of an Advanced Composite Bridge Deck,
Dr. L. Canning, Dr. J. Hodgson, Mr. A. Jarman , Dr. R. Karuna, Dr. S. Luke
ACIC 2002, 15-17 April 2002, Southampton, UK.

Modelling and characterisation of fiber-reinforced plastic honeycomb sandwich panels for highway bridge applications
J.F. Davalos, P. Qiao, X. Frank Xu, J. Robinson, K.E. Barth
Composite Structures: 2001, Vol. 52, Iss. 3-4, pp. 441-452

Design Guidelines for Bridge Deck Slabs Reinforced by CFRP and GFRP.
Hassan, T., Abdelrahman, A., Tadros, G., and Rizkalla, S. (2000) Bridge Engineering Conference 2000, Sharm El-Sheikh, Egypt, March 26 to 30, Vol. 1, pp. 259-270.

GFRP Modular Bridge Decks
Williams, B., Shehata, E., Church, K., Stewart, D., and Rizkalla, S. (1999) (A). World Wise '99, Winnipeg, MB, Canada, December 6 to 8.