Composites for Transport at CompositesUK Annual Conference

Introduction

Adrian Waddams of the Transport KTN attended day two of the CompositesUK Annual Conference held on 15 and 16 May 2013 at Southampton. The theme was mainly composites of glass, carbon, aramid and natural fibres set in thermosetting and thermoplastic polymer matrices. On day one delegates heard about the state of the global composites industry, and the opportunities and challenges for the UK in this fast moving and rapidly developing materials sector which serves all transport sectors as well as many other industries.

Day two covered opportunities for end users in surface transport sectors of rail, road and marine and the renewable energy and construction industries that includes transport infrastructure. Aerospace and defence applications were not covered. Significant growth of composites in all transportation markets was predicted with speakers covering topics broadly grouped as follows.

Motorsport and Niche Vehicles

Starting at higher end applications demand for advanced composites is growing in motorsport applications with racing cars in F1 and other classes, rally cars, motorbikes and racing powerboats. Composites are generally of carbon, aramid or high performance glass fibre reinforcements with wet or pre-preg epoxy resin systems. Other high performance resin/matrix systems are used where special properties are required e.g. phenolic resins for higher temperature resistance.

In F1 racing cars carbon fibre reinforced polymer is used extensively including main structures and load bearing components, plus suspension, aerodynamic aids and body panels. Rally cars benefit from carbon/aramid infused epoxy and acrylic resin protection panels, which are lighter and tougher than GRP or steel, as well as bonnet, door and boot lid panels to save weight. Similarly, other racing classes and an increasing number of high performance, low volume, niche road cars, e.g. McLaren are becoming mainstream users of composites.

Automotive - Volume OEMs

Moving from motorsport and high performance niche vehicles to higher volume applications there are several examples of major car manufacturers (OEMs) developing strategic agreements with material suppliers. In volume automotive markets developments of new lightweight composite applications are also resulting from OEM investments in R&D and supplier joint ventures. Several automotive OEMs are in strategic collaborations to develop low cost carbon fibre composites for volume applications, e.g. Jaguar Land Rover with Cytec.

With the growing demand for advanced composites a number of the leading composite suppliers have consolidated through merger and acquisition into global businesses, such as Hexcel, Cytec, Gurit, Tencate, SGL and Toray.

In automotive applications the main drivers for composites include ease of creating complex features & styling, helping component integration, corrosion resistance, minor impact and dent resistance and weight reduction with opportunities for all of these throughout the vehicle. Weight reduction is a key priority that directly affects fuel consumption and CO2 emissions, being driven down through legislation with which manufacturers must comply or face penalties.

Although composites have been used in low volume niche vehicles since the 1950s, for volume vehicle production composites are now predicted to grow by about 50% by 2020 based on 2010 consumption, with glass fibre composites expected to remain dominant by a factor of 10 to 1 by weight over carbon fibre composites.

However, there are practical, regulatory and cost constraints on using thermosetting composites. High material and processing costs for volume manufacture, and regulations on end of life disposal and recycling are therefore encouraging interest and R&D investment in carbon fibre reinforced thermoplastics composites, which might overcome some of the current limitations of thermosets.

Overcoming the Challenges

The automotive industry and research organisations are working to resolve the challenges of product design, material processing, manufacture, environmental and vehicle safety legislation, quality and material consistency, and the cost of using composites versus metals. They are developing supply chains and material supplies in competition with other industry sectors, and with other industrialised countries becoming hungrier for finite material supplies.

The automotive industry's drive to achieve greater energy efficiency is accelerating interest in lightweight composite materials, as also in the other surface transport sectors of marine and rail.

Marine Leisure

The marine industry was one of the first to adopt composites in the 1950s using glass reinforced plastic for boatbuilding with its considerable attractions of a simple process for ease of application, relatively low skills compared to wood and steel construction in small craft, plus low maintenance, resistance to rot and corrosion, lightweight and design flexibility. The ability to produce moulded boats in larger volumes at lower cost led, among other factors, to the boom in boating from the early 1960s.

GRP is still the primary material used, but with hand layup giving way to resin infusion for cleaner processing by reducing styrene emissions and creating a cleaner working environment.

Infusion also improves product consistency and manufacturing efficiency, and lighter structures for improved performance and fuel economy. More advanced carbon fibre reinforced plastic (CFRP) is used in high performance vessels, both power and sail driven, and for reducing the weight of critical components in production craft particularly if affecting stability such as superstructures, radar arches, targa roofs, etc.

Ships and Larger Vessels

Larger vessels and commercial craft are subject to stringent safety regulations whereby fire, toxicity and smoke requirements must be met, and composites are currently more challenged by these than metal construction. For some naval and high-speed craft such as windfarm support vessels composites are already being used, and beyond the established leisure craft market the growth in composites applications in marine currently comes mainly from the workboat sector.

Larger ships also offer scope for composites, but mostly above deck for ancillaries not subject to fire regulations, e.g. railings, stairs, davits, walkways, balconies and for some tanks, vents and valves. The weight and maintenance benefits are attractive, with further potential expected from the cruise ship market with modular cabins, and on such items as hatch covers and accommodation blocks for cargo ships. The perceived view is that hulls and decks of large ships are still some way off a move to composites, but there is plenty of R&D going on.

Railway Rolling Stock

The Railway Industry also sees potential in composites. Moulded FRP train nose cones and fairings are already widely used and have been for many years, and other composite structures have been developed more recently as prototypes. However, although there is a weight benefit, advanced composites are still rarely used in rolling stock structures. This is because of the high material and manufacturing costs of traditional composite techniques, uncertainties over design issues such as fatigue and fire performance, and recycling and ease of repair.

The designs have tended to replicate conventional components rather than integrate additional functionality and exploit material benefits to the full. However, recent developments in lower cost manufacturing processes for production applications in road transport offer opportunities for knowledge transfer into the rail sector. Weight reduction in rolling stock offers energy saving benefits that can improve braking and acceleration performance to increase train throughput, line capacity and utilization of the fixed infrastructure.

Corrosion is a major problem with rolling stock, and composites can simplify repairs by patching over metal structures faster than welding, particularly on the lower body panels of passenger rolling stock. Rail is a standards driven industry based on existing technology and practices of long standing so inertia exists to change to composites until these materials are fully evaluated and standards revised to cover them.

As with other passenger transport modes fire and crash safety requirements are rigorous and composites must satisfy these before they can be applied to rolling stock. This requires collaboration between the rail and composites supply industries in working towards change.

Railway Infrastructure

Composites in construction are used in structures, cladding and complex architectural shapes and features. Some notable examples for transport infrastructure include railway bridges, gantries and platforms to replace existing steel and concrete structures, and large span footbridges. The benefits of these lightweight composite structures when replacing older metal and prefabricated concrete structures is their much lighter weight that reduces the time to install and consequent disruption and delays to rail or road traffic during installation. Composite structures also eliminate the corrosion of steel structures and reduce maintenance.

There are therefore very big opportunities for increased use of FRP composites in construction, particularly in bridges and buildings. However, larger projects would require sufficient supply chain capacity, and significant engineering input. These present challenges and opportunities for the construction and composites industries to work together as is found in all the other sectors described.

Open innovation is being encouraged and the Railway Industry has a number of programmes in place such as the *Unlocking Innovation in Rail* initiative led by the Rail Industry Association and supported by DfT and the Transport KTN.
https://connect.innovateuk.org/web/unlocking-innovation-in-rail

Renewable Energy and Offshore Support Vessels

The Renewable Energy Industry both on and offshore is already a big user of composites in turbine blades, spinners and related components such as nacelles and substation components, and growing fast. Supporting this sector is the offshore crew transfer and support vessel market where the UK is well placed with several yards flat out to meet demand – but facing tough competition from overseas.

As with marine, large structures and parts used in the renewable energy sector are produced in modest batch quantities. The materials and processes are similar too, with glass fibre the dominant reinforcement and resin infusion now widespread.

So there is a natural close co-operation between UK shipyards and the renewable energy sector, often co-located in ports with the necessary seaborne access to installation sites.

Supply Chain and Skills Development

With the increased demand for composites in transport and many other end user industries the established composites supply chain faces pressures and especially a need for more trained people. This need is for composites engineering skills rather than just basic craft skills, and training is a therefore a high priority if the industry is to grow successfully.

With this objective the Composites Skills Alliance and the Manufacturing Advisory Service are supporting the composites supply chain with skills and training.

Other initiatives to support the UK composites industry include the National Composites Centre (NCC), part of the High Value Manufacturing (HVM) Catapult, EPRSC and TSB funding for research, development and innovation, and the BIS supported Advanced Manufacturing Supply Chain Initiative (AMSCI) which is funding the Composites Innovation Cluster project led by the NCC and CompositesUK.

There is also the Composites Leadership Forum (CLF) that is currently developing the National Composites Strategy 2014, to bring up to date the composites strategy published by BIS in 2009 and create a comprehensive UK composites industry supplier database.

The main CLF stakeholders of BIS, TSB, EPSRC and Materials KTN are working with delivery partners the NCC, Composites Skills Alliance, CompositesUK, AMSCI Composites Innovation Cluster, Centre for Innovative Manufacture in Composites (CIMComp/EPSRC), and industry trade associations including those representing rail, automotive, motorsport and marine together with aerospace, renewable energy and construction, and materials suppliers.

The UK composites supply chain is 80% SMEs and very diverse, so these initiatives are providing the necessary support and leadership. The national composites strategy for 2014 will aim to develop and maintain cross sector composites capability, and build on the already large contribution to the UK economy and jobs from composites.

UKTI funded the UK Composites Supply Chain Scoping Study in 2010 that showed revenue from composites production of £1.5 bn with 45% exports. The NCC is central to this strategy as part of the HVM Catapult with strong emphasis on learning and skills at all levels working with academia and industry, to be strengthened further with NCC phase II opening in 2014.

Funding Opportunities

The concluding topic of the conference was funding opportunities for composites across all applications presented by Ajay Kapadia, Composites Sector Leader of the Materials KTN. Information on funding and other sources of industry support can be found via the Materials and Transport Knowledge Transfer Networks, and from the TSB. You can join these networks free at https://www.innovateuk.org/-/knowledge-transfer-networks

Boatbuilding Efficiently with Composites

Following the CompositesUK event the Materials KTN supported by the Transport KTN held a conference *Boatbuilding Efficiently with Composites* at Southampton on 2 July. This showed how far the marine industry has progressed in only a few years, by working more collaboratively with the composites supply chain and sharing knowledge within the industry, achieving significant improvements in productivity, product quality and vessel efficiency through lighter weight. Presentations and an event report by Stella Job of the Materials KTN can be accessed and downloaded at:

https://connect.innovateuk.org/web/composites/boatbuilding-efficiently-with-composites-2013