A timetable for the future of rail

The National Composites Centre offers the rail industry innovation support as well as the space to collaborate and exploit global growth opportunities

Composite materials offer untapped opportunities for the integration and optimisation of design. Composite structural components can be made light yet stiff by use of carbon fibre, glass fibre and sandwich structures. Components and structures can be re-designed to provide structural and functional support frameworks, brackets and ducts while eliminating the need for multiple parts.

This can reduce part count, tooling, manufacturing, energy and inventory costs. Composites are also extremely durable, both in fatigue under vibratory and repetitive loads, and in resistance to weather, corrosion and chemical attack, providing real opportunities for low maintenance products.

Right now is the perfect time for the rail sector to develop increased understanding in the design and analysis of these materials in the context of major investment programs for new rail rolling stock and infrastructure. These are also currently strong financial incentives to seek novel approaches,” said NCC’s Business Support Engineer, Paul Gallen. NCC is already working with suppliers of composite components to the rolling stock sector in developing the use of design and analysis tools to optimise lightweight design and crashworthiness.

Ambitious innovation

In his foreword to the Network Rail Technical Strategy 2013, Network Rail chairman Richard Parry-Jones, sets out the challenge and opportunity of ambitious innovation: “We see a future that challenges the limits of our current technical approaches – a future in which we must increasingly rely on our ability to exploit a rich stream of innovation.”

The NCC shares and embodies that ambitious vision of knowledge transfer by collaboration and innovation.

The NCC

The UK National Composites Centre (NCC) mission is to be the world-leading centre of excellence and innovation in composite technology. With more than 150 specialist composite engineers, designers and technicians working on innovative composite applications, the high-tech open-access centre provides industrial scale R&D facilities to meet the needs of sectors seeking to capitalise on high-strength, low weight, corrosion-resistant composite materials. “Inventions start with bright ideas but need testing against reality. To this end, NCC has a specialist team using design simulation to model and predict their concepts,” said Gallen.

The use of computer modelling and simulation can significantly reduce risk, prototype production time and costs. The centre’s state-of-the-art equipment can be booked by the hour and gives access to NCC’s manufacturing technique experts. Applications that can be explored at the centre include the resin infusion of large structures and high speed press forming, with an emphasis upon automated, efficient processing and established open moulding.

Both the design and manufacturing capabilities are supported by in-house validation through ultrasonic NDT and a fully-equipped materials laboratory.

Historical use of composites in rail

There is considerable experience within the UK rail supply chain in the design and manufacture of high-quality interior and hypo-British composite components, seats and WC modules – mainly using glass fibre reinforcements. Composites have been used in rail infrastructure for the manufacture of dusts and tramps, canopies, tunnel linings and bridge repairs.

According to Gallen: “Currently, there is an opportunity to leverage this industrial capacity further to produce more integrated and larger components for both intercity, structural car body and for freight car bodies, where inherently weather-resistant and fire retardant composite materials exhibit through-life cost advantages over painted metals.

Future use of composites in rail

The use of composites in other sectors, such as niche automotive and aerospace, indicate that composite primary structures can reduce weight by up to 45 per cent compared to an aluminium structure and 65 per cent compared to steel. These composite structures are proven to be more effective at preserving passenger survivability than metal structures, even when combined with very large weight reductions.

Introducing new design and construction techniques will benefit whole-life costs and reduce the carbon footprint of rolling stock by allowing lightweighting as well as lowering maintenance costs by reducing fatigue failures and corrosion repairs.

Rolling stock

The general trend towards increased weight in rail vehicle structures has begun to reverse although this has not yet featured in UK rolling stock. Post 2018, Network Rail expects a design towards increasing standardisation and modularisation of components, and the composite supply chain could play a key role in providing large components and enclosures to support a tailored supply chain model and reduce maintenance downtime.

The opportunities in rail vehicle design offered by composites can either be incremental, in the case of part consolidation and weight reduction, or more radical in the case of car body design, where the designer can create additional and larger doors, windows and inter-carriage apertures through effective usage of composites, due to their high stiffness to weight properties.

An increased number of larger doors can reduce dwell times at stations by accelerating movement of passengers from the carriage, and help overcome additional network capacity at relatively low infrastructure cost.

Within the roof of rail vehicles, there is significant opportunity to integrate ventilation into the structure. Both passive and forced ventilation systems may be used to augment, or partially replace air conditioning systems and reduce energy consumption.

Introducing these new design and construction techniques will benefit whole life costs and eliminate the need for corrosion repairs.

Infrastructure

Although some use has been made of the opportunities that composites offer, more could be made of the advantages that can be gained by rapid installation, low through-life maintenance, in situ exo-Oxide repairs or reinforcing plate for more conventional engineering superstructures.

The current and rail DC infrastructure is constrained by higher power requirements of heavier trains, so a reduction in the weight of carriages could potentially increase the passenger capacity of this network without expensive electrical infrastructure upgrading.

There is significant opportunity for prefabricated factory-made pedestrian bridges that can be installed overnight without requiring denial of rail paths or extended track possessions. NCC is working with the UK composites sector to develop prefabricated easily deployable solutions.

Following successful laboratory testing in late 2012, 2,000 composite sleepers were installed in Europe for use by both passenger and freight trains.

Siut. Enterprises is currently developing a UK manufacturing plant where waste plastic, composite and glass fibre materials will be diverted from landfill into Revenue sleepers and it is anticipated that this will commence production in late 2014.

London Underground successfully used UHF carbon fibre plates bonded to the underside of cast iron beams supporting the covered way carrying Circle line trains between High Street Kensington and Gloucester Road.

Large scale projects such as HS2 and widespread network electrification will require extensive replacement of line side equipment and cabinets. These can be economically produced and swiftly installed off-site using composite materials, with the advantage that they are non-electrically conductive and low maintenance.

Opportunities for collaboration with other sectors

Later this year, the Enabling Innovation Team, Rail Industry Alliance and NCC are joining forces in a bid to encourage unique opportunities to collaborate and share knowledge with industry partners.

A workshop on Improving the railway industry through use of advanced materials is set to take place on November 28th at NCC’s facility near Bristol. This and the related seminar event will give representatives of the composites supply chain and railway industry the chance to discuss upcoming projects and commercial opportunities.

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