

Construction and
infrastructure key drivers
of future growth



WORLD PULTRUSION CONFERENCE 2018

European Pultrusion Technology Association

ATTRACTIVE LONG-TERM PROSPECTS FOR PULTRUDED COMPOSITES

The long-term prospects for pultruded composites in infrastructure, construction, transportation and further key application markets were highlighted at the 2018 World Pultrusion Conference, organised by the European Pultrusion Technology Association (EPTA). This year's event attracted a record number of composites professionals from around the world to Vienna on 1-2 March to discuss growth drivers for the pultrusion industry, promising application areas, and the latest advances designed to improve performance and productivity.

Global trends such as sustainability continue to drive the adoption of strong, lightweight and durable composite materials in markets such as transportation, construction and energy. Fibre reinforced polymer composites deliver lower energy consumption throughout a product's life, combined with a long service life and reduced maintenance requirements, providing benefits in terms of life cycle costs and environmental impact.

Pultrusion, one of the few continuous processes for manufacture of composite parts, enables the cost effective, high volume production of structural profiles. In the pultrusion machine the reinforcing fibres are impregnated with resin and pulled through a heated die where curing takes place. The finished profiles are cut to length at the end of the line. Since pultrusion allows for high fibre loading and accurately-controlled resin content, pultruded parts have excellent mechanical properties and are produced at a consistently high quality. Reinforcement, resin and additives can be combined to ensure that the finished profile provides the optimum combination of properties required for a specific application. The conference's opening session addressed the growth drivers for pultruded composites.

A growth market

The global market for composite end products was estimated at US\$81.7 billion in 2016 and is forecast to reach \$109.4 billion in 2022. Composite materials have a low market penetration in most sectors and so there is significant opportunity for growth.

Europe accounts for approximately one third of global composites production. The European market for glass fibre reinforced plastic (GRP) composites is closely linked to GDP as well as the evolution of key application industries such as automotive and construction, noted Dr Elmar Witten, EPTA Secretary and Managing Director of AVK (the German Federation of Reinforced Plastics), discussing the findings of AVK's latest survey of the European composites market. Applications for carbon fibre reinforced plastics (CFRP) will also continue to drive growth. The pultrusion industry's share of European GRP production is around 5%

but growth has been steady over recent years and the majority of the survey's respondents believed that this will continue.

A positive long-term future for pultrusion is also anticipated in North America, which accounts for a further third of the global composites market. According to Dan Coughlin, VP of Market Development at the American Composites Manufacturers Association (ACMA), pultrusion represents 3% of the total North American end product market for composites and was estimated to be worth \$790 million in 2016. Analysts predict a CAGR of approximately 5% to reach \$1060 million by 2020, with construction and infrastructure the major growth sectors. Key challenges for pultruded composites include initial higher cost compared to competing materials, difficulty in manufacturing of complex shapes, and a lack of awareness of the benefits of pultruded products, Coughlin says. However, he pointed to a number of mergers and acquisitions within the composites sector that are helping to improve its efficiency and competitiveness with larger industries, and highlighted drivers favouring adoption of pultruded composites including ease of installation and superior mechanical and chemical properties, as well as infrastructure revitalisation initiatives.

New approaches to infrastructure

Opportunities for pultruded composites in next generation Infrastructure were highlighted by Kendall Thacker, Product Manager, Pultrusion, at Owens Corning. One target application is replacement of steel rebar (reinforcing bar employed to strengthen concrete structures), a \$120 billion market globally. It is estimated that 1 in 9 US bridges is structurally deficient and corrosion related to steel rebar is one of the biggest asset management costs. Now, new approaches aimed at minimising overall lifecycle costs are focusing on eliminating the corrosion related to steel rebar rather than simply mitigating it. GRP rebar is corrosion resistant, offers a high strength to weight ratio and ease of use. Research has shown that GRP rebar can maintain its mechanical properties after 15 years of service, offering new levels of durability and long term performance for infrastructure owners. The Halls River Bridge in Florida is one generation bridge initiative designed to demonstrate the reliability and benefits of composite materials. Composite materials are employed throughout the structure, including GRP rebar in the superstructure's deck, barriers and approach slabs, and in areas of the substructure and sheet pile walls.



Image courtesy of FDOT

An emerging infrastructure application was highlighted by Mikko Lassila, Product Business Owner, Telecommunication, Exel Composites. The company is developing infrastructure and building elements for the forthcoming 5G era, where pultruded glass fibre laminates can be designed to minimise attenuation of the high frequency, short wavelength 5G signals, whilst also delivering installation and durability benefits. The company is part of the LuxTurrin5G initiative on Smart City Digital Ecosystem Creation, which is developing smart lighting poles designed to create a telecommunications network fit for the world's rapidly growing urban environments. As well as providing energy-efficient lighting and other services, the composite poles will incorporate integrated miniaturised 5G base stations to create a high-capacity 5G data transmission network. The composite pole functions as mast, architectural casing, weather protection and radome for the 5G antenna. The pultruded pole tubes are manufactured from glass fibre reinforced polyurethane resin. The laminate structure is designed to minimise the attenuation of the 5G signals as they travel through the pole wall. The lightweight composite pole also offers easy assembly and a longer life compared with steel and wood alternatives.

Improving fire performance

The building and construction sector offers immense potential for pultruded composites, but the combustibility of GRP is one of the biggest barriers to its more widespread use. David Thull explained how Fisco GmbH set out to develop a non-combustible material for pultrusion that would fulfil the requirements of Class A1 according to DIN 4102-1/EN 13501-1 fire test standards. Since glass fibres are inorganic and do not burn, the project focused on replacing the traditional organic matrix resins with a non-organic, non-combustible matrix. The company selected an inorganic matrix based on 'water glass,' an aqueous solution of silicon dioxide and an alkali metal oxide. A suitable glass fibre and fibre sizing, as well as adjustments to the pultrusion tool and equipment, were needed to enable the successful pultrusion of the new matrix, which is highly alkaline and abrasive.

The new material - fi:resist - is non-flammable, emits no fumes, offers high thermal insulation, and has the potential applications in the construction, ship and rail sectors. Pultruded fi:resist profiles could be used to produce fire protection doors and fire roller doors to provide long functional integrity even at high temperatures, and in fire-resistant self-supporting cable duct and fire-resistant lamellas for wooden beams.

Fire performance was also addressed by Tom Kugelstadt at Scott Bader, who reported that the company's urethane acrylate resins offer high levels of fire, smoke and toxicity (FST) performance and are now certified to many of the most stringent fire specifications in the construction and rail markets (such as EN 13501-B-s1,d0; EN 45545 - HL2, and ASTM E84 - Class A).

Crestapol 1212 and 1214 (which contains a low profile additive for superior surface finish) are said to offer a number of advantages for pultrusion over traditional polyester and vinyl ester resins, including a tough resin matrix, improved line speed and excellent surface finish. The resin's low viscosity allows for a wide range of filler loadings, as well as excellent wet out of glass reinforcement. For high FST performance aluminium trihydroxide (ATH) fire retardant can be incorporated at up to 200 phr. The ability to carry high ATH levels and still retain good mechanical properties means these products are good options for projects with both fire and strength requirements. Crestapol 1212, with 170 pph ATH, was used to pultrude the 810 cm wide corrugated tunnel plates for the Pajares road tunnel project in Barcelona. In a building refurbishment project in Alicante, Spain, new façade panels were manufacturing using Crestapol 1212 by pultrusion and other processes. Using Crestapol 1212 in combination a UV resistant, marine quality gel-coat ensured that the composite panels met the required fire standard.

Bringing benefits to blades

Composites are the material of choice for the ever longer wind turbine blades being designed to harness more power from the wind. Blade designs and their associated manufacturing processes must deliver an overall package for low cost, high quality and high production volumes, scalable anywhere in the world. Prepreg and infusion are the dominant manufacturing technologies, but turbine and blade manufacturers are always looking for more cost effective and robust solutions and Dr Rakesh Raj of StrucTeam Ltd discussed the business case for pultruded blade spar caps.

Infusion is currently the dominant technology in spar cap manufacture, with only around 5% of blades prepreg-based and 5% pultrusion-based. The spar cap is structurally critical and pultrusion offers a level of 'guaranteed' quality and lower scrap rates. Pultruded solutions also offer lower overall blade cost versus infusion as well as savings in capital and operating expenditure. OEMs are actively seeking their own pultrusion solutions but without adequate supply chain positioning and relevant expertise this is challenging. They need a robust 'off the shelf' pultrusion product, providing specific properties, pricing and supply chain security. The Pullwind consortium - comprising StrucTeam, Olin, CPIC and DNV-GL - was established to address the challenges associated with the use of pultrusion in blades. For a typical 80 m blade, the Pullwind solution for pultruded spar cap designs enables overall cost savings of 9-12% and allows for a 10% CAPEX reduction and an overall reduction in blade weight of 3-7%. Raj notes that the best scenario is for a blade manufactured in Europe with pultruded part shipped from a low labour cost country.

Tailored automotive components

Scott Bader's urethane acrylate resins are also being employed with carbon fibre in automotive applications. Jeffrey Starcher outlined how automotive parts can be tailor made

for their application. Potential pultrusion applications include bumper beams, roof beams, front-end support systems, door intrusion beams, chassis rails, and transmission tunnels. Urethane acrylates offer thousands of combinations of resins to choose from, high elongation with high modulus, and Tg of nearly 300°C. The resins bond extremely well to carbon and glass fibre, deliver 'snap cure' and pass automotive processing temperatures. Scott Bader urethane acrylates make very tough parts, and tests on composite fenders developed for a new NASCAR K&N and ARCA Series car body have demonstrated strength and durability.



The Radius Pultrusion process enables the manufacture of curved profiles, opening up new application possibilities. Dr Klaus Jansen of Thomas GmbH + Co. Technik + Innovation KG discussed the first line developed for the automotive market and how the equipment was

adapted to fulfil automotive requirements. These included shorter changeover times between different profiles and less downtime in case of problems, automatic start/shutdown, full process documentation of process parameters and materials per part, and a reliable, operator-independent process.

Thermoplastic pultruded profiles are being developed by SGL Group, as part of its Thermoplastic Composites Toolbox approach, which offers 'mix and match' components to achieve the most efficient lightweight design. Sigrapreg® TP profiles are based on heavy tow (50k) carbon fibre with thermoplastic sizing, impregnated with polyamide 6 (PA 6). The profiles typically have a fibre volume content of 40-50%, 100 mm² cross sectional area, and 0.1-15 m length. They can be thermoformed and then injection moulded with Sigrapreg TP long fibre thermoplastic (LFT) to produce load-optimised parts for automotive framework designs. This automated process offers cycle times of 75 seconds or less.

Enhanced performance and productivity

Alongside discussions of market potential, increased productivity was a strong focus of the conference. New pultrusion resins and process technology are being pursued to improve performance over traditional resins such as unsaturated polyester and vinyl ester and enable higher line speeds without affecting properties. Advances in highly reactive resins such as polyurethanes, epoxies and thermoplastics are opening up new possibilities.

Covestro believes that the combination of processing and mechanical properties offered by polyurethane resins means that in many cases they are the most cost effective solution for pultrusion. Compared with unsaturated polyester, vinyl ester and epoxy resins, polyurethane offers improved bending strength and higher interlaminar shear strength (ILSS). Working with equipment specialist KraussMaffei, Covestro is developing new polyurethane systems designed to enable the industrialised manufacturing of pultruded polyurethane composites. As Dr Paul Heinz, Head of Aliphatic Composites, Covestro Deutschland, explained, line speed and coating costs are two of the biggest influences on the cost efficiency of the pultrusion process and so the company developed a resin system which allows for high line speed (Baydur®) and another which eliminates the coating step (Desmocomp®).

Baydur offers excellent fibre wetting and mechanical properties, has a fast cure and can be processed at high line speeds. It enables reduced wall thickness of profiles, reduced complexity of fibre reinforcements and increased profile complexity. A cost calculation indicates lower material consumption and increased productivity. Heinz revealed initial results of a study focused on increasing productivity at constant mechanical properties, which demonstrated a x1.9 increase in line speed to 2.9 m/min for the Baydur profile compared with a 'state of the art' profile, and potential cost savings of 20%. Desmocomp exhibits stability to UV and weathering, delivers excellent mechanical properties and simple processing. A Desmocomp profile lasted >15,000 hrs without change in accelerated weathering tests (CAM 180), and >20,000 hrs in a salt spray test. The resin is also said to achieve excellent flammability properties without additives.

BASF is also developing polyurethane formulations to enable more economic manufacture of pultruded profiles. Utilising a pultrusion line at IKV, Germany, and by balancing reactivity, internal mould release behaviour and fibre-matrix adhesion, profiles with good mechanical properties were obtained at a production speed of 1.5 m/min. Optimisation of the internal mould release system resulted in a reduction of pull force, which enables the fast production of more complex geometries. The profiles also exhibited good surface quality. Elastocoat C 6226/105 (for pultrusion with glass fibre) offers low viscosity at room temperature, a very low pull force of <2 kN, and a T_g of 115°C. Elastocoat C 6226/106 (for glass and carbon fibre) also offers very low viscosity, a pull force of <4 kN and a T_g of 130°C.

A liquid thermoplastic resin for pultrusion has been developed by Arkema. Elium® is suitable for thermoset resin processes such as pultrusion, RTM and infusion, using glass or carbon fibre with Elium-compatible sizing. Since Elium acts like a thermoplastic, it can be thermoformed, welded and recycled. Elium 591 and C595 are designed for pultrusion. The liquid acrylic resin undergoes radical polymerisation at moderate die temperatures (up to 115°C) and reactivity is adjustable with conventional peroxides. It has a viscosity of 500 mPA.s at room temperature, is pigmentable, and suitable for bath or injection processes. The resin is styrene and bisphenol A (BPA) free. According to Arkema's Dr Alexander Zoller, in trials performed on a pultrusion line at IRT-M2P in France, profiles with good mechanical properties have been manufactured at line speeds of 0.35 m/min. Further optimisation is

underway with the goal of increasing this to 1 m/min. Future developments will focus on developing a fire-retardant pultrusion resin.

Zoller highlighted GRP rebar as a potential application for Elium. Unlike thermoset rebar Elium rebar is 'bendable' and can be thermoformed into shape on the job site. It also exhibits excellent mechanical properties, as well as creep and chemical resistance.



For high performance epoxy pultrusion, Dixie Chemical has been developing new anhydride curing agents. Anhydride-cured epoxies offer ease of handling, long working times and long pot life, as well as excellent high temperature performance and thermal stability, high strength and good chemical resistance. However they require relatively high temperature cures at extended times and they are challenging for pultrusion, where active catalysts are commonly used.

As Michael J. Watkins, Senior Technical Advisor - Epoxy Thermosets, explained, there is growing demand for high performance pultruded parts as high strength reinforcement for wind turbine blades and high T_g cores for high voltage transmission lines. In response to this, Dixie initiated an R&D programme to develop epoxy curing agents for these challenging applications. The objective was to develop new catalyst technology for anhydride-epoxy pultrusion which could deliver pre-catalysed anhydrides with long shelf lives, long pot life with epoxy at room temperature, as well as high reactivity at cure temperatures, a high cured T_g, and no promotion of epoxy homopolymerisation. Laboratory studies highlighted a new catalyst technology which, compared to commercial anhydrides used for pultrusion, demonstrates significantly lower viscosity, longer pot life and higher T_g. A pultrusion study was carried out at the University of Mississippi to evaluate the new catalyst technology and identify suitable mould releases and key formulation and process parameters. Watkins reports that the goal to develop pre-catalysed anhydrides suitable for demanding pultrusion applications was demonstrated. The new catalyst technology pultrudes 2.5-3 times faster than conventional latent catalysts and new products are in development. Since the formulations incorporated 10% filler, a positive impact on economics was achieved.

Dr Michael Karcher of Huntsman Advanced Materials presented the company's development work on easy handling epoxy pultrusion systems for high T_g applications. Current formulations require numerous components - resins, hardener, accelerator, internal mould release and fillers. Huntsman's goal is to decrease number of components to three, increase toughness while maintaining the same T_g, increase productivity and improve surface quality. The new concept was compared with a state-of-the-art epoxy in pultrusion trials and the results showed a significant increase in fracture toughness for the new resin, comparable

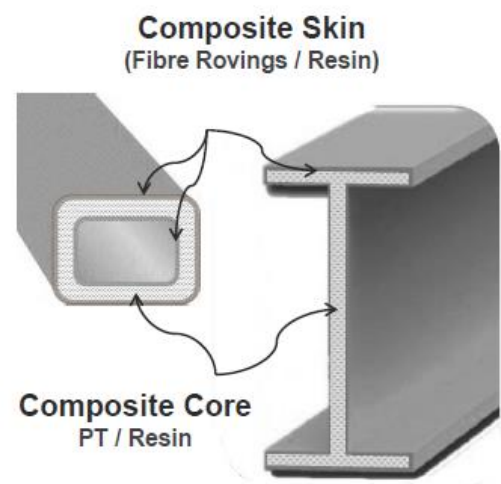
flexural and compression properties on a pultruded profile, and comparable lap shear strength (LSS) results with PU and MMA adhesive for a bonded specimen.

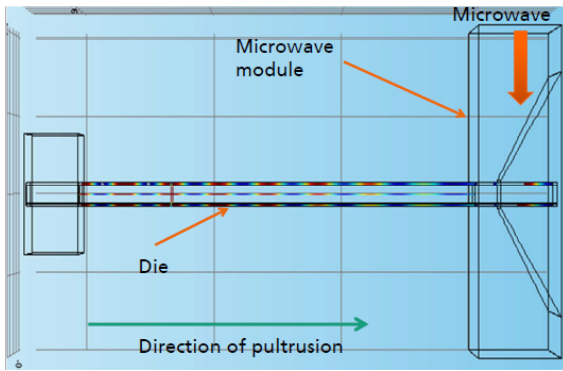
A Huntsman high Tg epoxy system (approximately 200°C) has been trialled in the production of composite cable core for high voltage transmission lines. The system delivered high pultrusion speed, excellent thermodynamic properties and outstanding mechanical properties with fibres, and a 6.5 day pultrusion run was performed without breakdown with a speed of 0.8 m/min. Positive results have also been achieved in oil extraction (sucker) rod manufacturing trials.

Styrene monomer is a readily available, low cost reactive monomer for composites but is subject to restrictive environmental and health and safety regulations. Vinyl toluene, a low emission, non-HAP reactive monomer, can be used as a replacement, but it has not been widely used in reactive polymer resins or low profile resins supplied into pultrusion applications. A study by Deltech Corp demonstrated the viability of using vinyl toluene as a partial substitute for styrene in pultrusion applications. According to Grant Richmond, significant product property enhancements were seen where the monomer in low profile resins was substituted with vinyl toluene, including higher strength and lower density. Line speed was also increased. Further work will focus on optimising resins, catalysts and run conditions to provide more property and process benefits.

Research initiatives

A project initiated by FPinnovations, a not-for-profit forest research organisation, addresses two key drivers for the composites industry: greater competitiveness against traditional materials, and a lower carbon footprint. Halim Chtourou, Senior Scientist, Cellulosic Biomaterials, presented on investigation into the potential application of twisted paper twines in pultrusion. Typical applications for NBSK (Northern Bleached Softwood Kraft) twisted paper twine include gift wrapping and paper bag handles. A preliminary cost assessment indicates that NBSK paper twines may be up to 27% cheaper than E-glass roving, and they require less energy to produce and are lighter in weight. In the new patent pending concept the paper twines are co-impregnated and co-pultruded with glass fibre to form a sandwich structure in which the skin consists of glass fibre rovings/resin and the core material of paper twine/resin. Results from pilot trials demonstrated improved flexural properties and a weight reduction of approximately 20% with respect to a similar E-glass fibre profile. Preliminary estimates indicate the potential of paper twine to reduce overall raw material cost by around 15%.





Rudolf Emmerich of the Fraunhofer Institute of Chemical Technology, presented a new concept for microwave-assisted pultrusion, developed as part of the European Coaline project. Curing time is an important parameter in pultrusion, especially for profiles with greater wall thickness and for resins with longer curing times like epoxy and polyurethane. Microwaves offer fast, homogenous or selective heating of materials. Microwave-

assisted pultrusion is state of the art but not used in industry primarily because it is necessary to replace the metal die completely with a microwave-transparent ceramic die or partially with a microwave-transparent ceramic insert. A concept for microwave heating without any major modifications has been developed in which the die geometry is used for transmitting the microwaves, and no ceramic parts are necessary. Retrofit of existing pultrusion dies is possible.

The challenge of in-line non-destructive testing (NDT) was also addressed. An efficient system is required which would enable the quick adjustment of process parameters such as temperature of resin and die, and pulling speed, in a closed control loop. The non-ionizing direct imaging testing NIDIT method for in-situ testing of pultruded parts was presented by Johann Hinken, FI Test- und Messtechnik GmbH. X-ray radiography is a powerful, direct imaging method of NDT, offering high spatial resolution, but X-rays are ionising and therefore harmful, requiring strict safety measures. However, if the devices under test (DUTs) are electrically insulating and the high spatial resolution of X-rays is not necessary, direct imaging with microwaves is a possible solution. The NIDIT set-up consists of a microwave source and an antenna which irradiates the DUT. The microwave radiation is affected by defects in the DUT and hits a microwave-absorbing foil which is then heated inhomogeneously. This heat distribution is recorded by an infrared camera and forwarded to a computer where it is instantly displayed and represents the defect distribution. Foil and camera act as a microwave detector. This NIDIT method has been shown to successfully identify defects in extruded wood plastic composite (WPC) planks and pultruded GRP plank. In the pultruded plank the technique identified a 1 mm diameter, 1 mm deep, drilled hole, and 1 mm diameter through-depth hole, 2.5 mm deep.

A number of pultrusion projects are underway at the Fraunhofer IGCV. These include preforming with pultrusion, which involves the production of dry preforms by applying binder to fibres, preforming them in a pultrusion process, and then further processing the preform by manufacturing processes such as infusion. A second focus is closed injection pultrusion where projects include the production of complex structural profiles for the automotive, rail and other sectors, manufacture of hollow 3D complex shaped, multiaxial reinforced parts for structural automotive applications such as torque transmission shafts, and ultrasonic-assisted pultrusion, which promises reduced viscosity, faster heating and higher performance.

The long road to standardisation

The conference concluded with status reports on two standardisation initiatives, the success of which will be crucial to facilitating future adoption of pultruded composites in the construction market and beyond.

In the US, initial work on a new tool to allow structural engineers to use pultruded products with confidence started in the 1990s. As the ACMA's Dan Coughlin explained, the objective was to provide strength, reliability and durability comparable to other materials of construction by using the load and resistance factor design (LRFD) approach. In 2007 the ACMA contacted the American Society of Civil Engineers (ASCE) to begin the project and the *Pre-Standard for Load & Resistance Factor Design (LRFD) of Pultruded Fibre Reinforced Polymer (FRP)* was published in 2010. The ASCE assigned the task of developing the standard to its Fiber Composites and Polymers Standards (FCAPS) Committee and it is now nearing completion.

The ACMA's Pultrusion Industry Council also initiated a *Code of Standard Practice for Fabrication and Installation of Pultruded FRP Structures* to serve as a companion document to the standard. This publication provides recommendations for construction contract documents, procedures and practices for the fabrication and installation of pultruded structures, and responsibilities of owners, engineers, fabricators, and installers.

The LRFD standard is intended to be employed for the design of new buildings and other structures constructed of pultruded GRP structural shapes, connections and prefabricated components. Its scope is limited to a maximum service temperature $< T_g - 40^\circ\text{F}$. The standard contains chapters on design requirements, and design of tension members, compression members, members for flexure and shear, members under combined forces and torsion, plates and built-up members, and bolted connections. Following final revisions and a public comment period, it is set to be approved as an ASCE/SEI standard in late 2018.

In Europe, historically many design initiatives have been undertaken for composites, reports European Composites Industry Association (EuCIA) Board Member, Eric Moussiaux. For pultruded composites, *EN 13706: Reinforced plastics composites - Specifications for pultruded profiles*, published in 2002, has been widely accepted. This specifies minimum requirements for a limited number of properties, but a more comprehensive approach is required for engineers to have confidence in designing safe structures with composites. Progress towards this is underway as part of an ongoing revision of the Eurocodes. This series of European Standards, written in the 1990s, provides a common approach for the design of buildings and other civil engineering works and includes a number of codes relating to concrete, steel and other construction materials. Work towards a new code for composites is currently being conducted by Working Group WG4 'Fibre Reinforced Polymers' under the European Committee for Standardisation (CEN) Technical Committee 250 (CEN/TC 250). The foundation for the new composites Eurocode is the EC Joint Research Centre (JRC)'s

Science for Policy Report *Prospects for New Guidance in the Design of FRP*, which was published in 2015. This includes chapters on basis of design, materials, durability, basis of structural design, ultimate limit states, serviceability limit states, connections, and production, realisation, management and maintenance. However, the EC demanded stronger industry commitment and following a request for assistance from the report's authors, EuCIA decided to provide finance and support to WG4. Response to the report was gathered during 2016-2017 and a modified document produced. This gained EC acceptance to move forward to the final phase of writing a technical specification which could become a Eurocode and present efforts are focused on improving the document and elaborating several topics.

However, there are still a number of significant hurdles to overcome, notes Moussiaux. These include finalising the list of properties to be characterised, and deciding how to manage the statistical variation of properties and define safety coefficients for structures produced using different composites technologies. It has to be decided whether or not to include adhesive bonding as an acceptable connection technique, and further topics such as sandwich structures also need to be addressed. The biggest challenge, Moussiaux believes, will be convincing the TC 250 Coordination Group that this code guarantees safe structures and there is still a lot of work to do if it is to be completed in line with the 2020 deadline for the next generation of Eurocodes.

Global interest

“This was EPTA's 14th World Pultrusion Conference and it was the biggest event ever,” comments Dr Elmar Witten, Secretary, EPTA. “The record number of 150 participants, coming from North and South America, Europe, India and South Africa, indicates a clear and growing interest in pultrusion globally. The high level of technology and application development activities showcased in the wide-ranging conference programme is evidence of a strong determination to improve the competitiveness of pultruded products and pursue growth opportunities.”

The World Pultrusion Conference is a biennial event and the largest forum for the pultrusion industry in Europe. The next conference will take place in March 2020. ●

About EPTA

The European Pultrusion Technology Association was created in 1989 by a group of leading European pultruders with the mission of supporting the growth of the pultrusion industry by maximising external communication efforts and encouraging knowledge sharing between members. Since 2006, the association has existed under the umbrella of the AVK - Industrievereinigung Verstärkte Kunststoffe e.V., in Frankfurt, Germany. Membership of EPTA is open to all companies and individuals worldwide wishing to further the application of pultruded profiles. For further information visit www.pultruders.org