'Core' material trends in a blade

We take a look forward to the 'core' of wind blade manufacturing technology and how it can contribute to reduce the Levelised Cost of Energy (LCoE).

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In late 2013, PES published an article that discussed the 'Core' material in a blade. It examined the challenges for wind energy; composites as a technology; the rise (and fall) of the market; looking ahead; core as an engineering material; the composite production processes (infusion and prepreg); and finally, it focussed on total blade cost. This follow-up piece takes the examination a step further…

Construction

Blades use core materials (typically 60-150 kg/m3) as part of a sandwich structure comprising of resin and reinforcement on either side. The core is primarily a means to reduce the laminate weight, while sustaining the out-of-plane strength and rigidity.

The load carrying part of a typical blade consists of structural webs connected to monolithic girders to form an approximation of a 'boxed beam' which in turn is joined to the root end. The surrounding two-part shell transfers wind loads to the load carrying members while providing the optimum aerodynamic shape.

Core material is normally used in the following components, optimised to deliver the required design performance:

a) Webs – these typically use lighter IPN core in the 60-80 kg/m3 or PET (100-115) density ranges

b) Shell (Root-Shoulder) – this and its immediate adjoining spar/girder area is often referred to as the primary structural element of the blade, as here, the considerable forces and loading come to bear in service life. It is most common to find core materials in the 130-150 kg/m3 range used, be they balsa or IPN.

c) Shell (Shoulder-Tip) – these typically use a much lighter IPN core in the 60-80 kg/m3 density range, or PET at 100-115 kg/m3.

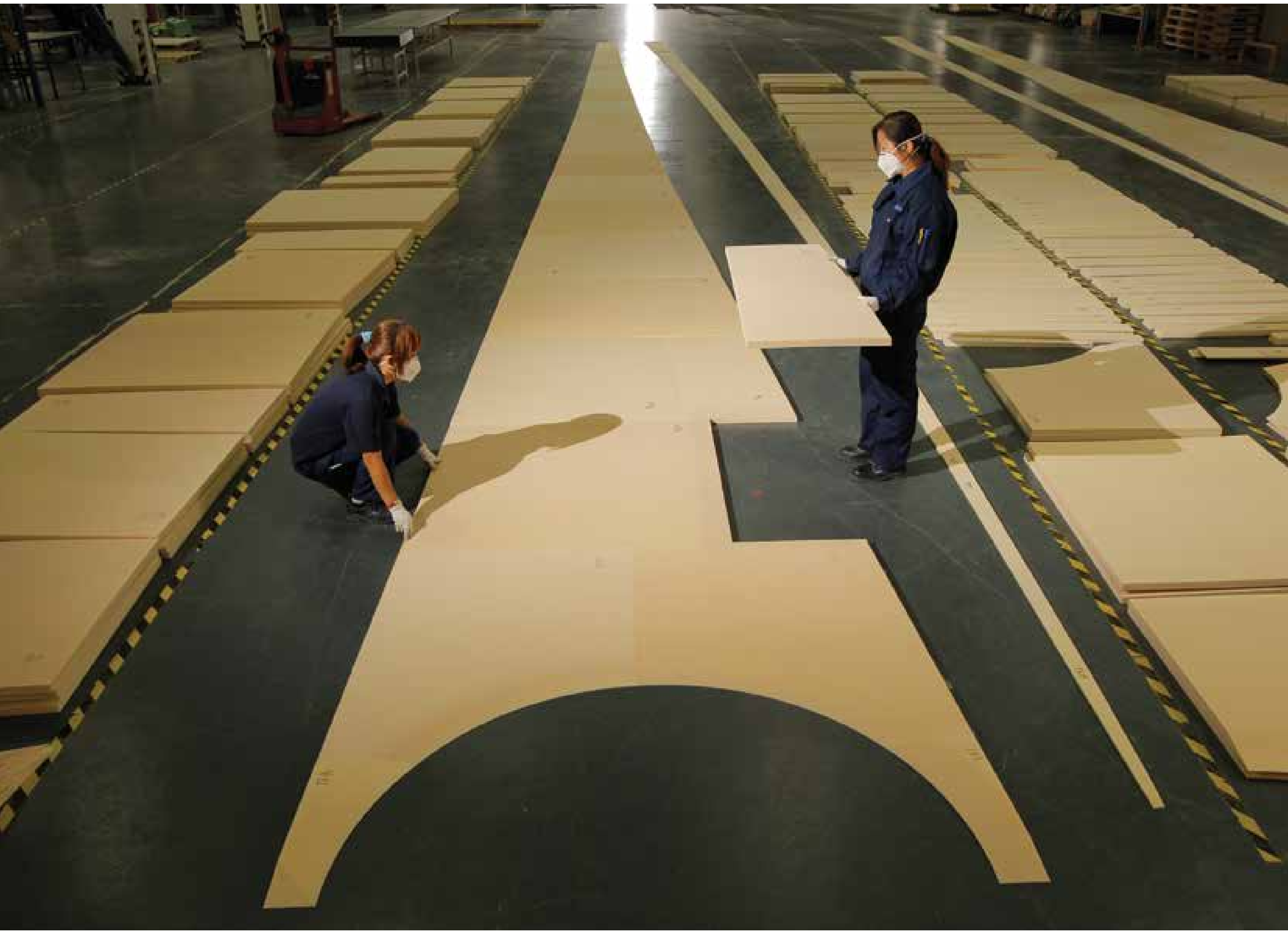
Manufacturing trends

The last year has seen two significant changes in blade manufacturing, which when combined, have made significant improvements.

1. Build-to-print blades – this development could be described as a paradigm shift. Previously, blades were predominantly built in-house, or outsourced. With demand increasing from 'emerging markets', different investment strategies have been considered and this niche is growing.
2. Infusion Manufacturing – already the most widespread process, prepreg blade manufacturers have also started to adopt this within their portfolio. This enables them to build-to-print, as due to the capex demands, prepreg has been very much an in-house process.

Material trends: Prepreg

Due to the above shift, this remains a niche process, so there have been no significant trend changes, as manufacturers stick to existing designs/approvals. In terms of core, this means 80kg/m3 heat-treated IPN or 115kg/m3 PET.



Material trends: Infusion

Manufacturers' current designs vary, so call-upon an (overall) diverse bill-of-materials. The materials selected are dependent upon the designer and from that; often there is a link geographically.

As stated above, the dominant core materials are still, overwhelmingly, balsa and IPN, providing as they have, a tried-and-tested platform and long track-record in service. Whilst there are some manufacturers who build 100% balsa or 100% IPN blades, the majority use a hybrid construction, with the balsa in the root-end and IPN in the shoulder-to-tip region.

Balsa

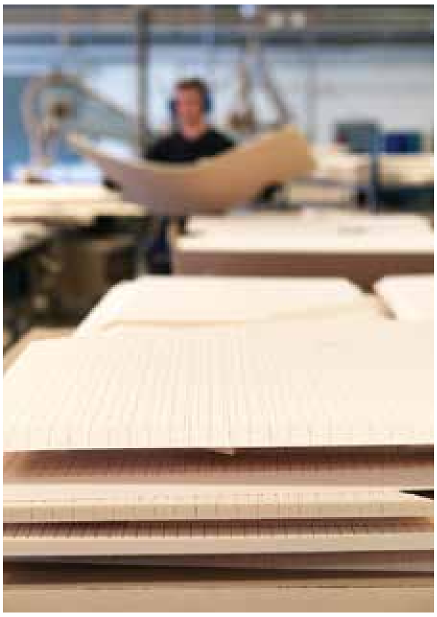
Developments have been around end users using coated or uncoated grades, as well as 100 or the majority 155kg/m3 format. Perhaps the most significant challenge for balsa is to maintain deliver the projected future volumes, given the lead-time needed.

IPN

To more accurately reflect the material composition, DIAB now use the terminology IPN (interpenetrating polymer network). As with balsa, the traditional, qualified grades continue to support the rapid market growth this last year and this. The market has seen an increased supply base, with new manufacturers and/or sites starting, or about to start, reinforcing (like balsa) the continued demand. New innovations are in the pipeline and expected in 2015.

PET

Originally used in prepreg blades, as resin uptake has improved, PET has become specified by some infusion manufacturers in some new designs. 'Replacing existing blade materials', be they Balsa or IPN is difficult due to design, re-qualification/ re-certification costs. The increased density need to provide comparable properties versus IPN (115 vs. 80 kg/m3) and lower compression modulus versus Balsa, are also factors. Recent talk has



centred on PET becoming the 'synthetic' substitute for balsa.

SAN and XPS

Unlike the above materials, as these are single-source products, market developments have been limited.

Other Materials

These innovative combination materials require designing-in, rather than substituting existing materials in current blades. 'New' technologies have found it hard to penetrate a comparatively conservative industry. There has been talk of these acting as 'balsa replacement' options, but whether these or PET can achieve this will be much dependent upon the market need for this to happen.

Finishing

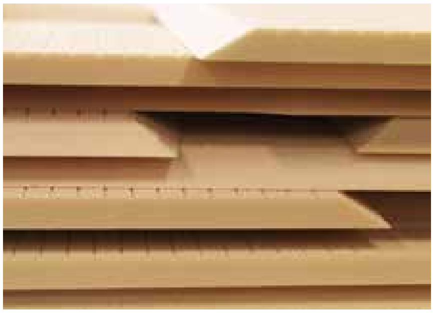
Whilst materials undoubtedly provide an important base position, so-called 'finishing' also has a significant impact on processing and materials costs. By adopting an efficient combination of Infusion grooves and/or Perforations and/or contoured cuts, it will enable manufacturers to speed up their infusion process (saving time, money and increasing throughput and capacity) and/or reduce the amount resin waste by optimising the amount used in excess flow, resin, absorption, resin uptake, etc. There are many ongoing developments such as ODC cuts which have been proven to reduce total costs.

Kitting

The final stage of the 'core process' sees the above material and finishing brought together as pre-cut pieces, in the form of a 'kit'. Typically, a kit covers around 10 component sections (e.g. pressure shell kit, suction shell kit, girder etc.) utilising a mixed combination of materials, thicknesses and finishes.

There are various levels of technology used to achieve these kits, much dependent upon the geographical location due to the impact of labour rates. As a result, some utilise CNC equipment and others, more conventional equipment.

To ensure the final kit provides a good fit to the mould and delivers optimum processing conditions for the subsequent infusion process, it is really important to have a good synergy between the material, finishing and kit, whether it is done by the same, or cooperating partners.



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Summary

Today, the market has recovered and is growing rapidly, globally in terms of manufacturing bases. As a consequence, focus is very much on production output and securing the supply chain.

In this respect, focus comes to bear on Balsa, IPN and PET today. Responding to large-volume business at short notice always rings challenges. In terms of foam (IPN and PET), capacity either is, or is coming on-line within the next year to support this e.g. DIAB, with their upcoming new Chinese Plant. With balsa, we seem to be in the cycle again where blade OEM's are questioning the supply chain.

The ability to respond to growth with the longer growing cycle/lead-time for this natural product is longer of course and furthermore the increasing length of blades too triggers an increased demand.

As a consequence, arguably new designs are looking to a more 50/50 hybrid construction of wood/foam, or with a larger proportion of more controllable and scalable foam production. ■

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