

Briefing note for Forestry Commission

An update on Wood Plastic Composites (WPC)

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Background

In February 2003 BRE report 211-511 "UK timber/waste plastic composites" was issued to Forestry Commission under project code PPD27/02 (BRE ref CV0254). In addition BRE published Information Paper 2/04 "Wood Plastic Composites: market drivers and opportunities in Europe".

This paper has been prepared in the light of these two documents and in response to a request from Forestry Commission to receive a brief update on WPC. This has been conducted under the BRE Consultancy contract CFS01/06 (CV0934).

What are WPC?

Wood Plastic Composites (WPC) are mixtures of wood fibre and a synthetic resin. The source of the materials can be either virgin or recycled material. They have been successful in North America in construction and particularly in decking applications. The components of a WPC are:

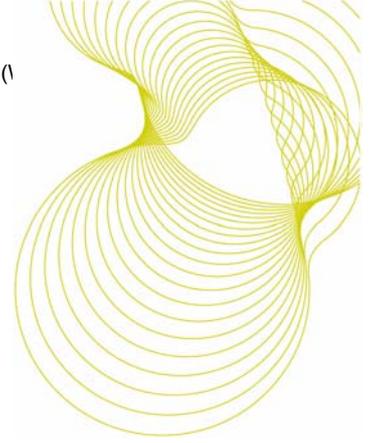
- Thermoplastic polymers: HDPE, LDPE, PP, PVC (reclaimed, recycled, virgin or blends)
- Wood: Pre-dried wood flour (<2% moisture content)
- Additives: Lubricants, pigments, stabilisers, coupling agents, biocides, inorganic fillers

Typically a dry blend of components are mixed and fed to an extruder, injection moulder or compression moulder.

Where are they used or targeted for use?

The existing world markets and future opportunities for WPC lie in four distinct areas:

- Building and construction
 - Decking and boardwalks
 - Cladding (siding)
 - Window profiles and door profiles
 - Exterior building trim (soffits, fascias and bargeboards)
 - Interior building trim (doors, skirting boards)
 - Sill plates and interface elements in construction
 - Future structural elements and marine, waterfront structures
- Automotive
 - Panels and trim
- Furniture
 - Outdoor furniture (picnic tables and benches)
 - Indoor furniture
 - Bathroom and kitchen cabinets
- Infrastructure
 - Landscaping timber
 - Garden structures (gazebos)



- Playground equipment
- Signage

Few examples are available for inspection in service in the UK.

What are the advantages and disadvantages of WPC?

Whilst WPC can be used (drilled, screwed, fixed) as timber they have advantages over wood as they can be extruded and moulded like plastic, providing a uniform material and appearance. Further to this:

Advantages

Recycled materials (increasing volumes)
Low maintenance
More thermally stable than plastic
Dimensional stability
Low water absorption
Resistant to rot (if they contain a biocide)*
Engineered profiles
Lower variability than wood
Do not warp and splinter
Tailored products
Light weight foamed WPC

Disadvantages

High costs
Unable to paint
Lower stiffness than wood
Thermal expansion
Rot free?
Low maintenance?
Recyclability?
Aesthetics
Creep under load
Heavy - density 1000kg/m³

* the promotion of WPC as rot free and not requiring wood preservatives was challenged as scientific evidence arose of the growth of decay fungi in WPC in service and the failure of WPC boardwalks in the southern states of America after a few years of service. WPC can readily incorporate zinc borate wood preservative to protect against decay and surface mould.

There are many pros and cons publicised and exchanged about the comparison between solid wood and WPC. It seems clear that the marketing of WPC products was over ambitious in its rot free claims and low maintenance. This promotion still occurs but has largely been tempered from original statements. It is however reminiscent of the marketing of uPVC windows in the 1970s in the UK. Now we have seen first generation uPVC windows replaced due to failure and discoloration consumers are less easily convinced by the maintenance free long-life promotion.

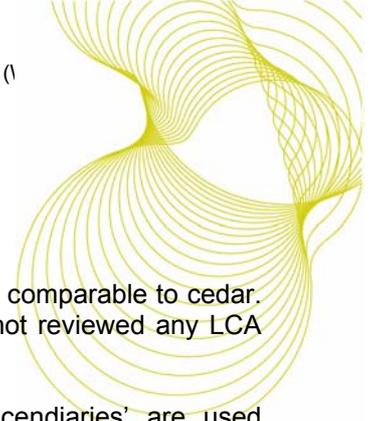
North American markets

In the USA WPC are seen as a value added opportunity as efficient resource utilisation, hazardous fuel removal from forests (Healthy Forests Restoration Act) and the utilisation of small diameter logs, wood residues and machining co-products.

In 10 years the market is now 700,000 tonnes per annum with a value of \$1 billion. In the region of 85% of the world WPC market is in North America. Of the total WPC US market 65% is decking in 2003 which represents a total of 14% of the total decking market for WPC of \$0.4billion. Decking market growth is noted to have moved from \$2.9b (1997) to \$3.7b (2005) and in the same period WPC have grown from \$50m to \$750m.

The residential decking drivers are summarised by the sector in the USA as:

Performance – WPC do not warp, twist, split, splinter, need maintenance, use chemicals. They do have long term decay resistance, no UV damage, easy to machine, slip resistance. (NOTE: See above about biocide use)



Value – WPC deck boards are twice the price of CCA/ACQ treated boards and comparable to cedar. Less maintenance of WPC leads to lower life cycle costs. (NOTE: We have not reviewed any LCA data for WPC).

Environment – “poison in your backyard” and other media generated ‘incendiaries’ are used frequently in North America related to the use of treated wood and especially CCA. Marketing that refers to wood treatments as hazardous and toxic are consistent features of WPC promotion literature. WPC are stated as having “excellent environmental status” we have not reviewed any environmental literature for WPC.

European markets

Some believe that markets in Europe are poised for ‘take off’ with enormous potential though they are developing in a different way to North America. It is a consistent feature of articles and presentations, especially those from plastics industry consultancies, that the forecast growth of WPC markets in Europe is highly optimistic. There are a few small scale companies in Europe and clearly a sounder footing is needed for WPC to ‘take off’ in Europe.

The European market in 2003 was 65k tonnes with 36k tonnes in automotive applications which are under pressure from flax and natural fibre replacements according to the National Non-Food Crops Centre. European market is expected to grow from virtually zero to €500m to €1billion which would be 1.3m tonnes of WPC by 2008! Highly speculative and inaccurate forecast. Applied Marketing Information Ltd (plastics consultancy) forecast 150k to 250k tonnes per annum in 2013, which is more realistic we believe.

Applications most likely to succeed in Europe are decking, fencing and outdoor furniture, door and window profiles. The use of recycled plastic and wood are an attractive feature of WPC for Europe and the UK where diverting wastes from landfill is key priority.

UK examples are:

- Plastics Reclamation Ltd (Knotwood) www.inspirerecycle.org/case/plastic/cut1.htm for outdoor and street furniture, landscaping products, waterways products and highway furniture.
- TimbaPlus® producing door profiles on a small scale. The company has developed a process for extruding wood and uPVC. The material is aimed principally at the door industry for use in frames and sills.

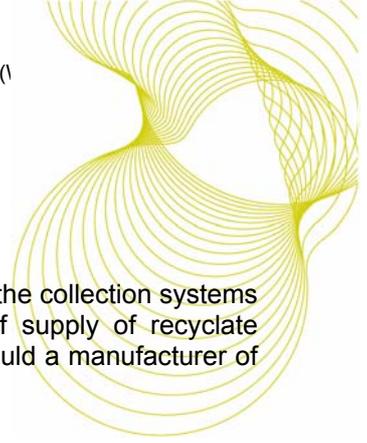
Think London’s Opportunities for environmental technologies and services in 2005 reported that WPC were currently underdeveloped and ripe for technology licensing. The opportunity is presented as a means of diverting some of London’s waste streams away from landfill – though no mention of timber and wood is made in the document.

NOTE: Market report available for Europe “Wood Plastic Composites in Europe. Analysis – Technology – Market Opportunities” (2006) Hackwell Group Report (UK based plastics consultancy) is a thoroughly updated version of the original 2003 report. Summary version available but £1,495 for the full report!

Barriers to entry

Market

- Lack of large volume market and production in Europe
- The route to market in each European country is different which complicates growth
- Cost of WPC – escalating costs of resins, oil derived and additives
- Poor image of recycled products. Customers expect them to be cheap, designers question performance and durability.
- Feedstock supply. Supply chains for timber processing wood co-product is established but there is great competition for this product (biomass energy, animal bedding, landscaping and



surfacing materials, cat litter). Post consumer recyclates are growing and the collection systems continue to take leaps forward. Consistency questions and security of supply of recyclate should WPC 'take off' is a concern – mixed and variable sources how would a manufacturer of WPC cope with this?

Confidence

- Lack of standards and specifications (as noted by WRAP; in 2005 CEN/TC249/WG13 “WPC” was established)
- Building codes designed for other materials and WPC do not fit
- How to test durability and other properties?
- Conservative consumers

Technical issues

- UV instability
- Biocide use in WPC is increasing
- Issues with lack of impact and bending strength
- Outdoor long-term performance trials on-going (same delay as for all new wood products/treatments)
- Environmental profiles or LCA data for products appears to be absent

Future developments

- A foamed WPC to give light weight, more like wood to process and fasten
- Use additives to tailor products to needs and focus on colour stability, physical property retention, mould and fungal resistance.
- Coupling agents to improve bond between wood and resin to reduce moisture absorption and increase impact and tensile strength.
- Flame retardants and mineral fillers for next generation products

Conclusions

WPC provide a challenge to solid wood products and this will increase on a small scale in the future as more recycled products are developed. Research is on-going and strong market growth is still being predicted, though perhaps tempered now by the over ambitious predictions at the start of the decade.

The key to unlocking the market in the UK is dependent on a number of connected initiatives and activities occurring simultaneously:

- Independent product specifications and standards must be developed
- Acceptance by consumers and designers of the product performance – plugging any gaps in knowledge base
- Establishing environmental profile data for products
- Appropriate and accurate articulation of benefits to users of products
- Reliable and consistent recyclate supply chains
- Exemplar demonstration projects
- Continued innovation in low impact tailored WPC products as solutions for the construction industry
- Product certification