Biocomposites for high-performance, low environmental impact, economical building products

The BioBuild project

COST FP1303 – Paris 27/28 January 2014

Bôke Tjeerdsma, Marina van der Zee (SHR)

G. Foulds[1], A. Stevenson[1*], G. Carra[2], S. De Vos Effting[3], R. van Gijlswijk[3]

Structure of presentation

- Introduction
- The BioBuild Project
- Materials & fibre treatment
- Manufacturing processes
- Case Studies
- Quick Scan LCA Approach
- Results & conclusions

- Industrial Interest Group meeting – 19 March 2014 at SHR

- Follow up in Horizon 2020 – Project proposal
  "Biofurniture and interior design"

Introduction

- Composite materials have lower embodied energy than many traditional building materials
- Biocomposites offer lower embodied energy than glass fibre composites
- Use of composites allow reduction in mass of structures therefore allows smaller/lighter supports etc.
- Composites offer great freedom of form
- Can be prefabricated off site
- Can be quick to erect

BioBuild project

Thirteen partners

Seven countries

Budget €7.7M

Part funded by the European Commission

Coordinated by NetComposites

Duration: 3½ years

End: 31st May 2015

Project Aims

AIM

To use biocomposite materials to reduce the embodied energy in building facade, supporting structure and internal partition systems by at least 50% over current materials with no increase in cost.

HOW?

By overcoming current actual and perceived shortcomings in biocomposites, such as:

- Resistance to degradation by weathering and microbial attack
- Flame resistance
- Dimensional stability

WHY?

Natural fibres have significantly lower environmental impact than glass in particular in the areas of climate change, ozone depletion, toxicity and eutrophication

Materials

Materials have been chosen according to the following criteria.

- Embodied energy
- Cost
- Mechanical properties
- Commercial availability
- Availability of preforms

Fibres – flax, jute

Resins – PFA, bio-polyester

Sandwich structures with cork

Fibre treatments

- To overcome natural fibres' tendency to absorb water
- To improve durability through better fibre-matrix compatibility

Treated samples will be compared with untreated (benchmark) samples, and with GFRP.

Mechanical testing will take place before and after weathering, UV degradation and fungal decay.

On <u>composite level</u> – coatings and fire retardant coating and additives is being investigated

Manufacturing processes

- Pultrusion of hybrid materials to produce profiles for a selection of case-study parts

- Pre-pregs – heated press
  - Monolithic panels
  - Sandwich panels

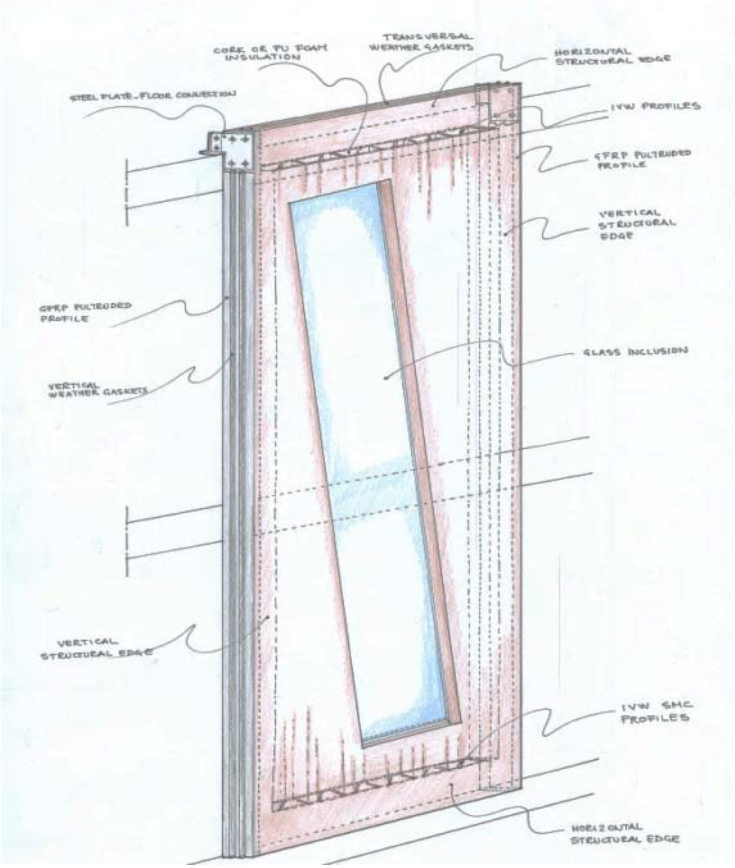
- Resin infusion (RTM)

- Vacuum-bagging
  - Monolithic panels
  - Sandwich structures
  - Complete façade elements

Case Study 1

External wall panel

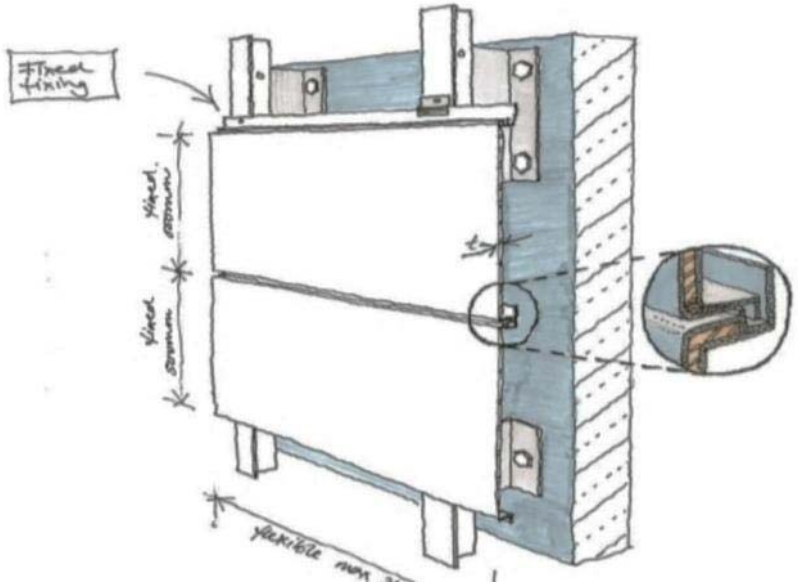
- must resist wind-load
- must prevent water getting in
- spans more than one floor
- can incorporate a window



Case Study 2

External cladding kit

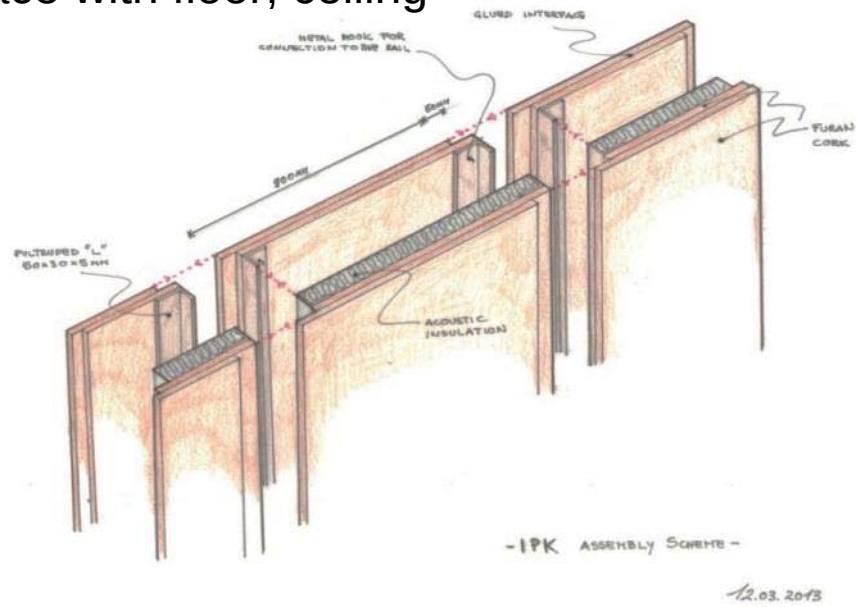
- rain screen
- aesthetic finish
- special attention paid to fixings & joints



Case Study 3

Internal partition kit

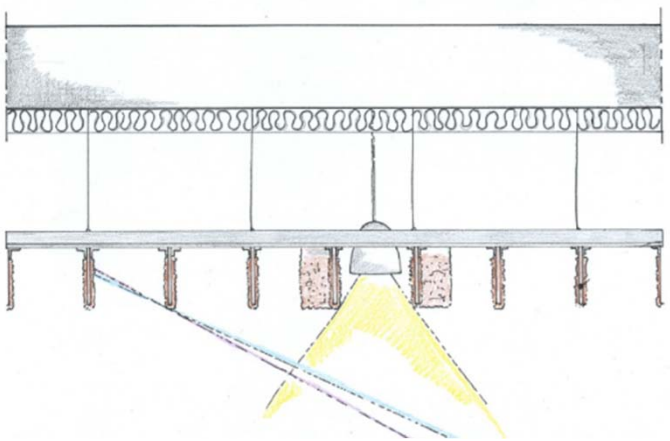
- fire, acoustic performance
- ease of installation
- connections, interface with floor, ceiling



Case Study 4

Suspended ceiling kit

- acoustic performance
- adaptability
- concealed lighting



Case Study 1

External wall panel

Production site at industrial partner

Resin infusion – vacuum bagging

The Quick Scan approach

- Life cycle analysis (LCA) is an important part of demonstrating real environmental benefits by the use of composites (often needed to justify higher initial cost)
- Most LCA done towards the end of a project by which time fundamental choices have already been made.
- LCA does not therefore contribute to optimisation during the project leading to sub-optimal solutions
- However, a full LCA is time consuming
- QuickScan approach allows informed decision making based on environmental impacts

Example analysis

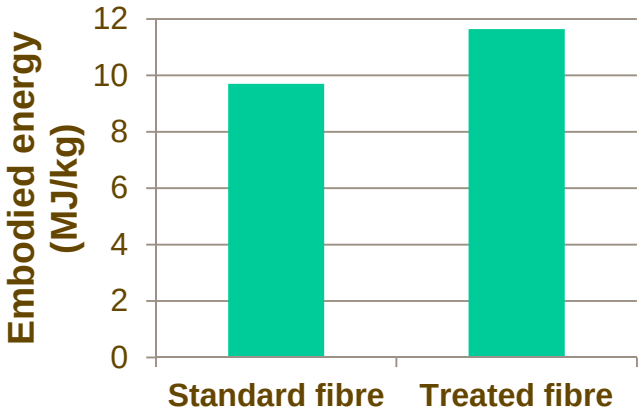
Item: external cladding kit (rain screen)

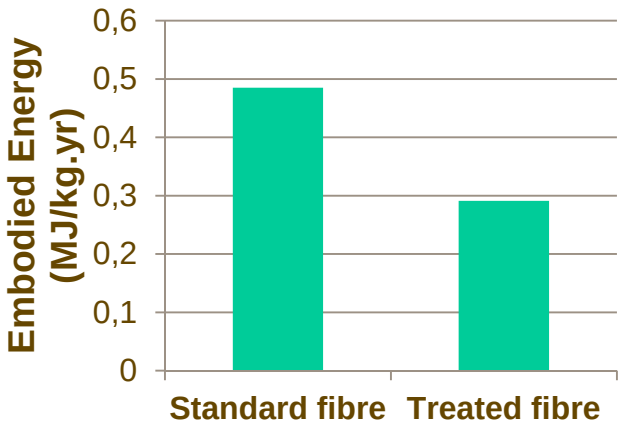
- QuickScan limited to embodied energy for reasons of speed
- Calculate embodied energy per square metre of panel
- Analysis includes fixing mechanisms
- Cradle-to-grave analysis:
- Determine part life & standardise on life of 40 years

Fibre treatments

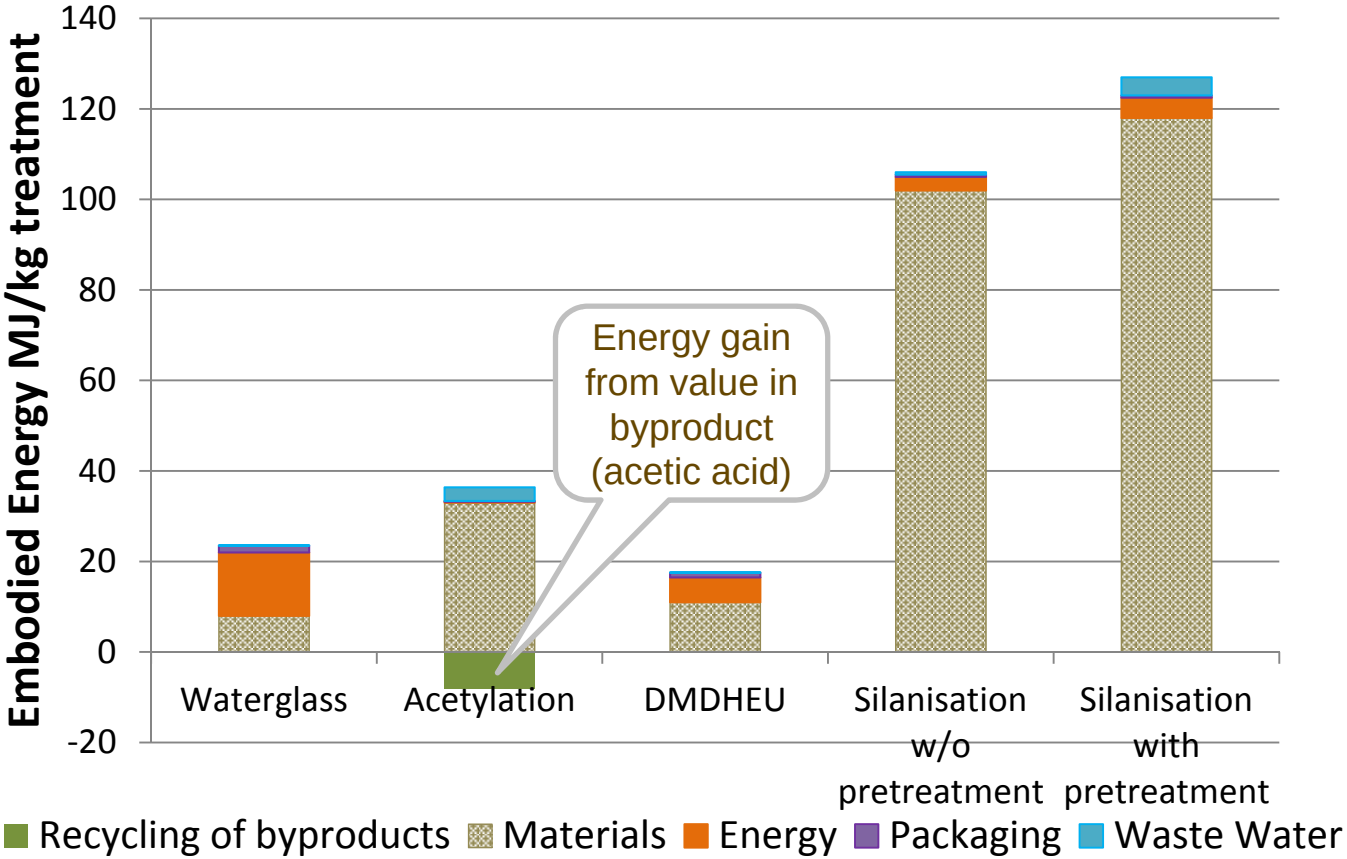
Fibre treatment can improve:

- Water repellence – essential for exterior parts
- Flame retardancy
- Fibre strength – allows for thinner sections

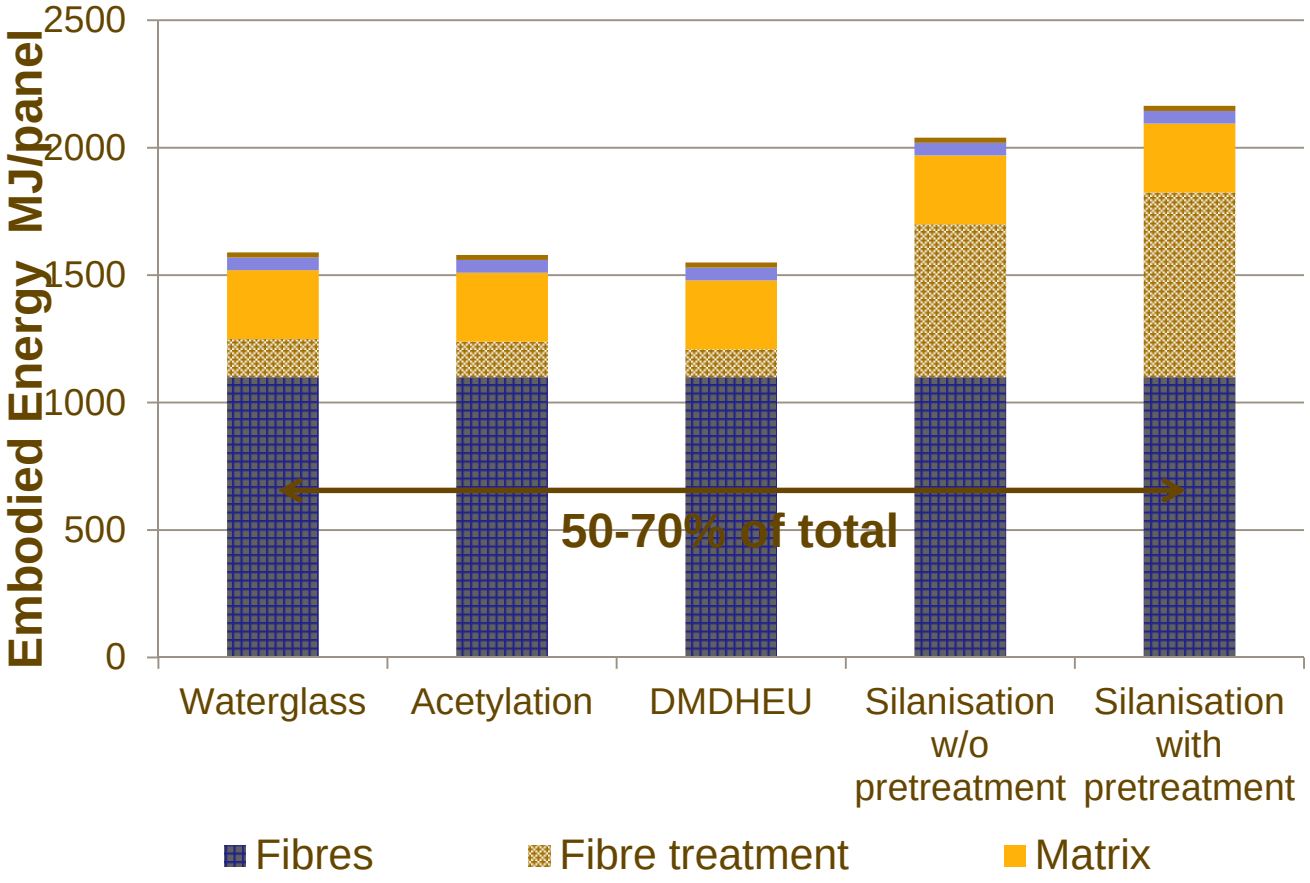




Fibre treatments



Effect per unit area of panel



Results

- Most of embodied energy in panel is due to the preparation of the fibres, accounting for 50-70% of the total
- Matrix accounts for 12-17% (in this example)
- Waterglass, acetylation & DMDHEU treatment all add about 10% to the embodied energy of the panel
- Silanisation treatment adds 25-30%
- Choice of treatment will be decided by effect on panel life
- Silianisation would have to offer a very large increase in life to make it justified on environmental grounds

Summary

- BioBuild will demonstrate that biocomposites can be used in architectural applications
- Four full scale case studies with reduced environmental impact
- LCA not a bolt-on at end of project
- QuickScan assessments done throughout project to inform decision making process
- Product life is very important. Fibre treatments to extend life will reduce overall impact, unless embodied energy of treatment is very high.
- If the right information is available at each design phase, it is more likely that sustainability goals can be met in industrial manufacturing

More information

The new BioBuild newsletter is available as a hard copy, or as a download from the BioBuild website:

www.biobuildproject.eu

BioBuild Industrial Interest Group on LinkedIn

b.tjeerdsma@shr.nl

anthony.stevenson@netcomposites.com

Or any other project partner!

Wednesday 19th March 2:00 - 6:00 pm

SHR B.V., Nieuwe Kanaal 9b,
NL-6709 PA Wageningen, Netherlands

THE PROJECT

The aim of the BioBuild project is to use bio-composite materials to reduce the embodied energy in building facade, supporting structure and internal partition systems by at least 50% over current materials with no loss in performance and no increase in overall cost.

Currently, bio-composites are not widely used in construction applications because the materials are prone to degradation by moisture and do not perform as well in fire tests as more conventional building materials. The project will develop bio-composites capable of offering 40 years outdoor durability by protecting the fibres using treatments and coatings. Treatments will also be applied to the fibres or the composite to improve the reaction to fire. Cork and other bio-based low density materials will be used to improve the thermal and acoustic-insulating performance of the materials, coupled with system design.

REGISTRATION

Places at this event are free of charge however spaces are limited and you must register. To register please use the Registration form and send this to info@shr.nl.

Joining instructions will be sent with confirmation of registration.

BioBuild

High Performance, Economical and Sustainable Biocomposite Building Materials

2:00 pm
Registration & Coffee

2:15 pm
Welcome to SHR
Bôke Tjeerdsma, SHR

2:30 pm
Introduction to the BioBuild Project
Anthony Stevenson, NetComposites

2:45 pm
The BioBuild Case Studies
Guglielmo Carra, Arup

3:05 pm
Environmental Quick Scan
René Gijlswijk, TNO

3:25 pm
Manufacturing with bio-composites
Jovana Dzalto, IVW

3:45 pm
Treatments to combat weathering
Bôke Tjeerdsma, SHR

4:00 pm
Refreshments & networking
Delegates can visit the SHR facility

6:00 pm
Close of meeting

Registration Form

Herewith I subscribe for the Industrial Interest Meeting at SHR at Wageningen, The Netherlands

Company: .....
Job Title: .....
Full name: .....
Address: .....
Zip code: .....
Telephone: .....
E-mail: .....

Please fax this form to Mrs Jos Gootjes: +31 317 467 399, or email it to info@shr.nl

Please note, SHR can host approximately 65 participants at this meeting. If interest exceeds this capacity, SHR reserves the rig select applicants in line with the target Industrial Interest Group.

The BioBuild project has received funding from the European Community's Seventh Framework Programme (FP7/2007 – 2013) under grant agreement no 285689 (BioBuild)

Follow up in Horizon 2020

- Novel Biomaterials – Furniture and Interior design
- Project proposal is in progress
- Still room for additional (new) ideas
- Still room for innovative materials, processes and expert (industrial) partners
- Open for suggestions