COMBINING WASTE TIMBER AND TYRE TEXTILES TO CREATE HIGH QUALITY COMPOSITE PALLET BLOCK

A STUDY ON COLLABORATION

Partners:

Mid-Cork Pallets & Packaging Ltd
Palfab Ltd
Eirebloc Ltd

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SUMMARY

This case study chronicles the collaboration between three companies in the south-west of Ireland to develop a unique demonstrator process for the recycling of waste wood and waste tyre textiles. The collaboration was supported by the European Union through the LIFE Environment programme as the project, titled ‘Manufacture of Composite Pallet Blocks using Waste Wood and Tyre-Derived Materials’, acronym ‘Tyre/Wood Block’.

Starting in October 2005, the project had a duration of 50 months, completing in November 2009. A key contracting partner, IMAL srl (Imal), was identified early in the project and provided machine design and development capability. A demonstrator unit was developed and located on a greenfield site in the townland of Lissarda, near Macroom in County Cork, Ireland. When fully commissioned, this unit had a capacity to produce up to 40K m³ of composite pallet block per annum, with the potential for this to increase to 80K m³ through the addition of further extrusion lines.

The collaboration was led by Mid-Cork Pallets & Packaging Ltd (MCP), an Irish company, which specialised in the manufacture of pallets for the Irish, UK and European markets. MCP collaborated with Palfab Ltd (Palfab), an Irish company specialising in the processing of timber, primarily for the construction sector in Ireland. A joint venture, Eirebloc Ltd (Eirebloc), was set up to manage the demonstrator for the collaboration.

A video on the collaboration is available on YouTube (in two parts). Please click on the following links:

- [http://www.youtube.com/watch?v=J68ZndLwrgE](http://www.youtube.com/watch?v=J68ZndLwrgE)
- [http://www.youtube.com/watch?v=Oa_8r8MGo0U](http://www.youtube.com/watch?v=Oa_8r8MGo0U)
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**BACKGROUND**

In 2004, the principals of MCP and Palfab met to discuss potential cooperation between their businesses. MCP, the largest manufacturer of pallets in Ireland, imported vast quantities of pallet blocks, which in a combination of either six or nine, act as a separator between the two planes of a pallet. It was looking for a more local source. Additionally, MCP had previously imported small quantities of blocks made from composite wood. While cheaper, these turned out to be generally inferior to standard blocks made from virgin wood. The principal problems related to dimensional stability, water absorption and nail retention. Palfab, as a producer of timber products, had a problem with the disposal of its waste sawdust, trimmings and shavings. The genesis for a composite pallet block facility was born.

Discussing the idea with their local Enterprise Ireland advisor, they were guided towards looking at the potential of the LIFE Environment programme as a source of support for the development of environmentally positive innovations. They were eventually linked up with Denis Kearney, an independent project manager, who reviewed and researched the LIFE Environment programme and discussed this with the principals of MCP and Palfab. In July 2004, a brainstorm meeting was held in Cork city, which included all of those mentioned above plus the principal of a tyre shredding business in the UK and a representative of the waste management services of the local authority. This meeting resulted in a decision to develop composite pallet block manufacturing plant, which, while primarily based on the use of contaminated or dirty wood, would also integrate waste materials from tyres.

Over the Summer / Autumn of 2004, a detailed proposal was researched and submitted to the LIFE Environment programme. In April, 2005, Sean Lehane, managing director of MCP, was informed of the success of the proposal with a potential grant assistance of close to €1.2m. Contract negotiations began immediately and were finalised in late Summer 2005. The Tyre/Wood Block project kicked off formally in October 2005.

**SUMMARY OF THE PARTNERS INVOLVED IN THE CASE STUDY**

**MID-CORK PALLETS & PACKAGING LTD.**

Web: [www.midcorkpallets.com](http://www.midcorkpallets.com)

Mid-Cork Pallets & Packaging Ltd was founded in 1977 and currently employs more than 100 people and its headquarters in Clondrohid, Co. Cork and in Dunboyne, Co. Meath. Founded by Sean Lehane, he remains as managing director.

Mid-Cork Pallets & Packaging is the leading manufacturer of pallets in Ireland. Its manufacturing facility is over 20,000 m² and its storage and distribution centre in Dunboyne is 7000 m². MCP is
strategically located to service the Irish market, close to all major road networks. MCP manufactures all types of timber pallets, such as:

- Epal 1200 X 800 4 way
- Standard 1200 x 1000 4 way
- 1200 x 1000 2 way

**PALFAB LTD.**

Web: [www.palfab.com](http://www.palfab.com)

Palfab Ltd is one of Ireland's largest specialist timber manufacturer dealing in a comprehensive range of sawn softwood timber for the construction, fencing, garden leisure and handling and packaging industries. Founded in 1977, it has grown steadily in tandem with increasing output from the Irish forestry industry. Its manufacturing operation is located at Lissarda near Cork City. Palfab's output is sold primarily on the Irish and UK markets.

Palfab supplies a comprehensive range of sawn softwood products. Its sawing, kiln drying, stress grading, vacuum treatment and machining facilities enables it to supply wood for a wide diversity of uses, including:

- Cladding & Siding
- Construction
- Pallet and Packing Board
- Structural & Decorative Beams
- Decking Components
- Fencing Post & Rail

**EIREBLOC LTD**

Web: [www.eirebloc.com](http://www.eirebloc.com)

Eirebloc is the result of a joint venture by the principals of MCP and Palfab, which came about as a direct result of the research and development activity of the Tyre/Wood Block project. Eirebloc began operations in September 2008, with commissioning of its plant. When fully capitalised, annual production capacity will exceed 60,000m³, making Eirebloc one of the world's largest producers of composite block.

**OVERALL PROJECT APPROACH**

As a 50 month project, the Tyre/Wood Block initiative was structured in three stages. These stages are described in the following sections.

**STAGE 1**  **BACKGROUND RESEARCH**
Within this stage, the following was carried out:

- An exhaustive search was carried out across Europe to identify appropriate technology expertise in the area of composite wood processing. Through business contacts and through visiting trade shows, the principals made contact with IMAL\(^1\), an Italian company based in Modena. It became clear early on that Imal were the only appropriate technology provider within the European area.

- A detailed review was carried out into the feasibility of the various elements of waste tyres for their suitability for inclusion in composite blocks. The table shows the major elements and their approximate composition.

<table>
<thead>
<tr>
<th>Material</th>
<th>Used car tyres</th>
<th>Used truck tyres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elastomers</td>
<td>47</td>
<td>43</td>
</tr>
<tr>
<td>Carbon black</td>
<td>21.5</td>
<td>21</td>
</tr>
<tr>
<td>Steel</td>
<td>16.5</td>
<td>27</td>
</tr>
<tr>
<td>Textiles</td>
<td>5.5</td>
<td>negligible</td>
</tr>
<tr>
<td>Zinc oxide</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Sulphur compounds</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Others</td>
<td>7.5</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

The one element of the tyre waste for which no use was found was the textile waste. The tyre textile, on average, comprised 5.5% of the weight of a tyre. Because of the aggressive shredding process used to recover the materials from waste tyres, the resultant textile waste was generally contaminated with particles of rubber, giving it a ‘dirty’ appearance (see diagram) and making it totally unsuitable for reuse as a textile material. As such, this material was, in the early stages of the project, available free from tyre recyclers.

- Most block makers in Europe used moulding for manufacturing blocks. Extrusion was an emerging technology. It was decided to go with the extrusion type process as Imal had independently developed the core technology which enabled them to double the throughput production of each press.

**STAGE 2 PILOT DEVELOPMENT**

Piloting was carried out at Imal’s premises in Italy. This began in Oct 2006 and continued to the end 2007. The main objectives were to identify the parameters and ingredients that would achieve the most economical and technically viable solution for the production of pallet blocks from recycled wood and tyre derived waste.

The flowchart shows a flow diagram of the pilot system. The process unit operated as follows

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\(^1\) Since its foundation in 1970, IMAL has steadily expanded over the decades to become a world leader in the manufacture and supply of plants and machinery for particle, MDF and OSB board processing. [www.imal.it](http://www.imal.it)
Recycled wood and tyre textile waste is loaded into the infeed hopper. This material is fed to a dryer and dried to a predetermined moisture content. The material is then fed at a constant rate to the blending machine. The glue kitchen prepares and pumps a predetermined amount of resin, hardener and emulsion to the blending machine. The blending machine continuously mixes these ingredients and feeds to the disc conveyor. The disc conveyor feeds the mixture at a constant rate to the infeed hopper on the extrusion press. The hydraulic system of the press pre compresses the mixture from one side into the main chamber. The final compression takes place in the main forms. Superheated steam is added at the start of the formers to activate the resins. The forms are 6m long and density is controlled by hydraulically clamping the top and bottom half of these forms. Blocks are stacked and used for testing. The picture shows the rudimentary extrusion system used in the pilot.

When the pilot application testing was near completion a number of sample blocks were shipped back to MCP during the period from September 2007 to December 2007. These blocks were used in the manufacture of sample pallets which were sent to key customers. The performance of these pallets was observed and tracked to compare the performance with the standard pallets that MCP were supplying to these customers. The main conclusions from the testing programme were:

- 6 – 8% is the optimum moisture content for the wood material.
- 8 – 9 kgs. Dry MUF resin per 100 kgs. of bone dry wood is required.
- 10% Melamine addition is required for water resistance.
- 5% addition of tyre textile has no adverse effect on the product or process.

STAGE 3 DEMONSTRATOR DEVELOPMENT

Developing the demonstrator was a major and core activity within the project. A greenfield site was purchase close by the existing Palfab premises in Lissarda. Site clearance started in Summer 2007 and the basic infrastructure was completed by late Autumn 2007. Equipment started to arrive in Lissarda towards the end of 2007 and continued up to the middle of 2008.

Commissioning commenced in April 2008. This extended for a considerable period and several design flaws were encountered, most notably, the lack of robustness in the saws. The latter had to be completely redesigned. Commissioning finally ended in early 2009, from whence production started to ramp up. The commissioning process was carried out entirely using waste wood only as raw material. When this was complete, the projected started to introduce the tyre waste.
Contaminated wood is received in moving bed truck containers. It is first loaded onto a conveyor system, is shredded and then goes through a series of separation stages to remove metals, stones and plastics. The residual material is processed through a hammer mill, where it is refined to a relatively homogenous size. It is then dried and stored in a silo to await block manufacture.

The appropriate quantity of waste tyre textile is now introduced followed by resins and glues. The mixed material is then extruded in a continuous process to a particular cross-sectional profile. On exiting the extruder, the continuous block is cut to length, the parameters of each block are measured, the blocks are automatically loaded onto a pallet, wrapped and sent to finished goods storage.
INTRODUCING TYRE TEXTILE WASTE

A series of internal tests were carried out in order to ascertain the comparative properties of pallet blocks which contain tyre textile materials. The following table compares results from standard (i.e. 0% Tyre Textile) to those containing 5% and 10%. While all measures are within the specification limits, note the effect that the textile has on swelling, absorption (after 24 hours immersion in a water bath) and nail retention.

<table>
<thead>
<tr>
<th>Swelling %</th>
<th>Absorption %</th>
<th>Nail Retention F N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>1.86</td>
<td>24.87</td>
</tr>
<tr>
<td>5% Tyre Textile</td>
<td>3.89</td>
<td>45.48</td>
</tr>
<tr>
<td>10% Tyre Textile</td>
<td>3.30</td>
<td>46.23</td>
</tr>
</tbody>
</table>

FIELD TESTING

Extensive field testing was carried out of the finished blocks, both those containing tyre textiles and those without. There were two distinct stages to the field testing:

1. Processing at the pallet manufacturer
2. Experience of the pallets in use

PROCESSING AT THE PALLET MANUFACTURER

Pallet manufacture, using the test blocks, was carried out at MCP’s facility in Clondrohid. This facility is highly automated, with no manual handling. As an automated facility, it is not forgiving for any deviations in allowable tolerances, either at an individual block level or at a gross level (i.e. in a pallet load of stacked blocks). Several loads of blocks were processed into pallets through the normal production process, with the key performance characteristics being assessed.

In comparison to the quality data from other types of blocks, i.e. those made from virgin wood or composite block manufactured using moulding, these blocks consistently outperformed them.

USER EXPERIENCE

Quantities of the manufactured pallets were sent to several clients of MCP for evaluation purposes.

From an overall perspective, there was no perceivable difference in the performance of the pallets from those generally used by the clients. Some comments were made about the ‘colour’ of the blocks.

QUALIFICATION

EPAL is the recognised standard across the industry for pallets. EPAL has stringent guidelines for pallet blocks and these are tested rigorously before block and pallet manufacturers are allowed use the EPAL mark. All EPAL-controlled wooden pallets are marked with a quality control staple bearing the EPAL quality mark. Repaired EURO-pallets are certified with an EPAL repair marking nail.

Eirebloc received EPAL approval in December 2008.
LIFE CYCLE ANALYSIS

A Life Cycle Analysis was carried out on the Tyre/Wood Block process. The study concluded that using waste wood for pallet block manufacturing has an advantage (decreased environmental load) over using virgin wood. A lower value of the Eco-indicator was obtained (347806.64 mPt against 521940.46 mPt). Overall, the pallet block manufacturing activity is ‘greener’ when using recycled wood and tyre-derived materials.

OUTCOMES & CONCLUSIONS

The Tyre/Wood Block project has demonstrated the feasibility of manufacturing composite pallet blocks using waste contaminated wood and textile waste from tyres. The latter has been used in volumes of up to 5% by weight. At full production, the following situation arises in terms of the recycling of waste materials:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
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<tbody>
<tr>
<td>Total production of composite pallet blocks ~ 100,000 m³, equivalent to ~ 65,000 Tonnes.</td>
<td></td>
</tr>
<tr>
<td>Average conversion ratio ~ 80%</td>
<td></td>
</tr>
<tr>
<td>Total raw material = 81,000 Tonnes, of which ~ 4,000 Tonnes is tyre textiles.</td>
<td></td>
</tr>
<tr>
<td>Metals / stones and other recyclable materials removed (10%) = 8,000 Tonnes</td>
<td></td>
</tr>
<tr>
<td>Water evaporation (drying process) = 6,200 Tonnes</td>
<td></td>
</tr>
<tr>
<td>Net residue to landfill = 81,000 – 8,000 – 6,200 – 65,000 = 1,800 Tonnes</td>
<td></td>
</tr>
<tr>
<td>Total material saved from landfill = 81,000 – 1,800 = 79,200 / annum</td>
<td></td>
</tr>
</tbody>
</table>

On a broader level, the project has demonstrated that composite pallet blocks, while composed primarily of wood, can contain other waste materials. There is no reason why other cellulose-based waste materials, such as corn husks or straw, could not be evaluated as raw materials for pallet blocks.

During the installation and commissioning process, the Tyre/Wood Block project injected several million Euro into the local economy through subcontract and services. On a sustainable basis, the Lissarda facility will provide employment of about 50 persons full time, with additional local services contributing to a total of approximately €2m / annum injection to the local economy.

A Life Cycle Analysis has demonstrated that, overall, the pallet block manufacturing activity is ‘greener’ than using virgin wood. The impact on the environment is lowered by the avoidance of landfill as well as the recycling of ferrous and non-ferrous metals and the reuse of sand and stone.

The Tyre/Wood Block project helps to meet national targets in relation to waste management, such as that prescribed by the Waste Management (Packaging) Regulations 1997, which set a goal for 2005 of a minimum recycling rate of 15% in Ireland for various packaging material including wood. It also facilitates the EU Directive on the Landfill of Waste (99/31/EC) which focuses on the reduction of landfill as a waste management option over the period up to 2016.

The Tyre/Wood Block project can be replicated elsewhere. It makes sense to build facilities near the location of waste materials, rather than transporting to a central location. Over time, the innovation can be expected to replace all virgin wood as a source for pallet block manufacture. This trend will be driven by cost advantage and by the increasing preference of pallet makers for the composite block because of its dimensional and performance characteristics.