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Verso l'economia circolare: tracciabilità dei manufatti in Compositi Fibro Rinforzati
Krožni ekonomiji naproti: sledljivost izdelkov iz kompozitov, ojačanih s steklenimi vlakni
Towards the Circular Economy: The Traceability of Fibre Reinforced Composite Products

New applications for recycled fibre-reinforced composites In the building sector

Giorgio Betteto [a]

[a] Gees Recycling Srl – Via Monte Colombera 22 AVIANO Italy (geesretracking@gmail.com)

ABSTRACT

The building sector uses large quantities of panels for scaffolding and formwork. Currently, these panels are mainly made of wood, wood-metal, fiberglass-metal or all metal materials. No recycled-content materials are being used even if most EU countries have Green Procurements Plans adopted that give preference to circular economy products. In the article, we show the advantages of using recycled fibre-reinforced composites jointly with an embedded tracking system, products developed at the Gees Recycling Srl and Infordata Srl.

INTRODUCTION

Half a century of fibre-reinforced composites (FRC) production has generated 80 million tonnes of products destined to reach the end of their service lives with no efficient recycling solutions. Since the early 1960s, fibreglass manufacturing has been a dominant factor in the field of mass production and has been used in various industrial sectors due to its low production costs. FRCs are gaining significant application in the construction, medical, automotive, aviation and marine fields by replacing traditional materials such as aluminium and steel. The recycling of these FRCs at the end-of-life phase is a step further to achieving sustainability.

Building activity is always done in environment, where water, weather events, dirt and construction materials, like mortars and concrete, create chemical corrosion. The large adoption of reinforced concrete absolutely requires the use of formworks, from simple ones as four wooden planks nailed together, to complex self-levelling structures. All these applications need panels that will stand the forces, resist water and weather conditions and will not rust too early or be corroded by construction materials. Panels for gangways and flooring are also required in scaffolding. Sometimes the same products are used for formwork, sometimes specific lower-cost products are used.

New application of recycled FRPs in scaffolding and formwork are presented in this article. Gees Recyling with an innovative technology offers a material that could resolve problems, be competitive with virgin materials and offer circular economy future to this.

Scaffolding (Fig. 1) is defined as a structure of metal poles and wooden boards put against a building for workers to stand on when they want to reach the higher parts of the building (Cambridge dictionary). Scaffolding requires panels with good flexural strength, capability to stand heavy shocks

and with anti-slip surface. Products widely used are pressed steel profiles and pultruded composites profiles. Wooden boards (Fig. 2), plywood boards as well as normal wood planks are used particularly in the northern Europe, where the corrosion aspects are very present.

Figure 1: Scaffolding (www.peri.com)

Figure 2: Wood scaffolding (www.woodguide.org)

Formwork (Fig. 3 and Fig. 4) is the term used for the process of creating a temporary mould into which concrete is poured and formed. Traditional formwork is fabricated using timber, but it can also be constructed from steel, glass fibre reinforced plastics and other materials. Formwork is a more complex activity than scaffolding, and the number of different industrial solutions used in these applications is very high, from simple plank wood structures to modular metal formwork up to custom designed and built special formworks. Most of the use is shared between modular wood-based formwork, laminated virgin wood or phenolic plywood, and metal structures, with faces of metal foil, plywood or fiberglass.

Figure 3: Wood formwork (www.construire.it)

Figure 4: Metal-plywood formwork (www.ceta.it)

Wood and Plywood panels used in scaffolding and formwork are more flexible in use, could be cut and slotted for adapting, fixed with screws or nails, but this means heavy use of manpower. Main problems of usage with time derive from the action of water and weather that degrade wood and wood-based materials. Metal modular panels are faster to set up, using their specific and proprietary equipment; nevertheless, this makes the adaptation to yard required modifications not possible. Chemical corrosion from mortars, salts and cement affect metal modular panels. So, there is a request on the market for alternative products that could offer resistance properties joint with durability and competitivity.

PROCESS AND RESULTS

After testing with Polyvinyl chloride (PVC) and recycled rubber sheets (Fig. 5), which showed good results that will be exploited in different sectors, an interesting opportunity arose, when a reputed composites company, Polmix Srl based in Busto Arsizio, pioneer in producing Sheet Moulding Compound (SMC) and Bulk Moulding Compound (BMC), asked Gees Recycling to find a recycling option for out-of spec uncured SMC and BMC. These fibre-reinforced materials could be processed in the recycling line since the polymerizing parameters (heat and pressure) are not so different.

Figure 5: Left co-moulded Recycled Fibre Material (RFM) & recycled rubber, right co-moulded RFM & SMC (Gees Recycling, 2020)

We chose to make a medium-lightweight panel, with density of 550-600 kg/m3 (comparable to plywood) using a selected mixture of fibreglass waste from laminate and rigid expanded foam from core materials, processed to obtain panels of 2,3x1 m with different thickness, adding a layer of SMC. Tests of co-moulding the SMC sheet on one side, covering the other with Recycled Fibre Material (RFM) granulate, have shown a good operability, perfect adhesion with total continuity between the two materials (Fig. 6).

Figure 6: Layer of SMC (white) co-moulded on RFM (Gees Recycling, 2019)

Panel's strength and performances are ruled by several norms, including Italian Technical notebooks for temporary or mobile construction sites (Rossi et al., 2018). The wider applied are EN 12810-12811 1 & 2 (Table 1) where load classes according to EN-12811-1 are shown. In Fig. 7, types of load testing required are shown. These requirements are important, wood products normally reach class 2, higher classes requires metal or continuously supported panels with I-Beams.

Table 1: Load classes according to EN-12811-1 (Source: Euro norms)

Load Class	UDL (kN/m2)	Concentrated Load (500x500mm)	Concentrated Load (200x200mm)	Partial Load Area (kN/m2)	Partial Load Factor
1	0.75	1.5	1	-	-
2	1.5	1.5	1	-	-
3	2.0	1.5	1	-	-
4	3.0	3.0	1	5.0	0.4
5	4.5	3.0	1	7.5	0.4
6	6.0	3.0	1	10.0	0.5

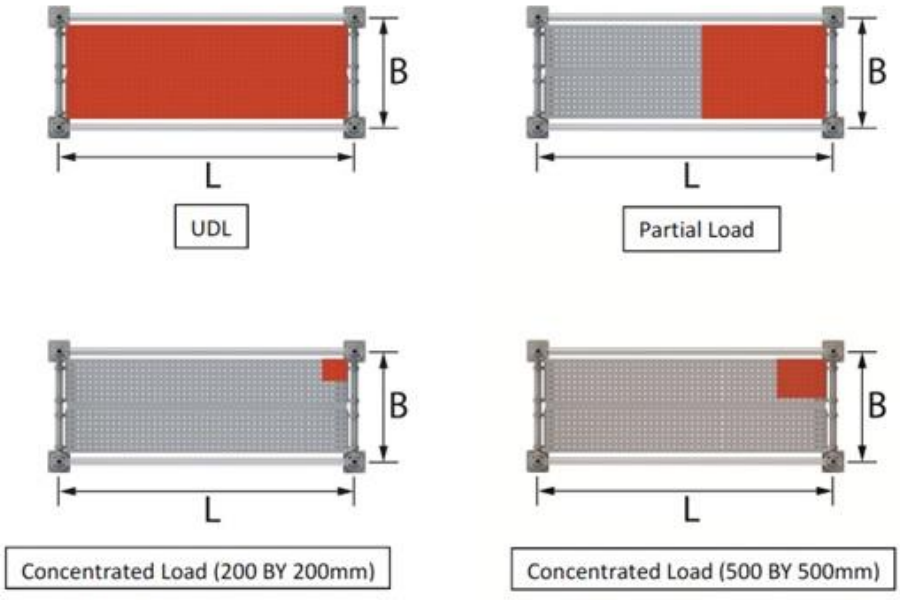

Figure 7: Type of load testing required (Source: Euro norms)

RFM® Recomplax recycled FRC panels may comply with these requirements (Fig. 8). But since the demand for a continuous surface, anti-slip for scaffolding, high gloss or embossed for formwork was expressed, research was done to combine recycled composites with a continuous film, made of polymeric materials, for the water and corrosion resistance requirements in a single production step.

Figure 8: No deflection with a 100 kg man (Gees Recycling, 2019)

Trials were done also by adding small stripes of unpolymerized SMC to RFM mixture, to exploit the high quantities of trimmings that derive from parts moulding. The results are very promising. Panels may have at choice a smooth and gloss surface or could be embossed to obtain decorative patterns (Fig. 9). This could be obtained in a simple and fast way during the co-moulding, also for small production series.

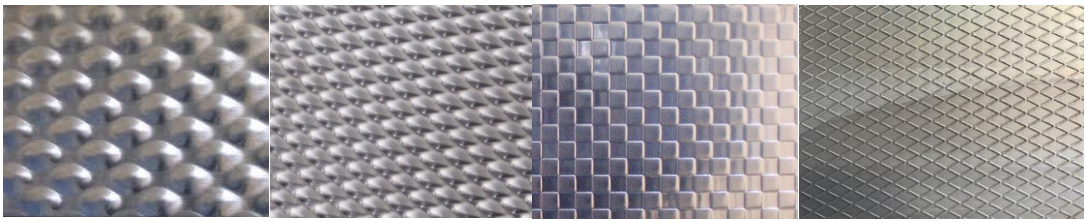

Figure 9: Different types of patterned surfaces (Gees Recycling, 2019)

Tests show that panels could be screwed-in with very good screw retention properties, nails could be used on lower density panels, although this is not an advised fixing method. Panels could be rapidly cut with rotary or alternative saws, in the same way as wooden panels. It is recommended to use hard metal blades.

We focused our attention to another problem, the theft of parts and panels. In the past, RFID chips were already put into panels as tests under the condition that the surface was flat. Another option for the attachment of RFID used was screwing on the side of the panel, which created problems with handling of the panel. Our system, where RFID is embedded inside the panel, solved most of these problems. Difficulties of attaching RDIF systems on or into the panels is one of the reasons why these tracking systems are not more widely used. Several companies tried and failed to do so.

CONCLUSIONS

The Co-moulding process of Sheet Moulding Compound and Recycled Fibre Material could lead to new 100% recycled panels, giving new recycling opportunities to uncured Sheet Moulding Compound & Bulk Moulding Compound polymer waste. The production of the panels is still in the testing phase, but empirical trials have shown more than good performances. Another important fact is that it is still

possible to embed RFC and NFC tags in the panels, thus making automated inventory and control a very interesting opportunity in the building sector. The combination of recycled composites and uncured polyester/epoxy shows more than promising development for a more efficient, sustainable building construction. With the installation of RFID chips, panels would be counted in seconds and tracking becomes easy for customers, reducing loss for thefts.

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LITERATURE

European Standards EN 12810-1 EN 12810-2 EN 12810-3

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WHERE TO FIND US

W: www.ita-slo.eu/retracking

E: retracking@gzs.si (SI), enrico.pusceddu@polo.pn.it (IT)

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