APPLICATION GUIDE OF THE INTEGRATION PROCESS OF POLYURETHANE WASTE IN A GYPSUM PREFABRICATED

Start: October 2017
Project duration: 39 months
Total Budget: 1,289,434 €
EU Contribution: 773,660 €

LIFE-REPOLYUSE

REcovery of POLYurethane for reUSE in eco-efficient materials

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Project Co-funded by the LIFE Programme
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TECSA

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What is Life-Repolyuse?

LIFE-REPOLYUSE is a European Union project that addresses the problem of waste management of polyurethane foams (PUR, PUF, PIR). They are currently being managed as inert waste or recovered using techniques that are not environmentally sustainable.

The project has implemented a **new technology** which integrates this **polyurethane waste** into a new construction material. A **prefabricated gypsum tile** has been developed for removable ceilings, thus extending the life cycle of the waste.

This contributes to the achievement of the objectives of the Roadmap for a resource-efficient Europe and supports the implementation of the European Union's VII Environment Programme.

The project consortium is formed by the University of Burgos, TECSA Construction Company and Yesyforma Europa.

The Building Engineering Research Group (GIIE) of the **University of Burgos** (UBU) is leading this project. Its activity is focused on the search for new alternative materials to the traditional ones, through the recycling of industrial waste, to obtain useful products for use in construction.

TECSA Construction Company belongs to the largest services and construction group worldwide (ACS group). Its activity is focused on the construction of large transport infrastructure projects (railways, highways and roads), as well as industrial and urban development works, environmental works and residential and non-residential building.

Yesyforma Europa is the leader in the sector of plaster false ceiling prefabricated products, being a reference in quality and variety in Europe. Specialists in the marketing and export of this type of products, it offers the best solutions in plaster to distributors, installers, specifiers and individuals.

The **main objective** of this project is to develop a **new building material**, a **prefabricated**, removable **ceiling tile**. It can be said that this objective has been fully achieved.

The implemented technology has allowed to manufacture a new material with similar characteristics to the current commercial standards, being improved in some facets. In addition, the added value of the new product on an environmental level must be taken into account, as it manages to recycle polyurethane waste.

The new material has undergone all the tests indicated by the sector's regulations to certify its technical viability, and it has the **CE Mark**.

In the new tiles with polyurethane, a 28% weight reduction has been achieved compared to a tile manufactured without waste and a thermal conductivity of 0.22 W/(mK) has been achieved (lower than a standard tile).

The water demand for the manufacture of the new tiles has also been reduced by 24.4%.

The lighter weight of the Life-Repolyuse tile compared to a standard tile allows for increased performance when laying the tiles. As they are lighter, the installer can considerably reduce the effort required for movement, which results in fewer injuries for the operator. In addition, the speed of installation is increased. Likewise, the weight of the material transport from the factory to the work site is lower, so the environmental impact of transport is also reduced.

Having achieved an **A1 classification** in the reaction to fire tests, it is possible to compete under better conditions with products of this type on the market, since there are similar products in terms of insulating properties (thermal and acoustic) and lightness, with a worse reaction to fire classification according to the Eurocode.

In order to verify its constructive viability, pilot tests have been carried out with the new prefabricated product in a false ceiling system in three buildings in Burgos and Vitoria (Spain) and in Coventry (United Kingdom).

In this project we have worked with **Polyurethane Foam Waste** from different industries (automotive sector, refrigeration sector, treatment of end-of-life vehicles) in order to seek the greatest possible replicability of the technology implemented.

REFRIGERATION SECTOR

This yellow rigid polyurethane foam waste is generated in the manufacture of insulation panels for the refrigeration sector.

It is presented in powder form and compressed in pellet form, if it comes from milling the edges in the production stage.

Or in the form of blocks/plates if they come from the rejection of formed panels and remains of panels used in factory tests.

AUTOMOTIVE SECTOR

Semi-rigid grey polyurethane foam waste is a mixed waste generated in the manufacture of car roofs. It is chopped up and compressed into pellets or sheets.

TREATMENT OF END-OF-LIFE VEHICLES

Semi-rigid polyurethane foam waste from car wrecks.

There are different types of Polyurethane Foam Waste

Since the second half of the 20th century, the use of plastics (polyethylenes, polypropylenes, polycarbonates, polystyrenes, polyamides, silicones, polyurethanes, phenolic and acrylic resins, melamines, etc.) has progressively spread.

It can even be considered an essential material in all facets of our lives, being consequently very present in urban and industrial waste.

According to the latest report published by Plastic Europe-the Facts 2019*, the demand for plastic in Europe in 2018 was 51.2 million Tn. The demand varies according to the type of polymer, being 7.9% in the case of polyurethane (PUR), which meant an annual demand of 4.0 million Tn.

Of this polyurethane, approximately 25% became waste (1,000,000 Tn), of which 50% is polyurethane foam,

Of the plastic collected after its use, 32.5% is recycled, 42.6% is revalued energetically (incinerated) and the remaining 24.9% is taken to a landfill.

PLASTIC PRODUCTION

359 Millions of Tons (2018)
348 Millions of Tons (2017)

World wide

61.8 Millions of Tons (2018)
64.4 Millions of Tons (2017)

Europe (EU28+NO/CH)

DEMAND

OF PLASTICS 51.2 MILLONES OF TON (2018)
OF POLYURETHANE 7.9% (4.0 MTN) (2018)

Europe (EU28+NO/CH)

25 % Polyurethane waste (1,000,000 T)
Polyurethane foams 50% (500,000 T)

WASTE

* Plastics – the Facts 2019. An analysis of European plastics production, demand and waste data. https://www.plasticseurope.org/

In Europe alone, polyurethane waste amounts to 1,000,000 tons per year.

Life REPOLYUSE

APPLICATION GUIDE OF THE INTEGRATION PROCESS OF POLYURETHANE WASTE IN A GYPSUM PREFABRICATED

This "**Guide to the application of the process of integration of polyurethane waste**", aims to show all those interested the process used in this project, so that it can be easily understood and reproduced.

The objective is to document the waste integration process, so that prefabricated manufacturers have sufficient tools to understand the simplicity of the process and can consider the application of this new technology.

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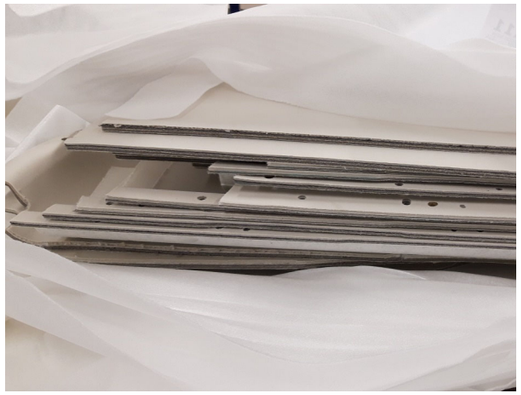
Polyurethane waste can arrive at the precast company in the form of large-format panels (on pallets), in powder form (in sacks, big bags or drums), in the form of pellets (in boxes, sacks or big bags), or in pieces of various sizes (in sacks, big bags or drums).

The same industry can use polyurethane waste of different nature and origin, whose subsequent treatments are slightly different, so it is advisable to allocate a separate reception and storage area with physical barriers, according to the different types of waste.

The collection area for the waste should preferably be under cover to avoid being affected by bad weather (snow/rain).

Polyurethane waste panels



Waste Sheets

Polyurethane waste pellets

Different sized pieces

Waste Application Guide

In order to integrate the polyurethane waste into the new product, it must be transformed into a powdery material. The waste is processed in a grinding equipment designed for this purpose, which should be located in the same area or near the storage.

It is convenient that the grinder is physically separated from the rest of the production line, to avoid as much as possible the projection of particles into the environment in working areas. The equipment must have an integrated screen and must have a suction mechanism to prevent volatilisation of the shredded waste. The shredder will be valid for any type of waste. Only the speed and time of shredding and in any case the size of the screen passage must be varied, depending on the desired size of the shredded foam particle.

The shredded foam can be stored in silos or it can be taken directly to a closed intermediate container (storage hopper) before the mixer. In all cases the transport of the shredded waste, either from the shredder to the silo or from the silo to the buffer tank, will be carried out in closed air-driven ducts.

Waste Application Guide

Waste in sheets

Polyurethane before processing

Grinding equipment

Processed polyurethane

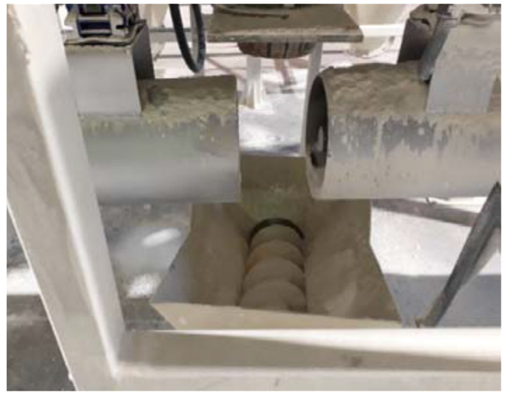
The basic materials for the manufacture of the new tiles are gypsum, polyurethane residue and water.

The first phase of production involves the dry mixing of the polyurethane waste with the gypsum, for which an industrial-scale mixer has been defined and built. The mixer consists of two storage hoppers, one for the gypsum and the other for the polyurethane waste (powder). After filling them with the raw materials, they have to be covered to prevent the volatilization of particles.

Storage hoppers

Storage hoppers

Dosificador Volumétrico



Mezclador

The prototype has a weight-controlled volumetric dispenser that works continuously and provides the right amount of gypsum and polyurethane waste. A worm gear is used to mix both raw materials homogeneously.

From this moment on, all the process, machinery and personnel in the manufacture of tiles with polyurethane is identical to that used for standard tiles.

Waste Application Guide

The mix (gypsum/polyurethane waste) is transported with a screw conveyor to the entrance of the production line, where it is joined with the fibres, the additive and the water. A mixer is used which is the same one used in the manufacture of all tiles models

At this point the manufacturing process is equal to that of a traditional production line of tiles for demountable ceilings.

The mixture is poured into the moulds with a pump adapted to the density and viscosity of the mixture, by means of a continuous system on a mould carrier chain, and is pressed to eliminate the excess mass.

The dimensions of the new tile have a modulation of 600 x 600 mm with a thickness of 15 mm, dimensions similar to those currently present on the market.

Waste Application Guide

Mixture transport

Line input

Production line

Line output

When it acquires the appropriate consistency, the tile is removed from the moulds and placed vertically on trolleys to be transported to the drying area.

The packing of the tiles is done in boxes of 8 pieces, following the same method as for the standard tiles. The transport does not require any special conditions.

Packing machine

Packaged Tiles

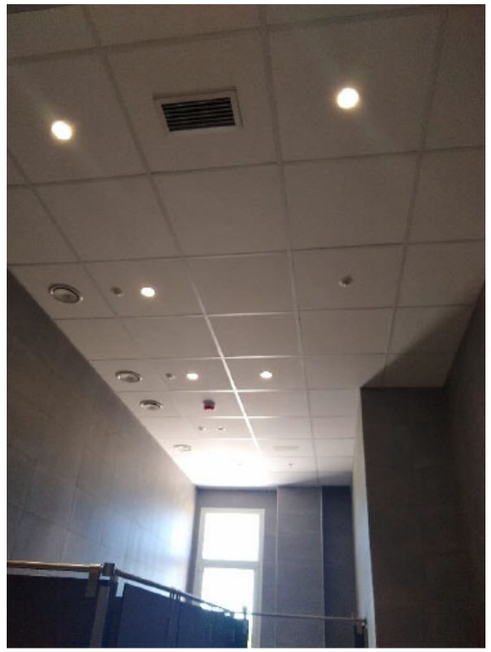
Cars

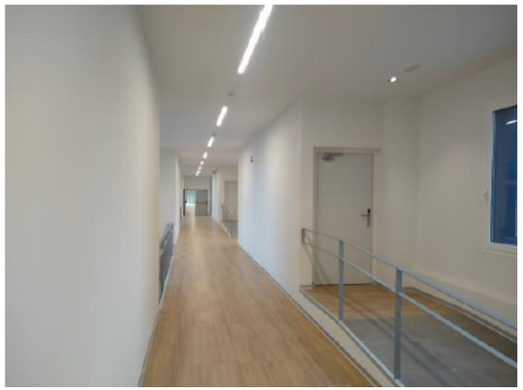
Drying room

Transport pallets

New Tiles

Life-Repolyuse tiles are laid with the same type of structure as standard ceilings, and holes can be made for lighting, fire protection and similar systems.





WASTE APPLICATION GUIDE

↘ ¿What adaptations do I have to make in my industry?

The only adaptations needed are the two hoppers with the dosing device, which can occupy a surface area of no more than 6 m², and the storage and grinding facilities, which can be in separate annexes.

↘ Is the process very complex?

The whole process, machinery and personnel in the manufacture of tiles with polyurethane is identical to that used for standard tiles.

↘ Do you have any waste generators near your industry?

It would be very interesting to have the waste producer close to the precast industry.

↘ Is it feasible for the waste producer to shred the waste and send it in silos by truck, the way prepared mortar silo are sent to the building sites?

Yes, in this case it would be sufficient to lower the silo from the truck and replace it with the empty silo.

↘ Can I crush directly without a storage silo?

It would be feasible. In this case it is possible to shred on demand in the waste store itself and connect the outlet of the shredder directly to the regulating tank (hopper).

WASTE APPLICATION GUIDE

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To make the use of resources more efficient in Europe

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