Utilization of Municipal Plastic and Wood Wastes in Industrial Manufacturing of Wood Plastic Composites

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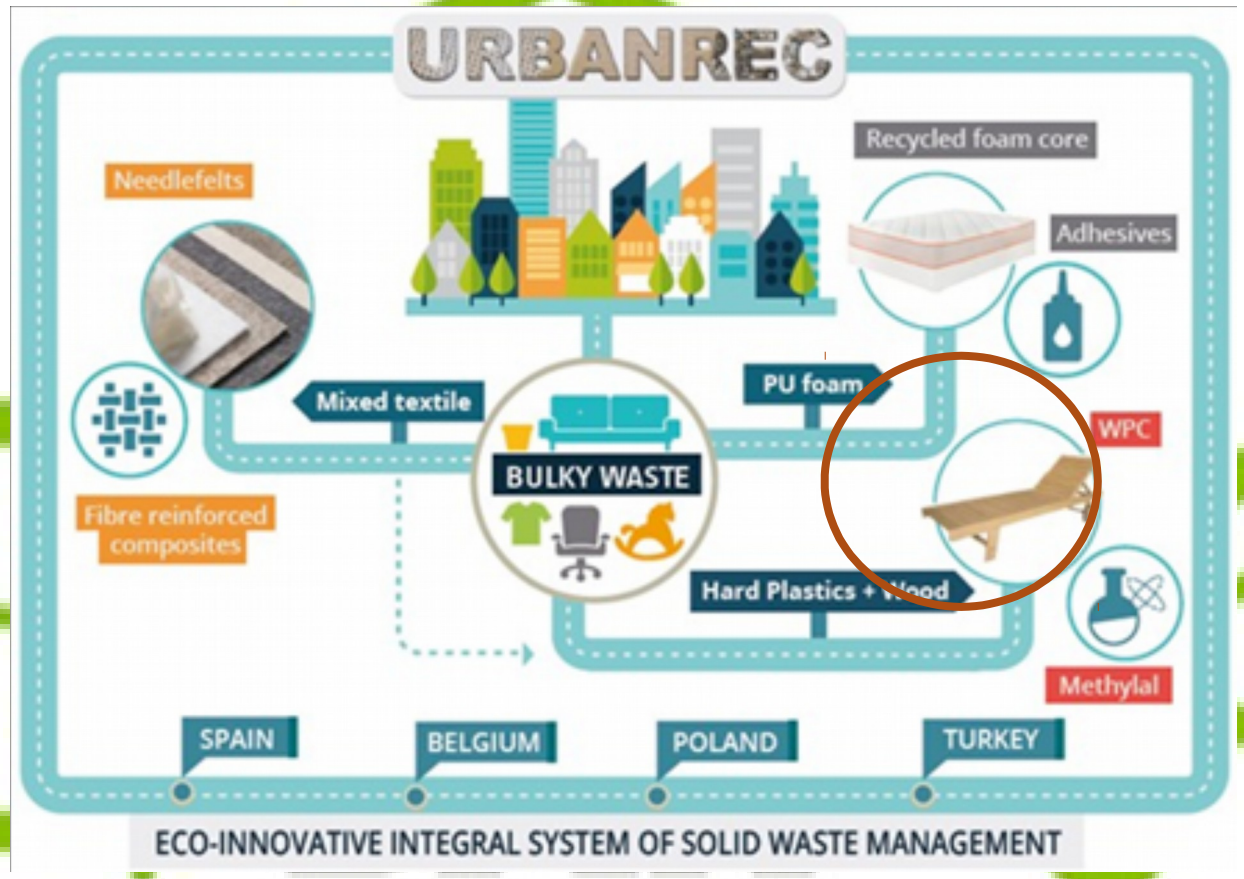
Content

- URBANREC
- Bulky Waste
- Wood-Plastic Composites
  - Experimental Work
  - Results
- Conclusions

Motivation-HORIZON2020



New approaches for the valorisation of URBAN bulky waste into high added value RECycled products

More info and collaboration:please check our web sites and contact with related person

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BULKY WASTE MANAGEMENT

New approaches for the valorisation of URBAN bulky waste into high added value RECycled products

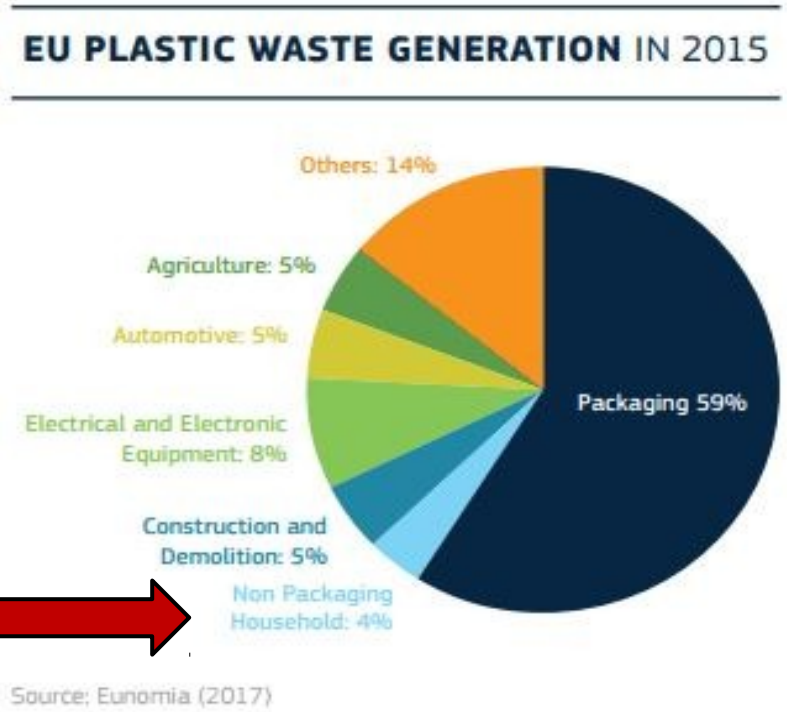
- "To have new products by using bulky waste as a source in the objective of circular economy",
  - The logistics: Improving collection and implementing reuse. (Minimization of waste)
  - Separation and disassembling (Recycling)
  - Fragmentation: Implementing advanced techniques such as fragmentation (3D cut).
    - To obtain high quality raw materials, i.e. metal, plastics, wood, textile, foams, etc.
  - Promoting innovative valorization routes for those which are considered more problematic.********
- The obtained results will be employed as a base to propose recommendations for a draft European legislation on bulky waste management.

Introduction-Bulky Waste

- BULKY WASTE: solid waste that may require special handling and management, and which by reason of its bulk, shape, or weight cannot be placed in a container or bundled".
  - In the context of the project this waste redefined as
    - Furniture → Wood, PUF, mixed textile (cotton, polyester wool) etc.
    - Mattresses → PUF, Mixed textile fraction, metal etc.
    - Upholstery → Textile fraction
    - Garment → Textile fraction
    - Garden and outdoor furnitures → Plastics (PE, PP, PVC etc.), Wood fraction
    - Other large fixtures and fittings, toys → Plastics
  - 19 million tonnes of furniture, mattresses, upholstery, textiles and plastic garden products, among others in each year in the European countries end up in the waste, and 60% of these wastes goes to landfills.
  - The characteristics of this waste fraction greatly vary depending on the economic, social or geographical situation of every country

Plastic Waste Recycling

>300 million tonnes plastic waste globally (2017)..



- Prevention of environmental problems caused by plastic waste accumulation
- Conservation of natural resources due to non-renewable petroleum based polymer use

Goal of this study

- To find a pathway for valorization of bulky waste through the utilization of Wood and Plastic components.
  - This study presents physical and mechanical test results and industrial demonstrations of WPCs manufactured from recycled bulky wastes.

Separation and Fragmentation

Wood

Plastic

Formulation for the WPC compounds

WPC Compounds

WPC Products

Wood Plastic Composites (WPC)

- Composed of wood flour/particles and polymer matrix (PE, PP, PVC..)
- Wood used to decrease of environmental impact of non-renewable polymers, reduction of price and aesthetic reasons.
- Increase in applications ranging from construction and automotive sectors to consumer products such as outdoor/indoor decking, cladding or garden furnitures.
- In the WPC market, mechanical strength and water absorption are the required properties to evaluate WPC's quality.

- Market Situation:
  - WPCs one fast growing sector with an 5-year average growth rate: approximately 35% in China, followed by 11% in Europe, and 8% in North America.

Experimental Work

Materials

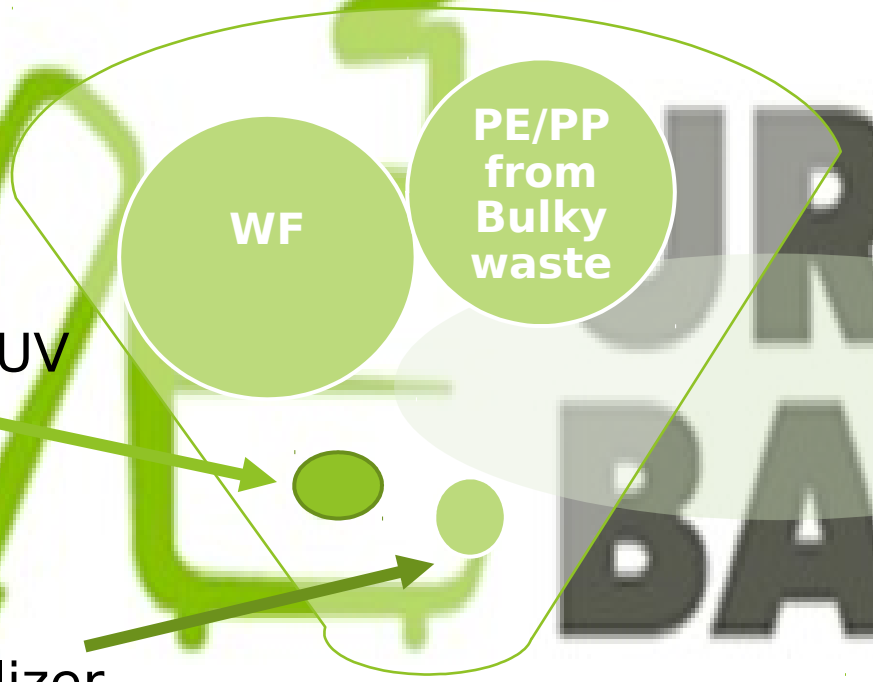
- Virgin PP/PE (PETKIM)
- Recycled PP and PE (VANHEEDE-Belgium) obtained from bulky waste
- Wood Flour (WF) from bulky waste
- Reactive Coupling Agent
- Additives: Antioxidants, UV stabilizer, Lubricant

Sample Code	Polymer Type	Melting Temperature (T_m) (°C)	Melt Flow Index (MFI) at (230 °C) (g/ 10 min)
Virgin PP	Nonrecycled MH418	163	4.5
Virgin PE	Nonrecycled I 668	134	5.5 (190 °C)
PPMMFI	PP homo polymer medium MFI	164	7.3
PPHMFI	PP homo polymer high MFI	165	22.1
PPFGF	PP filled garden fraction high MFI	162	11
MixPO	Mixed Polyolefin high MFI	230	14
LLDPEgrass	LLDPE artificial grass	-	2.5-3 (190 °C)

Experimental Work

- WPC compoundings:Twin Screw Extrusion @ both in lab and industrial scale
- WPC Product Industrial Demo:Injection molding was used for products manufacturing.

Extrusion process temp: 185-215 ° C



Antioxidants, UV stabilizers, Lubricant

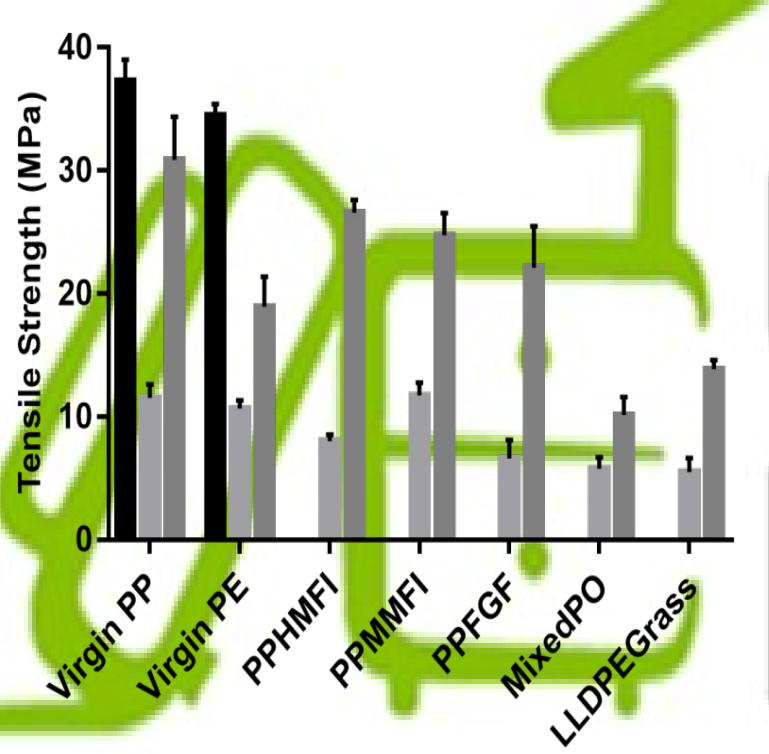
Compatibilizer

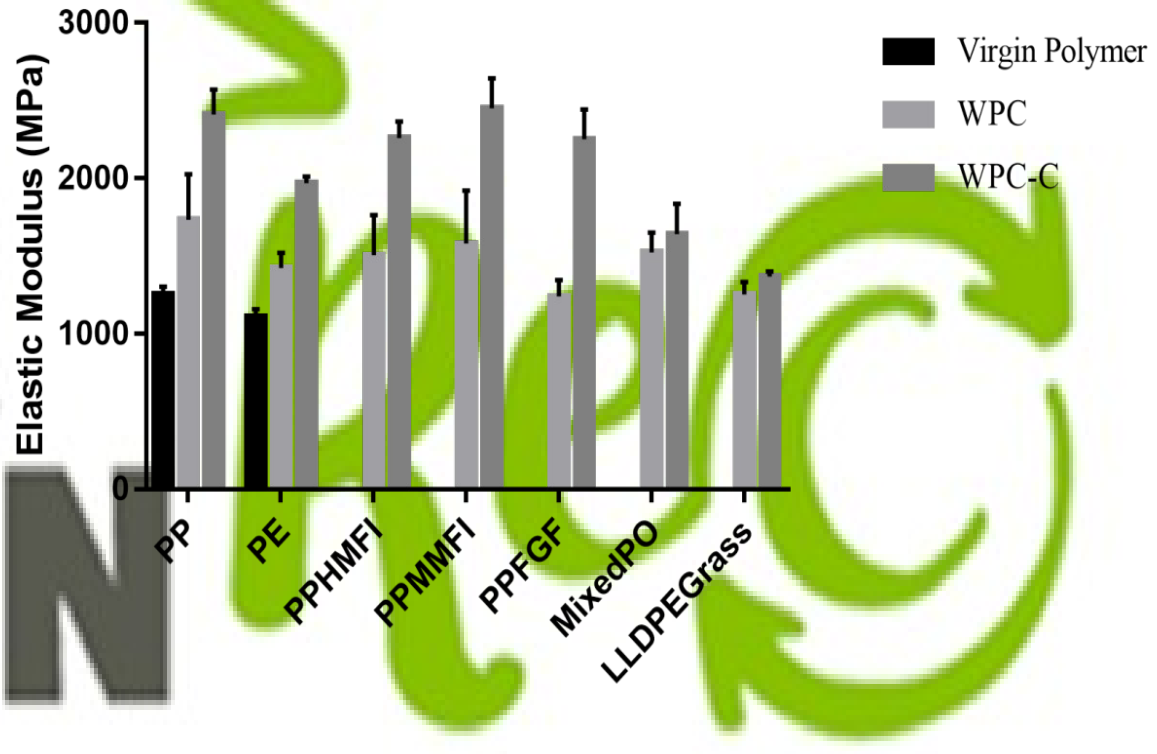
r-WPC Compounding

Mechanical Tests :
Tensile (ASTM D 638)
Impact (ISO 179-1)
Flexural (ASTM D 790)

Tensile Strength of WPC composites-Lab

- Effect of Compatibilizer on different type of plastics

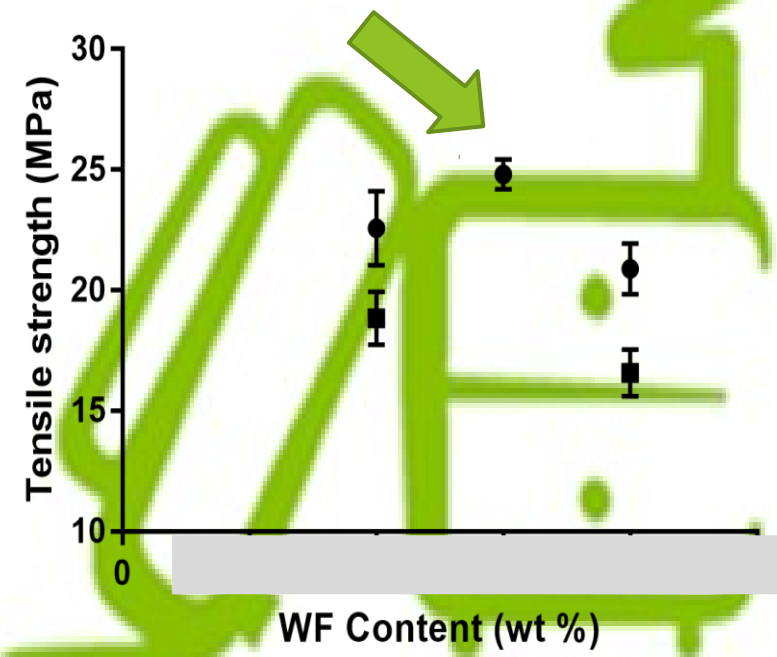


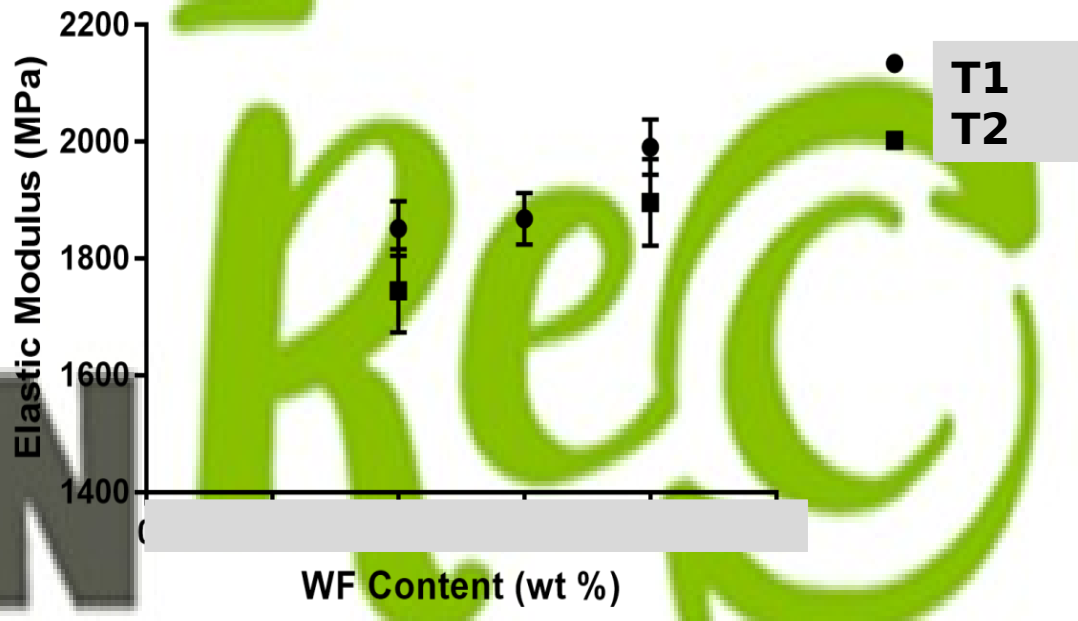


- Compatibilizer addition increased tensile strength and elastic modulus in all combinations.
- PPGF were used for industrial manufacturing due to vast availability of the waste stream.

Tensile Strength of r-WPC Compounds-Industrial

- Effects of WF content and Extrusion Process Temperature



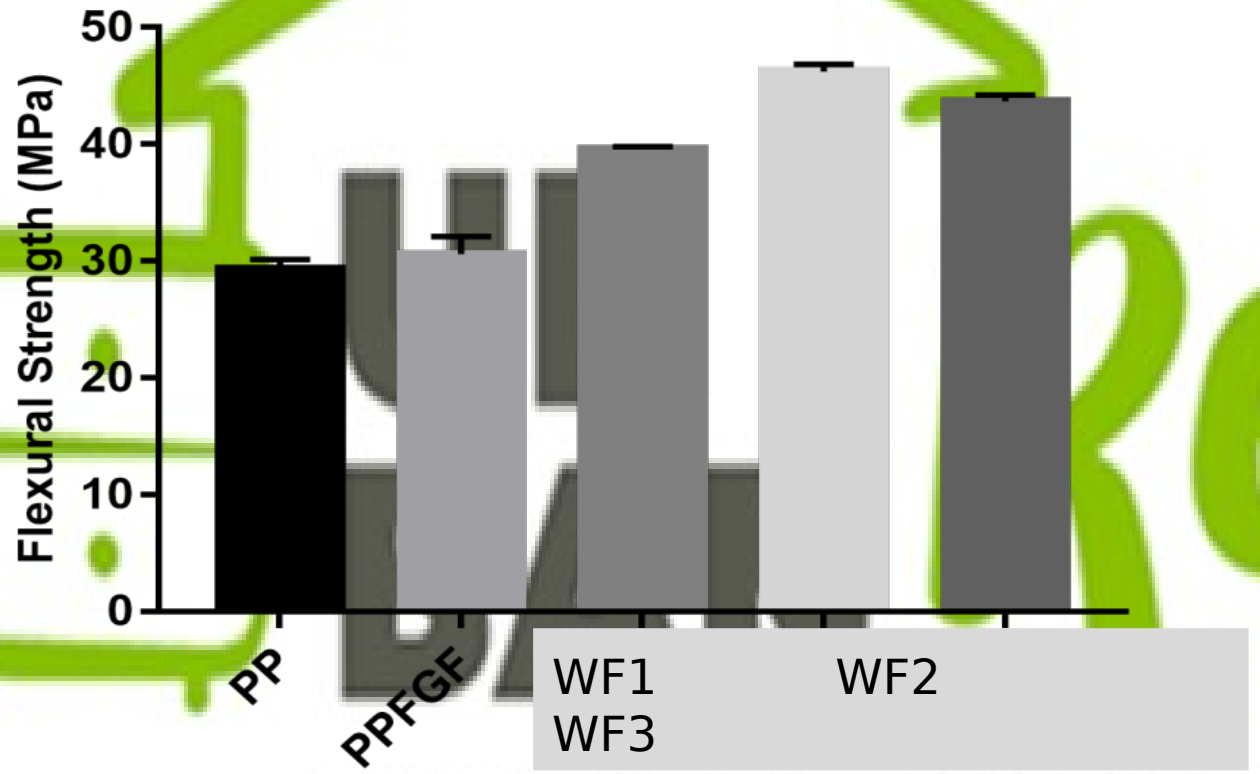


- Optimum ratio of WF filled r-WPC compounds were obtained at lower T.
- The maximum tensile strength value was obtained as 24.8 MPa for optimum WF loading.

Impact Strength Results of r-WPC Compounds-Industrial

- When WF content increases, significant decrease observed in the impact strength.
- The decrease in impact strength with recycled PP and WF loading reveals to the reduction of adsorbed energy.

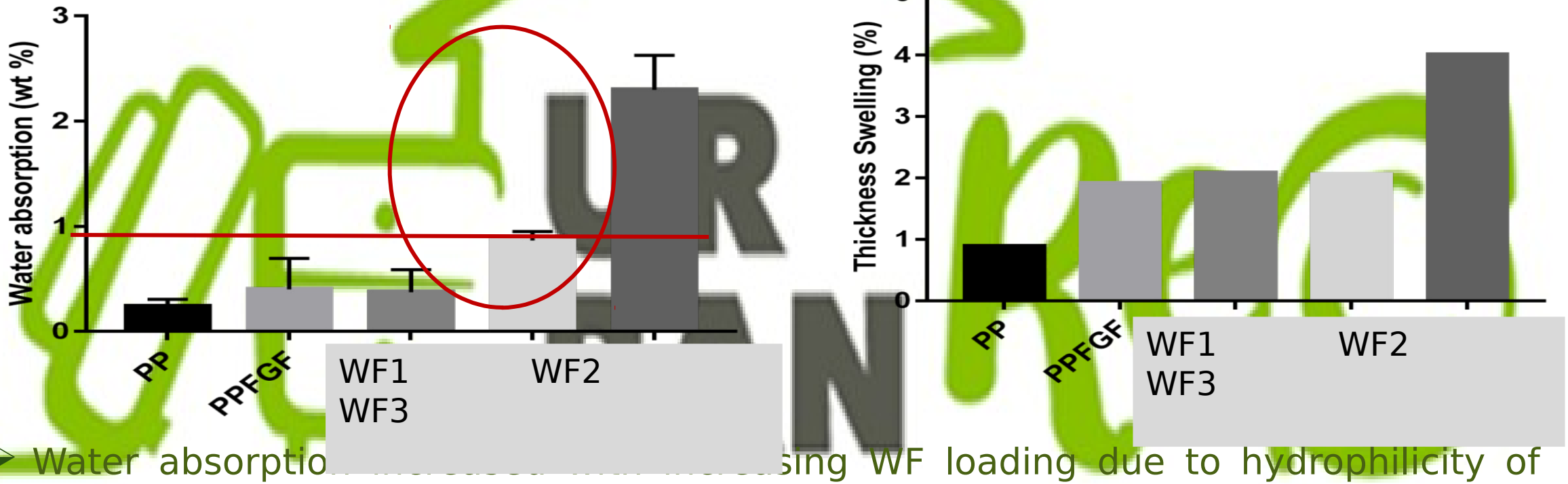
Flexural Strength of r-WPC Compounds-Industrial



- Flexural strength increased with an increase in WF loading in recycled PPFGF.

Water Absorption and Swelling Results

- Effects of WF content



- Water absorption increased with increasing WF loading due to hydrophilicity of wood.
- Water absorption of r-WPC compounds (except WF3) were lower than 1 wt% which is acceptable level for WPC market.

Samples WPC Products

- After the optimization of the processing parameters, two products: Crates/box and table legs have been manufactured.
- Crates/box and table legs indicate the applicability of WPCs from recycle plastics and wood.

Conclusions

- It is demonstrated that bulky waste plastic and wood can be used in the industrial production of Wood-Plastic Composite Compounds and Products.
- Many other alternatives of r-WPC products depending on the requisites and demands of consumers can be manufactured from bulky waste.
- This application would lead to a better waste management for the municipalities in future.

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Partners

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Thank You
Questions?

URBANREC CONSORTIUM

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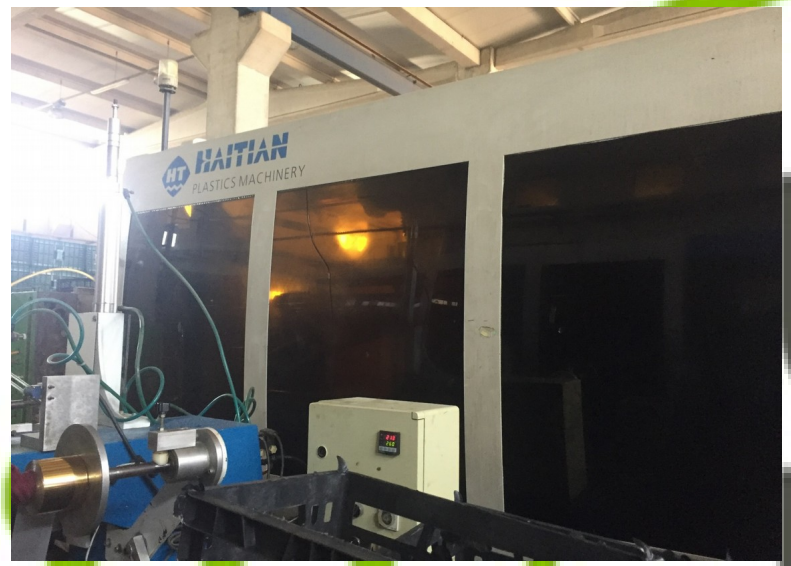
BULKY WASTE MANAGEMENT

Experimental Work

Industrial Manufacturing of WPC Products



Crates and table legs from r-WPC compoundings at injection molding machines manufactured

Haake Rheomixer @ speed of 40 rpm for 10 min @185 or 165 ºC

Compression Molding sets size: 150x150x1mm 185 -200 ° C, 2000 psi

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WPC Specimens for test