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WASTE STREAMS MOST SUITABLE FOR PRODUCING WOOD–PLASTIC COMPOSITES IN THE CIRCULAR ECONOMY CONTEXT

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Abstract: Wood–plastic composites (WPCs) are hybrid materials made from a blend of thermoplastics and lignocellulosic fibres, offering a sustainable alternative to conventional materials in construction, automotive, and consumer goods. In the circular economy framework, WPCs play a pivotal role by valorizing waste streams and reducing reliance on virgin resources. WPCs exemplify the principles of the circular economy by transforming plastic and wood waste into high–value, durable materials. Prioritizing clean, compatible, and abundant waste streams–such as post–consumer plastics and wood residues–maximizes both environmental and economic benefits. This report explores the strategic integration of WPCs into circular economy frameworks, emphasizing their role in waste valorisation and resource efficiency.
Keywords: waste streams, Circular Economy, Wood Plastic Composite (WPC)

INTRODUCTION

The current trend of developing friendly environmentally products leads researchers to look for alternative materials in a variety of applications.[1–6]

WOOD PLASTIC COMPOSITE (WPC) is becoming popular in many sectors, particularly in construction and automotive, due to the attractive properties it presents compared to traditional materials like wood. Originally wood plastic composites were focused on non–structural applications, mainly in the automotive – car boot trays, ceiling and door panels, train interiors, busses – and construction sectors – prefabricated houses, rooftops, profiles, fences, pavements, handrails. At present, these areas continue to be of great interest, but they are also present in various sectors such as industrial sectors – packaging or pallets –, furniture – bins, kitchen fittings, doors, windows, garden and urban furniture –, or other sectors – toys, bicycle frames, snowboards, musical instrument covers.

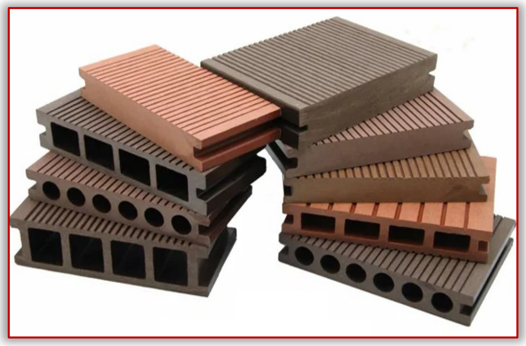

Figure 1. Wood Plastic Composite (WPC) products

The reasons for using WPC are many. However, other causes enforced many countries to tend for using alternative sources to virgin materials. The awaiting market for WPC is huge due to the high production of plastics and wood, which constitutes a significant amount of solid waste, which is mostly disposed not recovered. The environmental concerns are focused on limiting the use of finite resources and the need to manage waste disposal.[7–10] Consequently, this minimizes the solid waste content and conserve the natural resources. Therefore, costs, energy, and depletion of virgin materials are reduced. Therefore, the tendency to recycle materials at the end of their useful life has increased tremendously. In addition to the enforced environmental policies, the growth of environmental awareness led to a new orientation to use wasted natural materials for different applications and industries such as the automotive, packaging and construction industries.[1–10]

Versatility of design, finish, and process, able to be moulded into any shape and size, including arched or bent shapes, are main benefits of these products. Possibility to be treated like wood concerning final touches like drilling, brushing, sanding, and dyeing. Advantages, desired properties, environmental regulations, and awareness have led to the substitution of using conventional woods with the WPC. Its production is growing over time due to its several applications. Main motives include:

— It can be moulded in any particular mould with a variety of shapes and angles, flat or curved, so it can give any desired design.
— It can be treated in the same manner as the conventional wood using the same cutting and sawing equipment.

Due to the low cost of the fibres and the high volume than can be incorporated in the polymer conduct to the cost reduction per unit of volume in WPC composites. Are lightweight, by being able to manufacture profiles and hollow and/or foam products. Wood Plastic Composites (WPCs) have a good humidity resistance, high resistance and durability in climate conditions can therefore be used in exterior applications, without requiring specific maintenance with varnishes, paints, or oils, having a better shelf life than products made exclusively from wood. WPC is also used in producing panels where it is produced by mixing wood flour and plastics giving a material, which can be processed similar to 100% plastic–based products. [11–19]

WOOD–PLASTIC COMPOSITES (WPC)

Wood–Plastic Composites as hybrid materials

Wood and plastics (virgin or recycled) with various types, grades, sizes, and conditions are the main materials utilized in WPC production. WPC is composed mainly from a plastic matrix reinforced with wood and other additives sometimes are added using the appropriate processing procedures.[11–19] This type of material belongs to the family of bio–composites comprised mainly of cellulosic materials and a thermoplastic polymeric matrix, which can be virgin, recycled, or bio–based. In fact, WPCs are very versatile materials, which can be custom made according to the product application, acquiring specific properties. [11–19] Regarding vegetable fibres, usually wood flours or fibres are used. Up to 60–70% in weight can be incorporated into the polymer and they can act as a filler or as a matrix reinforcement agent. Generally, the polymers used for this type of composite are Polyethylene (PE), Polyvinyl chloride (PVC), and Polypropene (PP). In fact, any recycled plastic, which can melt and be processed in a temperature less than the degradation temperature of the wood filler (200^{0}C) could be used to produce WPC. [13–15]

WOOD–PLASTIC COMPOSITES (WPC) are hybrid materials composed mainly of wood fibres combined with thermoplastic polymers or recycled plastics. Wood–Plastic Composites (WPCs) are innovative materials combining wood fibres and thermoplastic polymers to provide an eco–friendly, high–performance alternative to traditional wood products. Comprising approximately 70% biomass (wood fibres or recycled wood waste) and 30% thermoplastics, WPCs leverage the best qualities of both components to achieve enhanced durability, sustainability, and low maintenance. [11–19]

WOOD–PLASTIC COMPOSITES (WPCs) are innovative hybrid materials composed primarily of natural wood fibres combined with thermoplastic polymers.[11–19] This unique combination capitalizes on the complementary strengths of both components–wood providing aesthetic appeal, stiffness, and biodegradability, while plastics contribute enhanced durability, moisture resistance, and processability. WPCs are produced by uniformly blending wood flour or fibres (sourced from sawdust, wood chips, or agricultural residues) with plastics such as polyethylene (PE), polypropylene (PP), or polyvinyl chloride (PVC), alongside various additives like coupling agents, stabilizers, colorants, and lubricants to optimize performance and longevity. [11–19]

Figure 2. The components of WPC

The components of WPC typically include:
— Wood fibres: Often sourced from recycled wood, wood waste, sawdust, or other biomass. These fibres provide strength, texture, and the natural wood appearance. Depending on the region of manufacture and on the availability, softwoods as well as hardwoods in the form of fibres, particles, or fine flour serve as raw material.

- Plastics: Common thermoplastics used are polyethylene (PE), polypropylene (PP), and polyvinyl chloride (PVC). Each type of plastic contributes different properties: PP enhances heat resistance and structural integrity; PE is commonly used; PVC adds strength, weather resistance, and fire resistance.
- Additives: To improve surface finish, adhesion, durability, and UV resistance, additives like coupling agents, colorants, lubricants and stabilizers are included.

The raw material sources for Wood–Plastic Composites (WPCs) are primarily two:

- The wood components – wood fibres or wood flour –, mainly sourced from recycled wood, sawdust, wood chips, agricultural residues, or sustainably harvested biomass. As a variety of types of wood particles or fibres can serve as raw material for WPC, this material offers an opportunity to enhance the sustainability of the wood processing industry in the form of added value by optimizing the material use and minimizing and recycling wood wastes.
- The plastic component – plastics (thermoplastics) –, often come from recycled materials such as HDPE, PVC, or PP, further enhancing the sustainability of the composite.

Additives like lubricants, inorganic fillers, UV stabilizers, biocides, and fire retardants are also included in formulations to enhance processing and improve material properties.

The wood components in WPCs

The wood components are usually in the form of sawdust, wood flour (fine particles), or wood fibres, commonly sourced from tree species such as maple, oak, and pine, which are relatively low–cost and readily available. Additionally, various agricultural residues or agro–wastes like wheat straw, rice husks, coconut shells, bagasse, corn stalks, olive stones, peanut hulls, coffee husk, bamboo, and other plant–based materials are increasingly used as a sustainable alternative to wood fibres, contributing to renewable, biodegradable reinforcement in WPCs. The constitution of the wood component influences the physical and mechanical properties of the WPC. While fibres, having a greater aspect ratio (length/width ratio), enhance the tensile strength, particles are easier to dose to the production process and easier to disperse in the polymeric matrix and therefore result in materials that are more homogeneous. In addition, the properties mentioned beforehand as well as visual properties of the WPC depend on the intrinsic properties of the wood species used.

Wood waste can be divided into post–industrial and post–consumer wood waste. While post–consumer wood waste may comprise sources like old newspapers, wood pallets, and building and construction residues, post–industrial wood waste includes sawdust, shavings, chips, milling residue, offcuts, trees, branches, and bark.

Figure 3. The wood components in WPCs

The provenience of wood flour or wood fibres from:

- sawdust (from sawmills);
- recycled wood waste;
- agricultural residues (e.g., rice husks, wheat straw).

These lignocellulosic fillers provide strength and texture.

The plastic component in WPCs

If the wood components provide the reinforcement, the plastic component in WPCs provide de matrix. The plastic component in Wood Plastic Composites (WPCs) serves as the matrix that binds the wood fibres and gives the material its structural integrity, flexibility, and resistance to moisture and decay. The roles of plastic component in WPCs are:

- encapsulates wood fibres, protecting them from moisture and decay
- provides flexibility and mouldability during extrusion or injection moulding
- enhances durability, UV resistance, and weatherability
- acts as a carrier for additives (colorants, stabilizers, coupling agents)

The plastic component in WPCs generally consists of thermoplastic resins such as polyethylene (PE) including low and high–density PE (LDPE, HDPE), polypropylene (PP), polyvinyl chloride (PVC), or polylactic acid (PLA). Both recycled and virgin plastics are used, with polyethylene–based WPCs offering better thermal stability and ductility, while polypropylene–based WPCs tend to be stiffer but more brittle. In fact, the main source of plastic component are:

- virgin polymers: from petrochemical industry
- recycled plastics: post–consumer and post–industrial waste (packaging films, bottles and containers, automotive parts etc.)
- bio–based plastics (emerging): PLA, PHA – used in experimental WPCs.

Figure 4. The plastic component in WPCs

Using recycled plastics reduces environmental impact and supports circular economy goals.

Sustainability of Wood–Plastic Composites

Wood or agro–waste content typically ranges from 50 to 70 percent of the final composite, influencing properties such as melt flow index and mechanical performance. The use of recycled plastics and agricultural residues as raw materials aligns with sustainability goals by reducing reliance on virgin resources and diverting waste from landfill or burning, supporting circular economy principles in WPC manufacturing. This combination allows WPCs to be widely used in decking, railing, outdoor furniture, automotive interiors, cladding, and other applications demanding durability and weather resistance.

The sustainability of Wood–Plastic Composites (WPC) improves significantly with higher recycled content percentages. Studies indicate that WPC formulations containing about 55–70% recycled wood fibre (sawdust or wood flour) combined with 25–40% recycled high–density polyethylene (rHDPE) achieve improved environmental benefits by maximizing waste valorization from both biomass and plastic sources. The inclusion of recycled plastics and natural fibres reduces reliance on virgin materials, cuts landfill waste, and lowers the carbon footprint of the final composite. Optimal coupling agents and additives (1–3%) are used to improve mechanical performance and durability without compromising the environmental advantages. In fact, a WPC composition with approximately 60–70% recycled wood fibre and 25–40% recycled plastic content is considered effective for enhancing sustainability–balancing material performance with significant resource recovery and waste reduction.

WPC combines the differing properties of wood and polymer. Wood is strongly hydrophilic and therefore prone to high moisture absorption and swelling rates resulting in decay and dimensional instability, which is disadvantageous especially for outdoor applications. By incorporating, the wood into a hydrophobic polymer matrix, the moisture absorption and sensitivity to fungal decay and insect attack is reduced.

WPCs stand out as versatile engineered materials with superior mechanical properties compared to pure plastics, including better strength, stiffness, and dimensional stability. Their plastic matrix reduces the hydrophilic nature of wood fibres, significantly improving resistance to water absorption, rot, and insect attack. This hybrid nature makes WPCs suitable for a wide range of applications–ranging from construction products like decking, cladding, and fencing to automotive parts, furniture, and consumer goods.

WASTE STREAMS MOST SUITABLE FOR PRODUCING WOOD–PLASTIC COMPOSITES

Wood waste streams

WOOD WASTE STREAMS are typically classified based on their origin, treatment, contamination, and potential hazards. These waste streams are managed differently depending on regulation and available treatment technologies and are increasingly valued for recycling and energy recovery to support circular economy goals in the wood product industry.

Figure 5. Wood waste streams

Wood waste streams include:

— WOOD FIBRES and FLOUR: Sawdust, wood flour, chips, and powder from lumber milling, furniture manufacturing, and agricultural residues are primary feedstocks for WPC.
— POST–INDUSTRIAL WOOD WASTE: Offcuts, trim, and wood residues from manufacturing processes.

These sources typically undergo sorting to remove contaminants like metal, plastics, and textiles before processing. These wood wastes are typically dry and well suited for compounding with plastics. Optimal wood waste sources include:

— POST–CONSUMER and INDUSTRIAL WOOD WASTE: Includes sawdust, wood flour, chips, and dust from sawmills, furniture production, packaging, pallets, and construction off–cuts.
— RECYCLED WOOD–BASED PRODUCTS: Wood dust or particles from recycled particleboard (PB), medium–density fibreboard (MDF), high–density fibreboard (HDF), and oriented strand board (OSB).

Plastic waste streams

PLASTIC WASTE STREAMS are classified based on their origin, composition, and treatment possibilities. Each stream has specific challenges related to contamination, polymer types, and recycling infrastructure, influencing methods of collection, sorting, and processing. Plastic recycling is critical to reduce virgin polymer demand and improve WPC sustainability.

Figure 6. Plastic waste streams

Sustainable plastic waste management aims to increase recovery rates, facilitate reuse and recycling, and reduce landfill and incineration to support circular economy objectives. Plastic waste streams include:

— Recycled Polyethylene (PE), Polypropylene (PP), and PVC: These plastics are common polymer matrices in WPC and sourced from post–consumer and industrial plastic waste.
— Plastic Film, Containers, and Packaging Waste: Sorted recyclable streams of plastics to be cleaned, shredded, and pelletized before use.

Mixed post–consumer wastes

MIXED POST–CONSUMER WASTES can be effectively used in Wood–Plastic Composites (WPCs) by upgrading and repurposing complex plastic waste streams that previously were considered unrecyclable. These mixed streams often contain multilayer packaging and films composed predominantly of polyolefin such as polyethylene (LDPE, LLDPE, HDPE) and polypropylene (PP).

Composite waste from demolition or product end–of–life (e.g., old WPC decking or panels) can be mechanically recycled into new WPC production, though sorting and contamination pose challenges. Using mixed post–consumer waste in WPCs promotes circular economy goals by diverting difficult–to–recycle plastics from landfills while substituting virgin polymers and timber.

The end–products are recyclable at their end of life, maintain durability comparable to natural wood, and show environmental benefits including reduced global warming potential and water use compared to conventional timber composites. This innovative use of mixed post–consumer plastic waste in WPCs is gaining industrial traction and scalability for sustainable building materials.

Special processing for plastic–heavy wastes

SPECIAL PROCESSING FOR PLASTIC–HEAVY WASTES used in Wood–Plastic Composites (WPCs) involves several key steps to efficiently convert these materials into composite feedstock with high performance and durability. PVC waste requires careful processing (crushing, grinding) due to its chemical composition but has been effectively used in PVC/WPC blends. Post–industrial or post–consumer WPC scrap itself can be shredded and reintroduced into the process, promoting circular economy and material efficiency.

By utilizing these waste streams, WPC production valorises forestry and plastic waste, reducing landfill pressure, lowering carbon footprint, and conserving natural resources. Internal production of WPC granules from collected wood and plastic waste can also reduce supply dependency and transport impact.

In summary, wood flour from industrial wood waste and recycled polyethylene, polypropylene, and PVC plastics from post–consumer and industrial sources are the most suitable and commonly used waste streams for sustainable WPC manufacture.

WOOD–PLASTIC COMPOSITES IN THE CIRCULAR ECONOMY CONTEXT

Wood–Plastic Composites (WPCs) represent a key material innovation aligning with circular economy principles by combining recycled wood fibres and plastics into durable, sustainable composites. At its essence, a circular economy is about the creation of an entire economic system in which materials never become waste, nature is regenerated and economic growth does not mean growth in utilizing natural resources. WPCs address urgent environmental challenges such as plastic waste accumulation and deforestation, promoting resource efficiency, waste reduction, and product longevity.

Figure 7. The concept of circular economy

The main goals, very shortly summarized, are:
— maximize use of recycled and renewable raw materials to minimize reliance on virgin resources.
— ensure durability to extend product lifespan and reduce repeat consumption.
— facilitate reuse, recycling, and recovery of WPC materials at end–of–life to close material loops.
— support low–impact manufacturing and reduce overall carbon footprint.

In the circular economy context, the Wood–Plastic Composites have the following scopes:
— application across construction, automotive, furniture, and packaging industries aiming for sustainable materials substitution.
— incorporation of up to 80% wood fibres (often from waste streams) combined with recycled plastics.
— development of manufacturing innovations enhancing recyclability and environmental performance.

In fact, WPCs are transformative materials that embody circular economy ideals by turning waste into valuable, durable products with reduced environmental impacts. Continuous innovation and systemic approaches in production, design, and end–of–life management are critical to fully realize their sustainability potential and broaden adoption across industries. The benefits can be summarized as:
— WPCs combine the natural aesthetic and feel of wood with enhanced durability and weather resistance of plastics
— significant diversion of plastic and wood waste from landfills and incineration, promoting sustainability by using recycled woods and plastics, reducing landfill waste.
— reduced demand for virgin timber, conserving forests and biodiversity.
— lower greenhouse gas emissions throughout lifecycle compared to conventional wood or plastic materials.
— long–lasting, low–maintenance products resulting in fewer replacements and less resource use, having a long lifespan and can be cost–saving over time.
— enhancement of local economies through waste valorisation and new industrial opportunities.
— offer good dimensional stability against moisture and temperature changes, being resistant to rot, decay, termites, and insects.
— require low maintenance and do not need painting or sealing like traditional wood.

In the same time, various challenges in adopting and developing WPCs are:
— compatibility between hydrophilic wood fibres and hydrophobic plastics can be a barrier to strong bonding without proper coupling agents.
— complex recycling at end of life can be complex due to mixed composite nature requiring specialized processing which requires careful moisture control of wood fibres to prevent defects.
— variability in recycled feedstock quality impacting consistency and performance, in

this sense high wood content composites may have reduced strength and water resistance.
- need for infrastructure and market mechanisms supporting collection and reuse.
- balancing mechanical properties with high recycled content without compromising durability.
- costs can be higher than traditional plastics or untreated wood, depending on quality and additives.

Overall, WPCs represent a versatile, sustainable building and manufacturing material solution that balances wood's natural properties with plastic's durability and weather resistance, making them popular for decking, cladding, fencing, and outdoor furniture applications. Wood Plastic Composites contribute significantly to circular economy principles by:

- Waste valorisation
  - Utilize post–consumer plastic waste and wood residues, reducing landfill burden
  - Transform low–value waste into high–performance materials
- Resource efficiency
  - Reduce demand for virgin timber and plastics
  - Extend product life through durability and resistance to decay
- Recyclability
  - WPCs can be mechanically recycled into new composite products
  - Suitable for closed–loop recycling systems in construction and furniture industries
- Environmental benefits
  - Lower carbon footprint compared to pure plastic or treated wood
  - Reduced deforestation and plastic pollution

CONCLUDING REMARKS

Wood–Plastic Composites (WPC) are considered sustainable composites due to several key reasons:

- Use of recycled and renewable materials: WPCs are manufactured primarily from recycled wood fibres (such as sawdust, wood flour, or agricultural residues) and recycled or virgin thermoplastics like polyethylene, polypropylene, or PVC. This reduces reliance on virgin timber and virgin plastics, conserving natural resources and diverting waste from landfills.
- Waste valorisation: WPC contributes to sustainable waste management by utilizing industrial wood residues and recycled plastics, closing the loop on these waste streams and reducing environmental pollution.
- Reduced environmental impact: By incorporating significant amounts of recycled content, WPC production helps minimize deforestation and plastic waste, promoting circular economy principles. The lifecycle carbon footprint of WPC products is often lower than solid wood or pure plastics because wood fibres sequester carbon and manufacturing generally consumes less energy.
- Durability and longevity: WPCs are resistant to moisture, decay, termites, and UV damage, which extends their service life substantially beyond traditional wood alternatives. Longer lifespan means fewer replacements and less raw material consumption over time, contributing to resource efficiency.
- Low maintenance: Unlike natural wood, WPC does not require frequent painting, staining, or sealing. This reduces the use of additional chemicals and resources during the product's service life, lowering overall environmental impact.
- Energy efficiency in manufacturing: The presence of wood fibres lowers melting temperature and energy needs during processing compared to pure plastics. WPCs can often be processed using existing plastic manufacturing equipment without costly modifications.
- Design versatility: WPCs can be engineered to mimic wood's natural aesthetics while enhancing mechanical strength and weather resistance, making them desirable in construction, furniture, decking, and automotive applications–areas where sustainability considerations are increasingly important.

Wood–Plastic Composites (WPCs) represent a transformative material innovation that aligns with the principles of the circular economy by converting post–consumer and post–industrial waste into durable, high–value products. Comprising recycled thermoplastics and lignocellulosic fibres, WPCs offer a sustainable alternative to traditional materials in sectors such as construction, automotive, and consumer goods.

In conclusion, WPCs blend the ecological benefits of renewable wood fibres with the durability and recyclability of plastics, resulting in sustainable composite materials that promote resource conservation, waste reduction, and long–term environmental benefits ideal for modern green building and manufacturing.

The growing emphasis on sustainability and circular economy principles has underscored the need for innovative strategies to reduce our environmental impact. Wood–based waste, produced in large volumes globally, remains an underutilized resource with significant potential for green production and value–added applications.

References

[1] Ashori, A. (2008). Wood–plastic composites as promising green–composites for automotive industries!. Bioresource technology, 99(11), 4661–4667.

[2] Lee, S. H., Antov, P., Kristak, L., Reh, R., & Lubis, M. A. R. (2023). Application of wood composites III. Applied Sciences, 13(11), 6712

[3] Friedrich, D. (2022). Success factors of Wood–Plastic Composites (WPC) as sustainable packaging material: A cross–sector expert study. Sustainable Production and Consumption, 30, 506–517.

[4] Tang, K. H. D. (2022). Valorization of plastic waste through incorporation into construction materials. Civil and Sustainable Urban Engineering, 2(2), 96–109.

[5] Sommerhuber, P. F., Welling, J., Krause, A. (2015). Substitution potentials of recycled HDPE and wood particles from post–consumer packaging waste in Wood–Plastic Composites. Waste management, 46, 76–85.

[6] Babatunde, F. O., Omotayo, A. B., Oluwole, O. I., Ukoba, K. (2021). A review on waste–wood reinforced polymer matrix composites for sustainable development. In IOP Conference Series: Materials Science and Engineering (Vol. 1107, No. 1, p. 012057). IOP Publishing.

[7] Braghiroli, F. L., Passarini, L. (2020). Valorization of biomass residues from forest operations and wood manufacturing presents a wide range of sustainable and innovative possibilities. Current Forestry Reports, 6(2), 172–183.

[8] Soni, A., Das, P. K., Yusuf, M., Ridha, S., Kamyab, H., Chelliapan, S., Mussa, Z. H. (2024). Valorization of post–consumers plastics and agro–waste in sustainable polymeric composites for tribological applications. Waste and Biomass Valorization, 15(3), 1739–1755.

[9] Teacă, C. A., Shahzad, A., Duceac, I. A., Tanasă, F. (2023). The Re–/Up–Cycling of Wood Waste in Wood–Polymer Composites (WPCs) for Common Applications. Polymers, 15(16), 3467.

[10] Petlitckaia, S., Barboni, T., Quilichini, Y., Tihay-Felicelli, V., Santoni, P. A. (2024). Valorization of plastic HDPE and cork wastes in the design of composite materials. In Macromolecular Symposia, Vol. 413, No. 4, p. 2300233.

[11] Stark, N., Cai, Z. (2021). Wood–based composite materials: panel products, glued laminated timber, structural composite lumber, and wood–nonwood composites. Chapter 11 in FPL–GTR–282, 11–1

[12] Wechsler, A., Hiziroglu, S. (2007). Some of the properties of wood–plastic composites. Building and Environment, 42(7), 2637–2644.

[13] Bhaskar, K., Jayabalakrishnan, D., Kumar, M. V., Sendilvelan, S., Prabhahar, M. (2021). Analysis on mechanical properties of wood plastic composite. Materials Today: Proceedings, 45, 5886–5891.

[14] El–Haggar, S. M., Kamel, M. A. (2011). Wood plastic composites. Advances in composite materials: analysis of natural and man–made materials. London: In Tech, 325–344.

[15] Basalp, D., Tihminlioglu, F., Sofuoglu, S. C., Inal, F., Sofuoglu, A. (2020). Utilization of municipal plastic and wood waste in industrial manufacturing of wood plastic composites. Waste and Biomass Valorization, 11(10), 5419–5430.

[16] Martins, G., Antunes, F., Mateus, A., Malça, C. (2017). Optimization of a wood plastic composite for architectural applications. Procedia Manufacturing, 12, 203–220.

[17] Doustmohammadi, N., Babazadeh, R. (2020). Design of closed loop supply chain of wood plastic composite (WPC) industry. Journal of Environmental Informatics, 35(2), 94–102.

[18] Ribeiro, L. S., Stolz, C. M., Amario, M., Silva, A. L. N. D., Haddad, A. N. (2023). Use of post–consumer plastics in the production of wood–plastic composites for building components: a systematic review. Energies, 16(18), 6549.

[19] Lanzoni, S., Guardigli, L. (2024, November). Wood Plastic Composites in Construction: Recycling and Reuse. In Construction Management Workshop (pp. 393–409). Cham: Springer Nature Switzerland

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