The Eurasia Proceedings of Science, Technology, Engineering & Mathematics (EPSTEM)
ISSN: 2602-3199

The Eurasia Proceedings of Science, Technology, Engineering and Mathematics (EPSTEM), 2025

Volume 38, Pages 337-348

IConTES 2025: International Conference on Technology, Engineering and Science

Eco-Friendly Recovery Method for Manufacturing Flexible Paver's Tile Construction from Waste Plastics

Roua'a K. Al-Ojar
University of Mosul

Yonis Ahmed Ismael
Ninevah University

Akram. W. Nayyef
University of Telafer

Ghadeer Amer Muhamed
University of Mosul

Fawzi Habeeb Jabrail
University of Mosul

Abstract: Different plastic wastes were manufactured into paver's tiles, which hardened using polyurethane binder. The waste of the most common engineering plastics known high density polyethylene, low density polyethylene, polypropylene, poly (vinyl chloride), poly (ethylene terephthalate), polycarbonate, and polystyrene were they washed, ground, extruded with heat, held with resin and finally pressed into special molds. Two types of tiles are manufactured with a surface area 15 x 15 cm^2 and 30 x 30 cm^2 have of 5 cm^2 thick. The manufactured paver's tiles were characterized by Fourier Transform Infrared spectroscopy, Field-Emission Scanning Electron Microscope, X-ray diffraction, and thermal analysis (Thermogravimetric analysis and Differential scanning calorimetry), in conjunction with mechanical and physical tests include compression strength, tensile strength, flexural strength, Charpy impact energy, surface roughness, and Rockwell hardness. Water absorption percentage and dimensional stability are the physical tests of the prepared paver's tiles. Polyurethane held plastic tiles show highly strength construction paver's tiles have hydrophobic nature and dimensionally stable.

Keywords: Polymer waste, Polyurethane binder, Alternative building materials, Plastic construction tiles, Enhancing mechanical qualities

Introduction

Now waste is a global problem, and one that must be treated in order to solve the world's resource and energy challenges (Bhawan, 2013; Basale et al. 2018)) specially the emerging plastic waste which is a major challenge to the environment. The use of plastic waste in civil engineering construction projects demands special attention to tackle this problem and enhance the project's economic aspects (Lamba et al. 2022; Thakur & Singh, 2021). Where recycling and reuse are considered solutions that reduce the volume of waste that is daily destined to sanitary landfills. It is important to plan and use tools such as management to harmonize time, wear, and amount of material (Lamba et al. 2022; Marques, & Ferreira Lima 2021). It is good to utilize plastic waste into useful construction material an attempt is made to utilize plastic in manufacturing of tiles with suitable proportions (Mohana & Gayathrib, 2019). Studies have shown that the plastics bricks and paver blocks product which can be used for long term applications and their durability and strength is also so high in absorbed test results. In addition, it will increase the raw materials for the construction's purposes and will solve the solid waste management problem (Kumar & Kumar, 2022). Recently, composite materials have obtained an advantage as replacements for traditional metals in component design and production. Today, fiber-reinforced polymer composites have become the preferred choice for a great proportion of the engineering materials market, with applications ranging from everyday products to advanced technologies. Efforts are still ongoing to seek more natural fibers that can effectively substitute synthetic ones (Agbo, 2025; Agbo, 2025). It may be useful to experiment with using plastic waste in concrete to overcome the dual issues of shortage of raw material and safe disposal of plastic waste. An attempt has been made to study the use of waste plastic mix concrete to get the advantages of plastic in concrete (Yaligar et al. 2018). For refractory manufacturers, selecting a suitable binder additive is therefore of decisive importance to increase production efficiency and to set the desired product quality (Hopp et al. 2021).

Many studies were investigated different binders that use for bonding the various layers of composite materials in the tiles such as epoxy, polyester, and a number of other resins compatible with the corresponding polymer matrices (Terekhov& Chistyakov, 2022), and in this context, unsaturated polyester resin with plastic was used as reinforcement in wall and floor coverings tiles (Halimi et al. 2017).

Among the plastics used, low-density polyethylene (LDPE) plastic waste was utilized in the manufacture of floor tiles by mixing fine sand with molten plastic waste in different proportions (Jock et al. 2022). Low-density polyethylene (LDPE) also can manufacture tiles and bricks from its waste, and comparative analysis of tiles made from traditional ceramic tiles to the conventional bathroom tile having the same dimension and flexural strength. Therefore, it is reasonable to say that the market for plastic recycling managing solid waste generally involves planning, financing, construction and operation of facilities for the collection, transportation, recycling and final disposition of the waste.

Polyethylene terephthalate (PET), the polyester resins is known for its excellent combination of properties such as dimensional stability, mechanical, thermal, chemical resistance (Raut et al. 2020), for these properties is added in concrete (Al-Hadithi & Alani, 2015). In addition, PET waste bottles and palm oil fuel ash (POFA) can be used to produce long-lasting, good strength, and highly low-water-absorption eco-friendly wall tiles or both residential and commercial applications .This possibility of producing tiles from PET waste and POFA would also serve as a waste diversion to reduce environmental pollution generated by plastic waste, not only reduce the cost of construction materials but use in construction industry (Tomar & Butala, 2020; Omosebi & Noor, 2022). PET is performed to reduce energy consumption in the construction sector and improve waste management resulting in an eco-friendly environment (Halim et al. 2019). PET particles reduce the requirement of fine aggregate, increase resistance to corrosion, and make the concrete lighter (Araghi et al. 2015; Rahmani, 2013; Alighiri et al. 2019) This provides evidence that the addition of PET plastic into construction materials in the form of plastic flakes can produce fine aggregate (Foti, 2013; Alighiri et al. 2019). Polycarbonate (PC) can reinforce the PET waste plastics tile using direct recycle process without chemical conversion by mechanical shredding with thermal press (Ahmed & Jabrail, 2024; Al-Hadithi & Alani, 2015). The tiles made from recycled poly (vinyl chloride) PVC waste collected from industries with epoxy resin and hardener were mixed and cast. Their produced tiles have higher flexural resistance and lower specific weight than ceramic tiles (Ahmed & Jabrail, 2024; SHALU et al. 2017). Polypropylene (PP), the common thermoplastic commodity plastic is also used in manufacturing of tiles due to its properties (Kashiyani et al. 2013), such as semi-rigid, low density, high crystalline, resist chemicals, good toughness, high mechanical strength, good heat resistance (Charles, 2000; Murahari & Rao, 2023).

In this study, the following plastic waste were used : high density polyethyelen (HDPE), low density polyethylene (LDPE), polypropylene (PP), poly(vinyl chloride) PVC, Polystyrene (PS), polycarbonate (PC), and polyethylene terphthalate (PET), for manufacturing plastic tiles with a surface area 15 x 15 cm^2 and 30 x 30 cm^2 have of 5 cm^2 thick.The binder polyurethane was used in between the plastic particles to form tiles. The manufactured tiles were characterized using the important mechanical and climate resistance tests. In addition, the tiles components were analyzed by FTIR, XRD, thermal analysis (TGA, DSC), and FESEM techniques.

Experimental

The following plastic wastes HDPE, LDPE, PP, PVC, PS, PC, and PET were purchased from the domestic industries in Mosul, Iraq. Where the factories collected the plastic waste from landfills in Mosul and classified each according to their types. The waste is washwith detergent and water, and grind into small pieces (about

5mm), and prepared for manufacturing processes. The binder polyurethane was purchased from Akfix (P645) Automotive and construction PU Sealant, China. A hydraulic press designed with a maximum pressure of 30.0 tons was manufactured in Mosul, Iraq. Tiles molds of surface area (15 x 15 cm^2) and (30 x 30 cm^2) have of (5 cm^2) thick with cover using (10 mm) steel plates were manufactured in Mosul, Iraq. Finally, for heat treatment of the waste, an extrusion machine containing a heater of (2000 W) was designed and manufactured by a local factory in Mosul, Iraq.

Manufacturing of Tiles from Plastic Waste

Different weights of plastic waste with a total weight of (450 g) and (900 g) were found sufficient to press inside the mold area of (15 x 15 x 5) cm^3 and (30 x 30 x 5) cm^3 respectively. Therefore, the exact weight of each plastic waste (Table 1) were transferred into the extrusion machine for extrusion at 200ºC. The molten plastic coming out of the machine was taken into the mold and (1.0 % v/ w) polyurethane binder is added to the plastic melt inside the mold. The mold is then covered with a lid and moved to the hydraulic press, applying (207 Mpa) (15 ton in^{-2}) pressure for (15 minutes). The tile is extracted from the mold and subjected to mechanical and physical checks.

Table 1. The types of the plastic waste and their weights used for preparing (15 x 15 x 5) cm^3, and (30 x 30 x5) cm^3 tiles

Plastic waste	15X15X5cm^3 Weight (g)	30X30X5cm^3 Weight (g)
HDPE	92.5	185
LDPE	92.5	185
PP	77.5	155
PVC	87.5	175
PC	45	90
PET	45	90
PS	10	20
Total	450	900

Mechanical Tests of Tiles

Compression Strength Test

The test represent a structural element that resist loads and gives a reduction in the size of the tested material. The test also represent a force applied to the measured sample from both its direction (top and bottom) until it is fractured or deformed. A universal testing machine for the compression strength tests was used , and the following Eq. (1) was followed:

$$\text{Compressive strength } (\sigma) = \frac{P}{A} \qquad (1)$$

Where; (P) represent the maximum load in (N), and (A) is the cross sectional area of the sample (m^2).

Tensile Strength Test

Tensile strength represent the maximum stress that applied to a specimen that it can resist while being pulled before breaking. A universal tensile testing machine was aplied for measuring tensile strength with the following Eq. (2):

$$\text{Tensile strength } (S) = \frac{P}{A} \qquad (2)$$

Where (P) represent the force required to break (N), and (A) represent the cross-sectional area (m^2).

The elongation, which is the change in the length of the sample in compareson with the original length before breaking. elongation percentage can be calculated from tensile strength according to the following Eq. (3):

$$\text{Elongation } (\%) = \frac{L_f - L_0}{L_0} \text{x}100 \qquad (3)$$

Where (L_f) represent the final length, and (L_0) represent the original length of the sample.

Flexural Strength Test

Flexural strength represent a mechanical parameter that appears the material can withstand deformation under a fixed load. The Toni ZEM-Model 1548 represent the machine which used, and the following Eq. (4) was followed:

$$\text{Flexural strength } (f) = 3PL/2bd^2 \qquad (4)$$

Where (P) represent the maximum load (N), (L) represent the supported length (m), (b) represent the width (m), and (d) represent the failure point depth (m).

Impact Test

The Charpy impact test represent a standardized high stress rate test, it can measure the energy absorbed by the specimen while breaking under a fixed load. The Charpy impact test was done using an advanced universal pendulum tester, and Eq. (5) is followed:

$$\text{Impact test} = W.\ L\ (\cos\alpha - \cos\beta) \qquad (5)$$

Where (W) represent the weight of the pendulum, (L) represent the length of the pendulum, (α) represent the angle, and (β) represent a constant. The values of impact test can be used for determination the toughness Eq. (6), and toughness represents the ability to absorbing energy by the material and deform without fracturing.

$$\text{Toughness} = \frac{\text{impact energy}}{\text{area of the specimen}} * 100 \qquad (6)$$

Rockwell Hardness Test

The Rockwell hardness test represent a method that gives the resistance of a material to indentation. The test was done by KARL KOLB Rockwell hardness tester from Germany, and the following Eq. (7) was followed:

$$HR = N - \left(\frac{d}{D}\right) \qquad (7)$$

Where (N) represent the load applied (N), (d) represent the depth of the indentation (m), and (D) represent the diameter of the ball (m).

Climate Resistance Tests

Relative Humidity (RH) Test

The test carried by drying the examined specimen in an oven at 80°C for (6 hours), and after cooling in a desiccator then weight. The specimen is prolonged exposure to high humidity for (24 hours) at 25°C. Finally, the specimen is weighted, and the following Eq. (8) was followed:

$$\text{Relative humidity (RH) } (\%) = \frac{W_f - W_0}{W_n} * 100 \qquad (8)$$

Where (W_f) represent the final weight; and (W_o) represent the initial weight of the specimen.

Dimensional Stability Test of Resilient Tile

Dimensional stability of resilient tile test covers the limitation of the changes in their linear dimensions when exposure to heat. The test measure the exact length, width, and, height of the specimen. Thereafter, the specimen is placed in an oven at 82ºC for (6 hours). The specimen is taken out and kept at room temperature for (24 hours). The Eq. (9) was followed:

$$\text{Dimensional stability (\%)} = \frac{V_f - V_i}{V_i} * 100 \qquad (9)$$

Where (V_f) represent the final volume; and (V_i) represent the initial volume of the specimen.

Characterization of Tiles

The tiles were characterized by the following techniques and their instruments:

XRD using a Philips X-ray diffractometer (PW1730). FT-IR using a Shimadzu FT-IR 8400 s spectrometer, Japan. TGA and DSC was done using TA Instruments DSC SDT Q600 V 20.9 build 20, USA. The Ref. Al_2O_3, and heat rate: (80ºC. min^{-1}) from room temperature to 700ºC,.TESEM using a TESCAN MIRAFSEM, Czech Republic.

Results and Discussion

Polymers face many challenges including landfill cumulative waste, performance limitations, environmental impact, safety and health concerns. Therefore, developing recycling methods is the goal of many studies, and aiming to reach cheap, effective, and simple methods. On the other hand, huge quantities of plastic waste make environmental pollution worse. The most common plastics in the world are PVC, PP, PS, HDPE, LDPE, PET, PC and their wastes in native form can be recycled in one method for manufacturing tiles which can be used in floor paving.

Characterization of Tiles

FT-IR Spectroscopy

The FT-IR spectroscopy of the tiles were measured, and the absorption frequencies of their main functional groups are given in Table 2.

Table 2. FT-IR absorption frequencies of the main functional groups of control sample and tile specimen prepared with binder

Specimen	ɤ(O-H) str.	ɤ(C-H) str. aliph.	ɤ(C-H) str. arom.	ɤ(C=O) str.	ɤ(C=C) str. arom.	ɤ(-CH2)	ɤ(-CH3)	ɤ(C-O) str.	ɤ(C-O-C) asymm.	ɤ(C-H) str. arom.	ɤ(C-Cl)
Control without polyurethane	3431	2918 2849	3057	1730	1647	1468	1375	1267	1074	721	633
Specimen	ɤ(N-H) str.	ɤ(O-H) str.	ɤ(C-H) str.	ɤ(C=O)str.	ɤ(N-H) in plane	ɤC-H)str. arom.	ɤ(-CH2)	ɤ(C-N) str.	ɤ(N-H)bend out of plane	ɤ(C-H) str. arom.	ɤ(C-Cl)
Tile With polyurethane	3416	....	2959, 2841	1678	1541, 1514	1456	....	1314	721	723	517

The FT-IR absorption frequencies of the control sample (a tile prepared without binder), shows (Fig. 1, Table 2) the main functional groups of different polymer waste that the tile contains. The absorption frequency peak at 3431 cm^{-1} is belongs to γ(O-H) str group, which comes from PET and PC. (Kumar et al. 2016) The peaks at 2918 cm^{-1} and 2849 cm^{-1} represent γ(C-H) str of aliphatic methine groups. The peak at 3057 cm^{-1} represent γ(C-H) str of aromatic methine groups. The peak at 1730 cm^{-1} represent carbonyl group γ(C=O) str, which belongs to PET and PC polymers. The peak at 1647 cm^{-1} represent to γ(C=C) str belongs to aromatic rings of PS, PET, and PC polymers. PVC shows peak at 633 cm^{-1} represent γ(C-Cl) group. Otherwise, the FT-IR spectrum of the tile prepared with polyurethane binder shows (Table 2, Fig. 1) all the peaks of the control sample, besides a strong peak at 3416 cm^{-1} representing γ(N-H) str of the polyurethane binder.In addition to the peaks at (1541,1514) cm^{-1} , 1314cm^{-1} and 721cm^{-1} which belonds to γ(N-H) in plane, γ(C-N)str and γ(N-H)bend (out of plane), respectively.

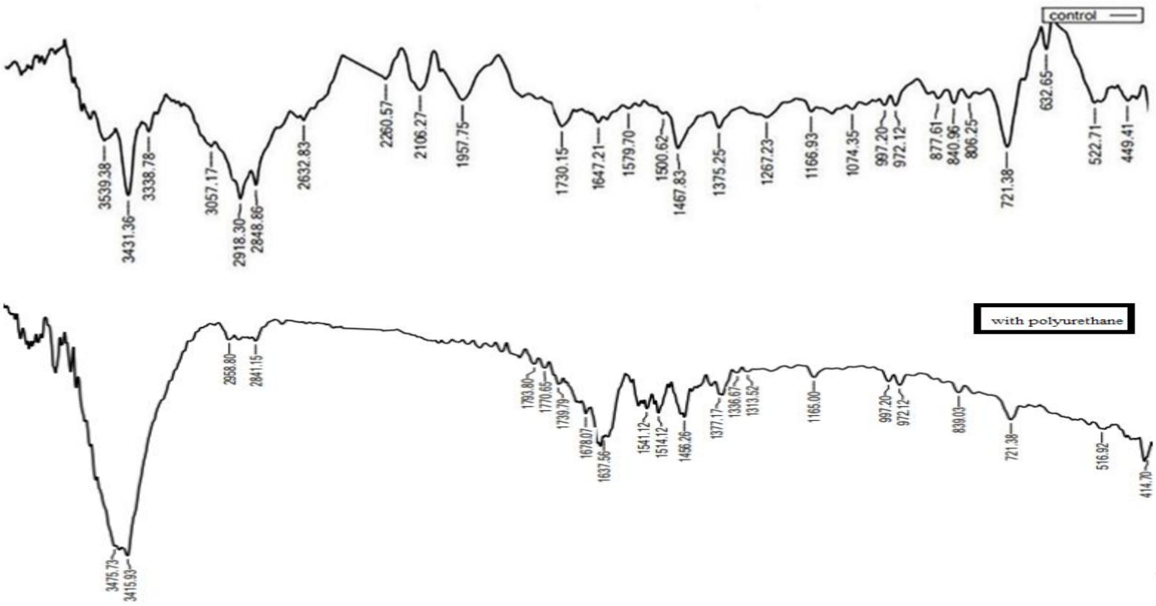

Figure 1. FT-IR spectrum of control sample and tile specimen prepared with polyurethane binder

Thermal Study (TGA and DSC)

The thermograms (TGA and DSC) of control specimen and bonded tile with polyurethane shows both specimens are thermally stable. The TGA thermogram of the control specimen shows lower initial decomposition temperature, final decomposition temperature, maximum decomposition temperature and crystalline decomposition temperature (Fig. 2 and 3, Table 3), with higher weight loss (%) compared with the tile specimen of polyurethane binder, which indicates that adding polyurethane to the tile will elevate its thermal stability.

Table 3. TGA and DSC thermal analysis of control sample and tile specimen prepared with polyurethane

Specimen	**IDT**	**FDT**	**Tmax**	**Tcr**	**Tg (°C)**	**Δ Hf (J g⁻¹)**
	0.1	82.0	41.0	78.0		922.2; 996.1
Control without polyurethane					96.0	
	45°C	620°C	450°C	500°C		94.1°C; 357.7°C
	0.08	76.0	40.0	72.5		1013; 301.6; 230.7
Tile with polyurethane					159.0	
	50°C	620°C	475°C	510°C		159.0°C; 479.2°C; 560.1°C

As will as, the DSC thermograms shows glass transition temperature (Tg) of the control specimen 96.0ºC, whereas it is 159.0ºC for the tile specimen prepared with polyurethane. The heat of fusion (ΔHf) from the DSC thermogram shows (Fig. 2 and 3, Table 3) that both have endothermic maxima, with two (ΔHf) for the control specimen, while the tile specimen with polyurethane shows three (ΔHf), where the third one belongs to the polyurethane binder. Finally, the TGA and DSC data (Fig. 2 and 3, Table 3) show that the tile specimen with polyurethane has high thermal stability compared to the control specimen. (Gonzalez et al. 2017).

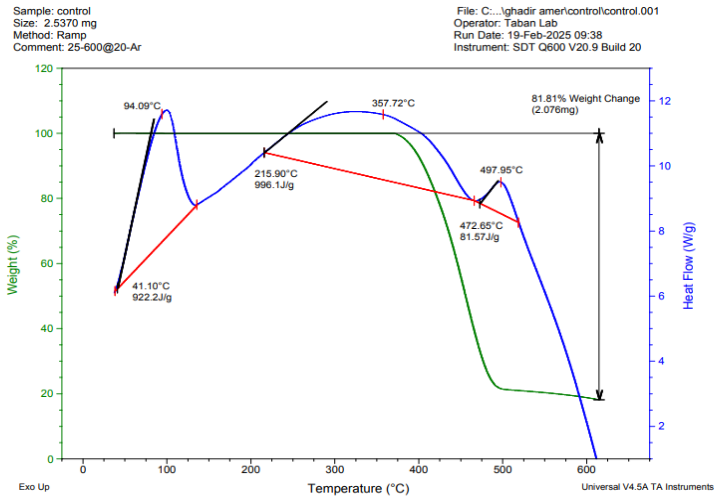

Figure 2. TGA and DSC thermogram of control specimen

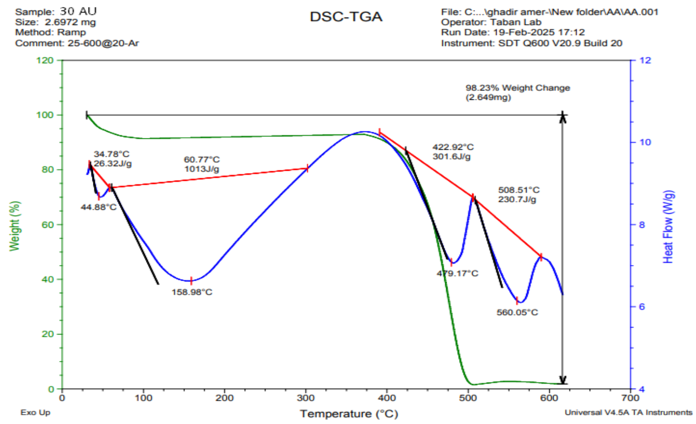

Figure 3. TGA and DSC thermogram of tile specimen prepared with polyurethane

FESEM Study

The FESEM image of the control specimen (Fig. 4) shows a week cohesion between the different components of the tile materials. The control specimen shows non-homogeneous surface morphology contains folds and some crystalline regions. Moreover, the FESEM image of the tile specimen with polyurethane (Fig. 5) shows a homogeneous surface morphology. The polyurethane binder works to increase the cohesion of the plastic components and make its surface more crystalline, with entangled fibers, non-smooth surface, and and the appearance of a frequent folds.

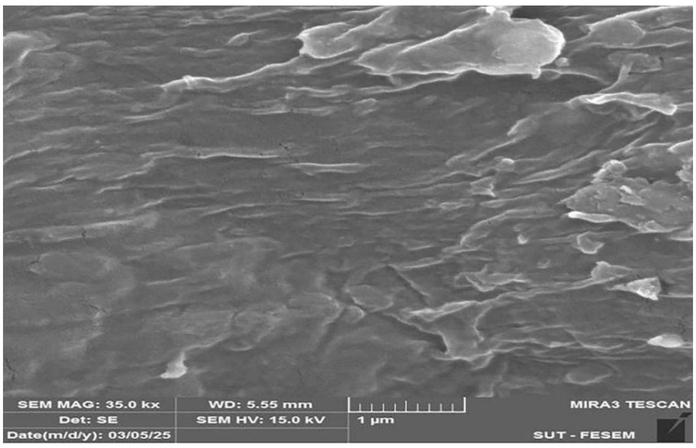

Figure 4. FESEM image of control specimen

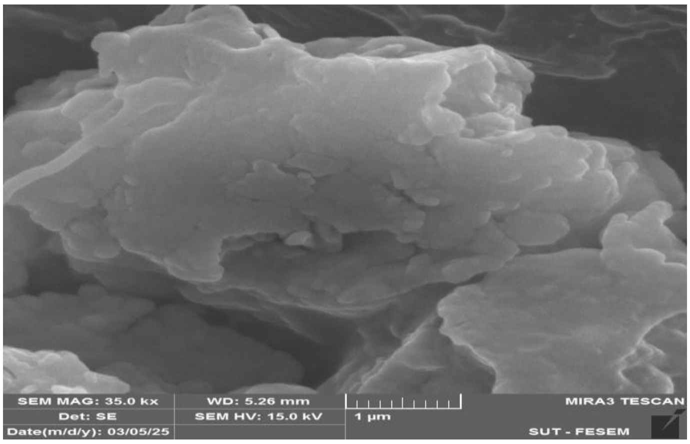

Figure 5. FESEM image of tile specimen prepared with polyurethane

XRD Study

The X-ray diffraction pattern of the control specimen (Fig. 6) shows that the specimen has a crystalline structure. Different types of plastics, after being heated, compressed, and cooled, give tiles that show in XRD pattern (Fig. 6) a number of peaks with different relative intensities representing the crystalline structure of the used plastic materials. On the other hand, the use of polyurethane binder for cohesion of plastic components in produced tiles its XRD pattern (Fig. 7) shows an increase in crystalline peaks with high intensity. This means that the polyurethane binder could promote the crystalline structure of the produced tiles, which in turn enhance its strength. (Abebe et al. 2025)

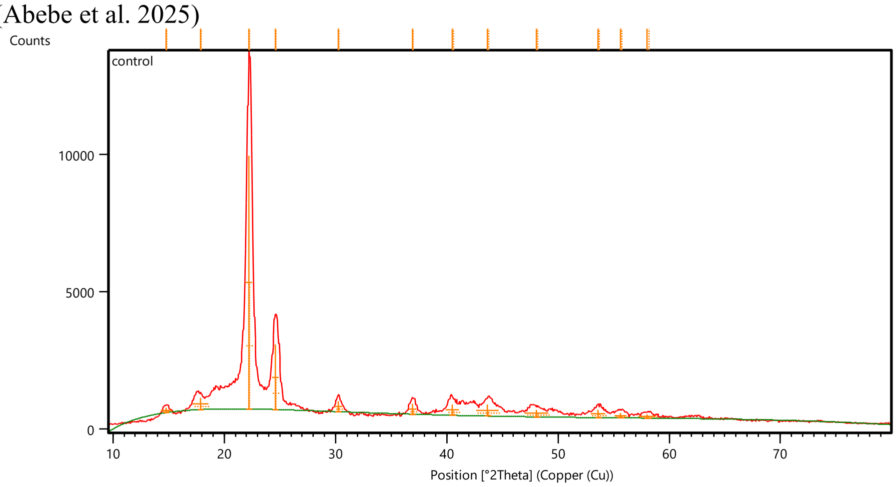

Figure 6. XRD pattern of control specimen

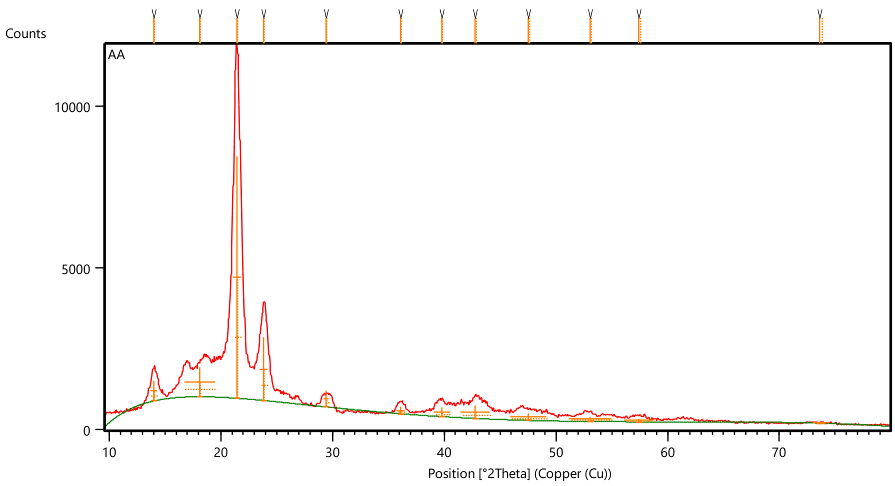

Figure 7. XRD pattern of tile specimen prepared with polyurethane

Mechanical Tests

Different mechanical tests of the control specimen and tiles prepared with a polyurethane binder have been done, and their data are given in (Table 4). The compression strength (σ) of the tested specimen, calculated from Eq. (1), reveals that the control specimen has (15.0) MPa, whereas the tile specimen with polyurethane gives (31.6) MPa, which means the latter shows higher resistance to compression, and the polyurethane binder gives excellent performance across a hardness range. (Wang et al. 2023)

Table 4. Mechanical data of control sample and tile specimen prepared with polyurethane

Specimen	Compression Strength (σ) (Mpa)	Flexural Strength (f) (Mpa)	Ultimate Tensile Strength (σ) (Mna)	Elongation (%)	Hardness Rockwell	Charpy Impact energy (J)	Toughness J (cm^{-3})
Control	15.0	4.48	27.7	9.4	43HHR	25.5	77.6
Tile with polyurethane	31.6	12.2	58.0	19.0	98HHR	35.5	175.7

The ultimate tensile strength (σ) beside the elongation (%) of both specimens have been calculated (Eq. (2) and (3)), where the control specimen shows (Table 4) an ultimate tensile strength(σ) of (27.7) MPa and elongation of (9.4 %), while the tile with polyurethane binder, give ultimate tensile strength (σ) (58.0) MPa and elongation of (19.0%) (Table 4). The tile with polyurethane binder has a higher ultimate tensile strength and elongation (%) because of the non-linear behavior of the polyurethane, which gives excellent performance to the tiles through a hardness range. (Ding et al. 2022) In addition, both specimens show higher elongation (%), which means they have flexible and ductile properties and can stretch before they break. (Gabriel et al. 2020).

Flexural strength test, which is one of the important mechanical tests, calculated according to Eq. (4) shows (4.48) MPa for the control specimen and (12.2) MPa for the tile prepared with polyurethane binder (Table 4). The results show that the tile prepared with polyurethane binder has very good flexural strength (Seydibeyoglu et al. 2013) because mixing plastic waste with polyurethane resin increase cohesion, and give resist bending under external force.

Charpy impact energy was measured and its magnitude is calculated according to Eq. (5), it gives for the control specimen (25.5 J) and (35.5 J) for the tile specimen prepared with polypolyurethane (Table 4). The Charpy impact energy value increase for polyurethane tile because it reinforces the plastic particles in the tile. (Harusa et al. 2021). The toughness parameter is calculated from impact energy value according to Eq. (6), which shows for the control specimen (77.6 Jcm^{-3}), while it is (123.7 J cm^{-3}) for the tile specimen prepared with polyurethane (Table 4). The high value of the toughness parameter for the tile with polyurethane is because the binder increases the strength of the tiles and makes them not easily broken or damaged.

The Rockwell hardness test, which uses a depth differential method for the hardness and its result was obtained from Eq. (7). The Rockwell hardness for the control specimen is 43HHR, while for the tile specimen with polyurethane binder is 98HHR (Table 4). The Rockwell hardness value is higher for the tile with polyurethane, which means the specimen is harder than the control specimen, but still, it is ductile.

Climate Resistance Tests

Relative Humidity (RH) Test

Table 5. Relative humidity (RH) (%); and dimensional stability test (%) of control sample and tile specimen prepared with polyurethane

Specimen	Relative humidity (RH) test (%)	Dimensional stability test (cm³) - before	Dimensional stability test (cm³) - after
Control	1.863	0.754	0.784
Tile with polyurethane	1.695	0.736	0.739

The prepared tiles have been measure their physical properties, including the relative humidity (RH) test, using Eq. (8) for calculation their values. The relative humidity (RH) (%) for the control specimen is (1.863%) while for the tile with polyurethane binder it is (1.695%) (Table 5), which means the relative humidity (RH) (%) for both specimens is very low because both are hydrophobic. Where, plastic materials absorb humidity to a limited degree and are ordinarily waterproof (Baschek et al. 1999).

Dimensional Stability of Resilient Tile Test

The second important physical test is dimensional stability test which is performed by exposure the tile to heat. The dimensional stability data are calculated from Eq. (9) and the values of both specimens before and after treatment are very close (Table 5), and once again, the tiles use polyurethane binder shows more dimensionally stable due to their thermal stability (Fig. 3, Table 3).

Conclusions

Plastic waste of the most consumed types of polymers were recycled and manufactured as paver's tiles that could be used in constructions as alternative materials. The most famous plastics were used in different weight percentages selected according to their cohesion, mechanical, ductile, and physical properties. Tiles of (15 x 15 x 5) cm^3 and (30 x 30 x 5) cm^3 size were manufactured using (450g) and (900 g) of plastic waste, respectively. The surface area of the tiles shows no big differences in their mechanical properties. For comparison purposes, tiles were manufactured with and without polyurethane resin and the results show the bonded plastic particles by polyurethane resin produce tiles have high mechanical and physical qualities in comparison with the control specimen prepared without polyurethane.

Scientific Ethics Declaration

* The authors declare that the scientific ethical and legal responsibility of this article published in EPSTEM journal belongs to the authors.

Conflict of Interest

* The authors declare that they have no conflicts of interest

Funding

* This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Acknowledgements and Notes

* This article was presented as a poster presentation at the International Conference on Technology, Engineering and Science (www.icontes.net) held in Antalya/Türkiye on November 12-15, 2025.

* The authors are grateful to University of Mosul for providing the facilities to carry out this work.

References

Abebe, Y., Palania, S., & Sirahbizu, B. (2025). Effect of Al2O3 nanoparticle on mechanical properties of polyester glass-wool fiber reinforced polymer composites. *Hybrid Advances, 10*, 100472.

Agbo, C. O. A. (2025a). Mechanical performance of rattan cane wood fiber reinforced polymer at high temperatures. *Academia Materials Science, 2*.

Agbo, C. O. A. (2025b). Study on the behavior of cane wood fiber–reinforced polymer composites for application in design. *Academia Materials Science, 2*.

Ahmed, A. W., & Jabrail, F. H. (2024). Composite construction tiles manufactured from PET and other waste plastics reinforced with polycarbonate and study their mechanical properties. *Pharmacognosy Journal, 16*(2), 241–248.

Al-Hadithi, A. I., & Alani, M. F. A. (2015). Mechanical properties of high performance concrete containing waste plastic as aggregate. *Journal of Engineering, 21*(8), 100–115.

Alighiri, D., Yasin, M. N., Rohmawati, B., & Drastisianti, A. (2019). Processing of recycled waste PET (polyethylene terephthalate) plastics bottle into for the lightweight and reinforcement bricks. *Journal of Physics: Conference Series, 1321*(2), 022023.

Araghi, H. J., Nikbin, I. M., Reskati, S. R., Rahmani, E., & Allahyari, H. (2015). An experimental investigation on the erosion resistance of concrete containing various PET particles percentages against sulfuric acid attack. *Construction and Building Materials, 77*, 461–471.

Basale, K., Jagtap, P., Midgule, Y., & Hulpale, M. (2018). Manufacturing and testing of plastic tiles. *Journal of Advances and Scholarly Researches in Allied Education, 15*(2), 638–685.

Baschek, G., Hartwig, G., & Zahradnik, F. (1999). Effect of water absorption in polymers at low and high temperatures. *Polymer, 40*(12), 3433–3441.

Central Pollution Control Board. (2013). *Overview of plastic waste management*. Ministry of Environment, Forest and Climate Change.

Ding, C., Xing, Z., Wang, Z., Qin, Z., Wang, J., Zhao, X., & Yang, X. (2022). The comprehensive effect of tensile strength and modulus on abrasive wear performance of polyurethanes. *Tribology International, 169*, 107459.

Foti, D. (2013). Use of recycled waste PET bottles fibers for the reinforcement of concrete. *Composite Structures, 96*, 396–404.

Gabriel, A., Solikhah, A., & Rahmawati, A. (2020). Tensile strength and elongation testing of starch-based bioplastics using melt intercalation method. *Journal of Physics: Conference Series, 1858*, 012028.

Gonzalez, M., Levi, M., & Turri, S. (2017). Development of polyester binders for the production of sustainable polyurethane coatings: Technological, characterization and life cycle assessment. *Journal of Cleaner Production, 164*, 171–178.

Halim, N. F. A., Azis, Z. A., Taib, N., & Ismail, H. (2019). Development of sustainable building material by incorporating plastic waste in concrete block. *The European Proceedings of Multidisciplinary Sciences*, 415–424.

Halimi, Y., Inchaouh, M., Zyade, S., & Tahiri, M. (2017). Characterization of a composite material reinforced by plastic waste: Application in the construction sector. *International Journal of GEOMATE, 13*(39), 172–178.

Harusa, S., Zhu, H., Jiang, W., & Shao, J. (2021). Evaluation of impact resistance properties of polyurethane-based polymer concrete for the repair of runway subjected to repeater drop-weight impact test. *Construction and Building Materials, 309*, 125182.

Hopp, V., Alavi, A. M., Hahn, D., & Quirmbach, P. (2021). Structure–property functions of inorganic chemical binders for refractories. *Materials, 14*(16), 4636.

Jock, A. A., Akpan, M., & Oluwadayo, F. A. (2022). Production and characterization of sand-plastic composite floor tiles. *Hungarian Journal of Industry and Chemistry, 50*(1), 29–32.

Kashiyani, B. K., Pitroda, J. K., & Shah, B. K. (2013). A study of utilization aspect of polypropylene fibre for making value added concrete. *International Journal of Scientific Research, 2*(2), 103–106.

Kumar, M., & Kumar, N. (2022). Analysis and utilization of waste plastic in building blocks through moulding process. *International Research Journal of Engineering and Technology, 9*(1), 895–907.

Kumar, R., Kamakshi, Kumar, M., & Awasthi, K. (2016). Functionalize Pd-decorated and aligned MWCNTs in polycarbonate as a selective membrane for hydrogen separation. *International Journal of Hydrogen Energy, 41*(48), 23057–23066.

Lamba, P., Kaur, D. P., Raj, S., & Sorout, J. (2022). Recycling/reuse of plastic waste as construction material for sustainable development: A review. *Environmental Science and Pollution Research, 29*, 86156–86179.

Marques, P. S., & Ferreira Lima, F. X. R. (2021). Planning and management for reuse of construction waste in compacted soil-cement blocks. *Academia Letters*, Article 2741.

Mohana, V., & Gayathrib, S. (2019). Effective utilization of plastic wastes in tile manufacturing: A step towards sustainability. *International Journal of Scientific Research and Engineering Development, 2*(3), 3670–3676.

Murahari, K., & Rao, R. M. (2013). Effects of polypropylene fibres on the strength properties of fly ash based concrete. *International Journal of Engineering Science Invention, 2*(5), 13–19.

Omosebi, T. O., & Noor, F. A. (2022). Tiles from recycled plastic bottle (PET) wastes and POFA: Strength properties and durability. *Civil Engineering and Architecture, 10*(4), 1253–1259.

Rahmani, E., Dehestani, M., Beygi, M. H. A., Allahyari, H., & Nikbin, I. M. (2013). Mechanical properties of concrete containing waste PET bottles as aggregate. *Construction and Building Materials, 47*, 1302–1308.

Raut, S. R., Makarande, S. G., & Kalmegh, V. A. (2020). Re-use of polyethylene plastic waste in concrete with plasticizer and test for compressive and tensile strength. *International Research Journal of Engineering and Technology, 7*(9), 3802–3804.

Seydibeyoglu, M., Misra, M., Mohanty, A., & Blaker, J. (2013). Green polyurethane nanocomposites from soybean and bacterial cellulose. *Journal of Materials Science, 48*(5), 2167–2175.

Shalu, S. A., Amrutkar, S., Pawar, D., Dere, M. D., Raut, C., & Shaikh, S. (2017). Utilization of plastic waste in manufacturing of plastic bricks. *International Journal of Research Publications in Engineering and Technology, 3*(6), 101–104.

Terekhov, I. V., & Chistyakov, E. M. (2022). Binders used for the manufacturing of composite materials by liquid composite molding. *Polymers, 14*(1), 87.

Thakur, A., & Singh, A. (2021). Review on utilization of waste plastic in civil engineering construction projects. *International Journal of Engineering Research & Technology, 10*(9), 243–251.

Tomar, A. R., & Butala, A. M. (2020). Experimental investigation on bricks using waste plastic materials. *International Journal for Scientific Research & Development, 8*(3), 195–197.

Wang, H., Yang, H., Gu, M., Du, G., Ni, K., Liu, S., Liu, T., Ran, X., Shi, Z., Gao, W., & Yang, L. (2023). Bonding properties of polyurethane enhanced by branched polyamine and wood interfacial activation. *Colloids and Surfaces A: Physicochemical and Engineering Aspects, 673*, 131860.

Yaligar, U. S., Mahashetty, M., Sarfaraz, M., & Aslam, M. (2018). Study on partial replacement of cement by waste plastic in concrete tiles. *IRE Journals, 2*(2), 35–40.

Author(s) Information

Roua'a K. Al-Ojar
University of Mosul
Mosul- Nineveh, Iraq
Contact rouaa.alojar@uomosul.edu.iq

Yonis Ahmed Ismael
Ninevah University, Pharmacy College
Mosul- Nineveh, Iraq

Akram. W. Nayyef
University of Telafer
Nineveh, Iraq

Ghadeer Amer Muhamed
University of Mosul
Mosul- Nineveh, Iraq

Fawzi Habeeb Jabrail
University of Mosul
Mosul- Nineveh, Iraq

To cite this article:

Al-Ojar, R.K., Ismael, Y. A., Nayyef, A. W., Muhamed, G.A., & Jabrail, F.H. (2025). Eco-friendly recovery method for manufacturing flexible paver's tile construction from waste plastics. *The Eurasia Proceedings of Science, Technology, Engineering and Mathematics (EPSTEM), 38,* 337-348.