Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering. Vol. XV, 2026
Print ISSN 2285-6064, CD-ROM ISSN 2285-6072, Online ISSN 2393-5138, ISSN-L 2285-6064

EXPERIMENTAL STUDY ON BRICKS MADE WITH BRICK WASTE AND SAWDUST

Mircea SĂLCUDEAN[1, 2], Maria POPA[3], Mirel GLEVITZKY[3, 4], Mihai Teopent CORCHEȘ[2]

[1]"Lucian Blaga" University of Sibiu, Doctoral School, Faculty of Engineering,
10 Victoriei Blvd, Sibiu, Romania
[2]"1 December 1918" University of Alba Iulia, Faculty of Computer Science and Engineering,
15-17 Unirii Street, Alba Iulia, Romania
[3]"1 December 1918" University of Alba Iulia, Faculty of Economic Sciences,
15-17 Unirii Street, Alba Iulia, Romania
[4]Politehnica University Timişoara, Faculty of Engineering Hunedoara,
5 Revolutiei Street, Hunedoara, Romania

Corresponding author email: mirel_glevitzky@yahoo.com

Abstract

The paper presents an experimental study on the production and testing of bricks that incorporate brick waste and sawdust as a sustainable solution for the construction industry. The aim of the research is to reduce environmental impact by reusing recycled materials and wood processing residues. Samples were manufactured using brick waste fractions (0-4 mm, 4-8 mm, 8-16 mm) and sawdust of different particle sizes, with cement as a binder, and tests focused on physical and mechanical properties (compressive strength), density, water absorption, and drying behaviour. Brick waste was analyzed using X-ray fluorescence (XRF) spectroscopy in order to determine its chemical composition and elemental distribution. The results indicate that the addition of sawdust influences density and porosity, while ceramic waste helps maintain structural strength. Data show a reduction in dry density by 5.8%, saturated density by 7.2%, water absorption by 13.8%, and compressive strength by 55.6%, indicating that the incorporation of brick waste and sawdust produces lighter, less porous bricks with significantly reduced mechanical strength. The conclusions highlight the potential of these materials for producing eco-friendly masonry elements.

Key words*: brick waste, compressive strength, experimental bricks, recycled materials, sawdust.*

INTRODUCTION

In recent decades, the circular economy has become a central principle in global sustainable development strategies (Velenturf & Purnell, 2021). The construction industry, being one of the largest consumers of natural resources and generators of waste, is under increasing pressure to adopt more responsible and innovative practices (Cudecka-Purina et al., 2024). In this context, the reuse of ceramic waste-originating from both manufacturing processes and demolition activities - offers an opportunity to valorize materials previously considered unusable, thereby reducing the environmental impact of construction activities (Gajzler et al., 2025).

Ceramic waste includes broken bricks, tiles, ceramic floor and wall coverings, and other ceramic products that can no longer be used in their original form (Sarner & Guillon, 2025). Recycling these materials not only reduces the amount of waste disposed of in landfills but can also partially replace natural aggregates, thereby contributing to lower production costs and the conservation of limited natural resources. Furthermore, products manufactured using recycled materials can exhibit performance comparable to that of conventional materials, provided that the proportions and manufacturing processes are carefully controlled (Chen et al., 2024). The use of ceramic waste also presents significant challenges. From a technical perspective, variability in particle size, composition, and porosity of recycled materials can substantially affect the mechanical and physical properties of the final product (Murali et al., 2025). From an operational standpoint, the collection, sorting, and processing of waste require specific infrastructure and involve additional costs (Olawade et al., 2024). From an environmental perspective, improper handling

of ceramic waste may generate dust and pollution, raising further health and safety concerns (Huseien et al., 2025).

Scientific literature shows a diversity of results and opinions regarding the optimal amount of ceramic waste that can be incorporated into construction mixes without compromising performance (Sălcudean & Popa, 2025). Some studies indicate that up to 30% of natural aggregate can be replaced with ceramic waste without significant strength loss (Silvestre et al., 2013), while other research warns about increased porosity and water absorption at higher proportions, generating discussions and controversies within the scientific community (Furszyfer Del Rio et al., 2022). This lack of consensus highlights the need for studies that simultaneously investigate the physical, mechanical, and durability properties of materials produced from ceramic waste. Combining ceramic waste with other recycled materials, such as sawdust, opens new perspectives for the production of eco-friendly bricks and masonry elements (Vidak Vasić et al., 2024). Sawdust, as an organic residue, can influence the porosity and weight of the material while providing a solution for valorizing waste from the wood industry (Adegoke et al., 2022). Investigating these mixtures requires a careful approach, simultaneously analyzing density, water absorption, porosity, and compressive strength in order to establish practical limits and assess their application potential.

The aim of this article is to evaluate the efficiency of using ceramic waste in combination with sawdust for the production of eco-friendly bricks, providing experimental data on the physical and mechanical behavior of these materials. The original contribution lies in offering comprehensive information on density, porosity, water absorption, and compressive strength, thereby complementing the existing literature and supporting the development of sustainable construction practices.

MATERIALS AND METHODS

For the evaluation of the influence of using brick waste and sawdust on the behaviour of bricks, a comparative experimental study was conducted. The analysis was based on two types of mixtures: a reference mixture, without any added recycled materials, and one that includes brick waste and sawdust, according to the recipe presented in Table 1.

Table 1. Composition of the mixture for the experimental brick

Material used	Quantity (kg)	Source
Cement 42.5 R	0.25	Heidelberg Materials, Chișcădaga, Romania
Brick waste 0-4 mm	0.27	Reciclare Moloz SRL, Vintu de Jos, Alba, Romania
Brick waste 4-8 mm	0.30	
Brick waste 8-16 mm	0.50	
Fine sawdust	0.2	Remarcabil Mobila, Ocna Mureș, Alba, Romania
Coarse sawdust	0.2	
Natural aggregates 4–16 mm	0.2	Elis Agregate, Cariera Jidovu – Pătrângeni, Alba, Romania
Water	0.7	APA CTTA SA, Alba Iulia, Alba, Romania

For the preparation of the experimental mixtures, processed brick waste with various granulometric sizes was used, as shown in Figure 1.

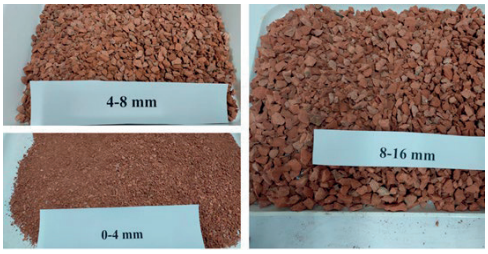


Figure 1. Brick waste with different granulometries

Additionally, fine and coarse sawdust was employed, presented in Figure 2.



Figure 2. Sawdust used in the composition of the mixtures: fine and coarse

Chemical composition determined by XRF. The brick waste aggregates were first dried at 105°C to remove moisture and then ground to a fine, homogeneous powder with a particle size of approximately 60-70 µm. The chemical composition of the brick waste was determined using X-ray fluorescence (XRF) spectrometry in accordance with SR EN 15309:2007

(Characterization of waste and soil. Determination of elemental composition by X-ray fluorescence n.d.). Measurements were performed with a Quant'X ARL energy-dispersive XRF spectrometer (Characterization of waste and soil. Determination of elemental composition by X-ray fluorescence n.d.) (Thermo Fisher Scientific, Waltham, MA, USA), following standard operating procedures for powdered ceramic materials. The analysis provided the content of major oxides (SiO_2, Al_2O_3, Fe_2O_3, etc.) and the Loss on Ignition, allowing characterization of the brick waste for potential reuse or recycling applications.

Brick waste is separated into granulometric fractions (0-4 mm, 4-8 mm, 8-16 mm) and crushed/sieved as necessary to achieve uniformity. The sawdust is dried and sieved to ensure it does not contain excessive moisture, which could cause cracking during firing. Natural aggregates are cleaned of impurities (stones, dust) and sorted to the 4-16 mm size range. Cement is kept dry and added to improve the cohesion of the mixture.

All fractions of brick waste are combined with the natural aggregates and sawdust into a homogeneous mixture. Cement is added to bind the materials. Water is gradually incorporated while continuously mixing to achieve a plastic, uniform consistency that is easy to shape. The objective is to ensure an even distribution of sawdust and waste particles to prevent segregation.

The mixture is molded using molds or by manual/mechanical pressing with UTEST UTC-0900E-T vibrating table, made in Turkey (Figure 3). The dimensions and shape are maintained in accordance with the experimental standard. Fine sawdust contributes to uniform porosity, while coarse sawdust creates a more aerated internal structure, reducing the overall weight.

The bricks are placed in drying chambers or in the open air for 3-7 days to reduce the moisture content to 5-7%. Drying must be gradual to prevent cracking, as the sawdust creates internal porosity. The amount of sawdust directly influences the density and thermal insulation properties. The proportions of brick waste and natural aggregates affect the compressive strength and durability. It is recommended to document in detail each fraction and to perform testing for optimizing the mixture. Homogeneous brick samples were obtained, free of visible defects, ready for subsequent mechanical and physical testing. The adopted method proved to be simple, reproducible, and efficient, providing a solid foundation for further research.



(a) (b) (c)

Figure 3. Preparation of the experimental bricks: (a) mixture prepared according to the recipe; (b) pouring into the mold; (c) brick after drying

The dry state mass is determined at the end of the slow drying period by weighing, expressed in grams.

The saturated state mass is determined after the brick has been immersed in water and left for 24 hours at a temperature of 20 ± 5°C. The brick is then removed and weighed in grams (EN 772-21, 2011).

The volume of the bricks was calculated by measuring the dimensions (length L = 230 mm, width l = 115 mm, and height h = 63 mm). Then, using the formula for the volume of a rectangular parallelepiped, the volume of the bricks was determined as $V = L \times l \times h = 230 \times 115 \times 63 = 1666.35$ cm³.

Dry state density/Saturated state density. Knowing the mass and volume of the standard solid brick and the experimental brick, the density was calculated for each using the density formula $\rho = m/V$, both in the dry state and in the saturated state: $\rho_{\text{dry standard}} = 2592.97/1666.35 = 1.556$ g/cm³; $\rho_{\text{dry experimental}} = 2441.35/1666.35 = 1.465$ g/cm³; $\rho_{\text{saturated standard}} = 3111.57/1666.35 = 1.867$ g/cm³; $\rho_{\text{saturated experimental}} = 2888.42/1666.35 = 1.733$ g/cm³.

The water absorption is determined after immersing the bricks in water for 24 hours. The samples are removed from the water, superficially wiped to remove excess surface moisture, weighed, and the water absorption is calculated using the formula $A = (M_1 - M_0)/ M_0$

× 100 [%], where M_0 represents the mass of the brick in the dry state (g), and M_1 represents the mass of the brick after immersion (g). For the experimental brick, the absorption was A_{cex} = (2888.42 − 2441.35)/ 2441.35 × 100 = 18.31 %, while for the standard brick A_{csp} = (3111.57 − 2592.97)/ 2592.97 × 100 = 20 %.

The compressive strength of the brick samples was determined using the Matest Cyber Plus Evolution static materials testing machine (model CO7gPN191, Matest, Italy), a specialized device for measuring the compressive strength of construction materials, with a measurement range between 25-250 kN and 20-3000 kN. The samples were subjected to a gradually and uniformly applied axial compressive load, under controlled temperature conditions (+5…+40 °C) and relative humidity (30-70%), until the state of failure by crushing was reached, at which point the maximum force sustained was recorded (EN 12390-4, 2009; EN 772-1, 2001).

The sample was subjected to a gradually applied axial compressive load until the state of failure by crushing was reached (Figure 4).

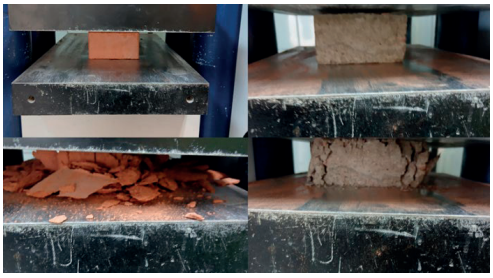


Figure 4. Experimental and standard brick samples under axial compression until failure

The compressive strength is determined as the ratio between the maximum force recorded at failure and the cross-sectional area of the specimen.

RESULTS AND DISCUSSIONS

The average chemical composition of the brick waste aggregate determined by X-ray fluorescence (XRF) analysis is presented in Table 2.

The chemical composition of brick waste determined by XRF shows that the material is rich in SiO_2 (55%) and Al_2O_3 (15%), the main constituents that provide hardness and stability.

Table 2. Chemical Composition of Brick Waste Aggregate (XRF Analysis)

Compound	Value (wt.%)	Interpretation
SiO_2	55.04	Contributes to mechanical strength and potential pozzolanic reactivity.
Al_2O_3	15.11	Enhances ceramic stability and may support secondary hydration reactions.
Fe_2O_3	7.65	Contributes to thermal stability
CaO	8.07	May influence hydraulic reactivity
MgO	4.83	It is associated with carbonate or clay minerals and can affect durability
SO_3	1.08	Related to sulfate phases; excessive amounts may influence durability.
K_2O	1.03	Alkali oxide from clay minerals; may affect alkali–silica reactivity.
TiO_2	0.28	Associated with accessory minerals; limited structural impact
BaO	0.22	From mineral impurities; negligible effect on overall performance.
MnO	0.10	May slightly influence coloration
Loss on Ignition	6.40	Indicates volatiles, residual carbonates, and unburned material affecting thermal behavior and durability.

The relatively high Fe_2O_3 content (7.65%) explains the characteristic red color of the bricks, while CaO (8%) may originate from lime or calcareous sand additives, influencing the material's strength and durability. K_2O (1%) and SO_3 (1%) are alkaline oxides that can affect chemical behavior during hydration or other reactions, whereas TiO_2, BaO, and MnO are minor components with minimal impact but useful for identifying the source of the raw material. The Loss on Ignition value of 6.4% indicates the presence of organic matter or moisture released during firing. Overall, the material is suitable for recycling as aggregate or as a raw ceramic material due to its balanced chemical composition.

Table 3 presents the mass, volume, density, water absorption, and compressive strength of the bricks, comparing the experimental values with the standard ones and highlighting the absolute and percentage differences.

Table 3. Physical and mechanical properties of experimental and standard bricks

Parameter	Brick type		Difference	
	Experimental	Standard	Absolute	%
Dry mass (g)	2441.35±4.0	2592.97±2.1	151.62	5.85
Saturated mass (g)	2888.42±0.9	3111.57±3.4	223.15	7.17
Volume (cm^3)	1666.4±0.0	1666.4±0.0	0	0
Dry density (g/cm^3)	1.465±0.1	1.556±0.1	0.091	5.84
Saturated density (g/cm^3)	1.733±0.1	1.867±0.1	0.134	7.17
Water absorbed (g)	447.07±0.8	518.6±1.2	71.53	13.8
Compressive strength (N/mm^2)	16.7±0.1	37.6±0.1	20.9	55.6

Values are means ± SDs (n = 3).

The compressive strength of the experimental brick decreases dramatically, by approximately 56%, indicating that the inclusion of waste significantly affects the mechanical performance of the material. At the same time, water absorption decreases by about 14%, a potentially positive effect if the goal is to obtain less porous bricks. Density and mass decrease slightly, by around 6-7%, suggesting that the brick's structure becomes lighter without changing its volume, so the observed differences are strictly due to changes in the internal material.

The experimental results illustrate both the potential and the limitations of using recycled materials in the production of construction elements, contributing to a deeper understanding of the possibilities for transitioning toward a circular economy in the construction sector. The incorporation of brick waste and sawdust as additives in brick production results in a distinct balance between reduced density, decreased mechanical strength, and improvement in certain porosity-related aspects, when compared to the reference mixture (Lewo Nkondi, 2025).

In the European Union, the technical specifications for masonry units, including fired clay bricks, are regulated by the harmonized series of standards SR EN 771 (SR EN 771-1+A1:2015 n.d.). The standard defines the characteristics, performance requirements, and conformity criteria for clay masonry units (dimensions, tolerances, strength, density, etc.), providing a clear framework for the evaluation of both industrially and experimentally produced materials (Affan et al., 2025). Furthermore, the design and calculation of masonry structures incorporating such units are governed at the European level by Eurocode 6 (EN 1996-1-1, 2022), which establishes general rules for reinforced and unreinforced masonry structures, including the properties of constituent materials and their behaviour under load.

In line with the results reported in the scientific literature (Meng et al., 2022; Hu et al., 2024), the incorporation of brick waste into the mixture contributes to the valorization of recycled materials and can influence the internal structure of the bricks, affecting their density and mechanical strength (Abdullah, 2021). If the obtained properties (e.g., density, compressive strength, or water absorption) fall within the limits required by SR EN 771-1, the respective materials may be considered compliant or close to technical compliance for certain masonry applications. Compliance with these requirements is essential for the acceptance of experimental samples as construction materials, particularly in projects adhering to European standards (Oyguc, 2025). The use of sawdust, due to its organic nature and variable granulometry, can lead to changes in the material's porosity, an aspect that is reflected both in the volumetric mass (density) and in the behaviour under mechanical loading (Robert et al., 2024).

As noted by Ludovice et al. (2025), the interpretation of the experimental results in the context of normative requirements provides a solid foundation for assessing the practical viability of the materials studied, opening pathways for the optimization of compositions and the continuation of research aimed at achieving or surpassing the performance levels required by international standards. Comparison of the obtained results with those of previous studies indicates that the proportion and type of recycled materials play an essential role in the final performance of the bricks. Thus, a controlled content of brick waste and sawdust can represent a viable solution for producing materials with reduced environmental impact, without significantly compromising their functional characteristics (Benjeddou, 2025; Jwaida & Di Sarno, 2025).

The experimental study highlighted several key lessons regarding the use of brick waste and sawdust in brick production. First, the integration of recycled materials leads to a significant reduction in compressive strength, underscoring the importance of controlling the proportions and granulometry of the components (Akbulut, 2025). At the same time, the addition of sawdust was found to contribute to a decrease in density and mass, offering an advantage in producing lighter materials with a certain level of thermal insulation (Esakki Priya, 2025). Water absorption can be positively influenced, indicating the possibility of obtaining less porous bricks, which provides benefits for durability in certain masonry applications (Raimondo et al., 2009).

In the long term, the use of brick waste and sawdust can have a significant impact on sustainability in construction (Rabiu & Damdelen, 2023). The adoption of these materials reduces pressure on natural resources, limits the amount of waste disposed of in landfills, and can lead to cost savings in production (Zhang, 2024). Long-term success depends on optimizing mix designs to maintain adequate mechanical properties and on compliance with international technical standards, so that the materials can be used in real structures without compromising safety and durability (Soave & Ferrara, 2025). Expanding research on long-term behaviour and resistance to environmental factors will be essential for the large-scale adoption of these technologies.

From a broader perspective, the results of this study support current research directions focused on the development of sustainable construction materials through the integration of industrial waste and natural by-products into manufacturing processes. Moreover, they highlight the potential of using recycled materials in brick production as an alternative to conventional raw materials (Popa et al., 2025; Anbarasu & Karuppusamy, 2025).

The statistical analysis of the experimental results was carried out in order to highlight the differences between the experimental brick and the standard brick with respect to the analyzed physico-mechanical properties. Given the small number of determinations performed for each type of material (n = 3) and the impossibility of robustly verifying the normality assumption of the distributions, data comparison was conducted using the nonparametric Mann-Whitney U test, applied to independent samples, at a significance level of $\alpha = 0.05$.

The obtained results indicated the existence of statistically significant differences between the two types of bricks, particularly in terms of compressive strength, for which the standard brick exhibited significantly higher values compared to the experimental brick ($U = 0$, $p \leq 0.05$). Similar trends were also observed for density and water absorption parameters, suggesting superior physico-mechanical performance of the standard material.

The application of the Student's t-test for independent samples, used for indicative purposes, also revealed the existence of a statistically significant difference between the two types of bricks with regard to compressive strength ($|t| \gg t_{(crit)}$, $\alpha = 0.05$), thereby confirming the results obtained using the nonparametric Mann–Whitney U test.

Table 4 presents the results of the t-test applied to all analyzed parameters, including the values of the t statistic and the corresponding significance levels (*p*-values) obtained for the comparison between the two types of bricks.

Table 4. Results of the t-test for the comparison of the physical and mechanical properties of the experimental and standard brick

Parameter	t-statistic	p-value	Interpretation
Dry mass	-58.13	1.04×10^{-5}	Highly significant difference – the experimental brick is much lighter in the dry state
Saturated mass	-109.89	2.71×10^{-5}	Highly significant difference
Volume	0.0	1.0	No difference observed
Dry density	-1.11	0.33	Statistically non-significant difference
Saturated density	-1.64	0.18	Statistically non-significant difference
Amount of absorbed water	-85.90	6.39×10^{-7}	Highly significant difference – the experimental brick absorbs much less water
Compressive strength	-255.97	1.40×10^{-9}	Highly significant difference – the experimental brick exhibits nearly half the compressive strength of the standard brick

The statistical analysis indicates highly statistically significant differences between the experimental brick and the standard brick with respect to dry mass, saturated mass, amount of absorbed water, and compressive strength ($p < 0.001$), highlighting a major impact of waste incorporation on these properties. The experimental brick is significantly lighter (both dry and saturated mass are significantly lower) and absorbs significantly less water, which suggests a lower porosity or a different structure (possibly more compact or with closed pores). Dry and saturated densities do not differ statistically significantly (although the mean values are slightly lower for the experimental brick) - the variability between measurements makes the difference non-significant with only three repetitions. Compressive strength is dramatically lower for the experimental brick (approximately 44% of the standard value), representing the most important practical difference.

CONCLUSIONS

The study confirms that the combination of brick waste and sawdust can be used for the production of eco-friendly bricks with physical and mechanical properties different from those of conventional bricks. Compressive strength decreases significantly, while density and water absorption can be adjusted depending on the proportions of recycled materials. The results suggest that, through careful optimization of mix designs, these experimental bricks may represent a sustainable alternative in construction, contributing to the circular economy and to the reduction of environmental impact. The study also opens opportunities for future research aimed at improving durability, environmental performance, and the long-term evaluation of the mechanical and functional behaviour of recycled materials.

REFERENCES

Abdullah, D. J., Abbas, Z. K., & Abd, S. K. (2021). Study of using of recycled brick waste (RBW) to produce environmental friendly concrete: A review. *Journal of Engineering*, 27(11), 1–14.

Adegoke, K. A., Adesina, O. O., Okon-Akan, O. A., Adegoke, O. R., Olabintan, A. B., Ajala, O. A., Olagoke, H., Maxakato, N. W., & Bello, O. S. (2022). Sawdust-biomass based materials for sequestration of organic and inorganic pollutants and potential for engineering applications. *Curr. Res. Green Sustain. Chem*. 5, 100274.

Affan, H., Arairo, W., Barraj, F., Khatib, M., Saba, M., & El Mendili, Y. (2025). Mechanical Characteristics of Clay-Based Masonry Walls. *Eng*, 6(10), 260.

Akbulut, Z. F., Guler, S., Yavuz, D., & Avcı, M. S. (2025). Toward sustainable construction: A critical review of recycled aggregate concrete properties and future opportunities. *Case Studies in Construction Materials*, 23, e05133.

Anbarasu, N. A., & Karuppusamy, M. (2025). A review of sustainable construction and waste management: Brick manufacturing using agro-industrial wastes. *Zaštita Materijala*, 66(4), 913–927

Benjeddou, O. (2025). Experimental investigation of the impact of wood sawdust incorporation on the physical and thermal properties of fired clay bricks. *Sci. Rep.* 15, 30855.

Characterization of Waste and Soil. Determination of Elemental Composition by X-Ray Fluorescence. https://www.en-standard.eu/bs-en-15309-2007-characterization-of-waste-and-soil-determination-of-elemental-composition-by-x-ray-fluorescence/?srsltid=AfmBOoowAMBhjSPnCz3fEsxnYWgFlX51p-OCngev4VAehHEJtj64kMKh.

Chen, L., Yang, M., Chen, Z., Xie, Z., Huang, L.; Osman, A.I., Farghali, M., Sandanayake, M., Liu, E.; Ahn, Y.H., Al-Muhtaseb, A.H., Rooney, D.W., & Yap, P.-S. (2024). Conversion of Waste into Sustainable Construction Materials: A Review of Recent Developments and Prospects. *Materials Today Sustainability* 27, 100930.

Cudecka-Purina, N., Kuzmina, J., Butkevics, J., Olena, A.; Ivanov, O., & Atstaja, D. (2024). A Comprehensive Review on Construction and Demolition Waste Management Practices and Assessment of This Waste Flow for Future Valorization via Energy Recovery and Industrial Symbiosis. *Energies* 17, 5506.

Esakki Priya, P., Vasanthi, P., Prabhu, B., & Murugesan, P. (2025). Sawdust as a sustainable additive: Comparative insights into its role in concrete and brick applications. Cleaner Waste Systems, 11, 100286.

European Committee for Standardization. (2001). EN 772-1: Methods of test for masonry units - Part 1: Determination of compressive strength.

European Committee for Standardization. (2009). EN 12390-4: Testing hardened concrete - Part 4: Compressive strength of test specimens.

European Committee for Standardization. (2011). EN 772-21: Methods of test for masonry units - Part 21: Determination of water absorption of clay and calcium silicate masonry units by cold water absorption

European Committee for Standardization. (2022). EN 1996-1-1:2022. Eurocode 6 - Design of masonry structures - Part 1-1: General rules for reinforced and unreinforced masonry structures. European Committee for Standardization

Furszyfer Del Rio, D. D., Sovacool, B. K., Foley, A. M.; Griffiths, S., Bazilian, M., Kim, J., & Rooney, D. (2022). Decarbonizing the ceramics industry: A systematic and critical review of policy options, developments and sociotechnical systems. *Renew. Sustain. Energy Rev.* 157, 112081.

Gajzler, M., Nowotarski, P., & Ratajczak, M. (2025). Economic and Environmental Analysis of Using Recycled Ceramic Demolition Materials in Construction Projects. *Sustainability* 17, 7560.

Hu, J., Ahmed, W., & Jiao, D. (2024). A Critical Review of the Technical Characteristics of Recycled Brick Powder and Its Influence on Concrete Properties. *Buildings*, 14(11), 3691.

Huseien, G. F., Joudah, Z. H.; Baghban, M. H., A. Khalid, N. H, Faridmehr, I., Dong, K., Li, Y., & Gu, X. (2025). Sustainability of Recycling Waste Ceramic Tiles in the Green Concrete Industry: A Comprehensive Review. *Buildings* 15, 2406.

Jwaida, Z., & Di Sarno, L. (2025). Utilizing agricultural wastes for fired bricks: A machine learning approach to compressive strength and water absorption predictions. *Cleaner Engineering and Technology*, 29, 101109.

Lewo Nkondi, B., Azama, N., Blaysat, B., de Baynast, H., & Moutou Pitti, R. (2025). Fired clay bricks made by incorporating organic additives: A review. *Case Studies in Construction Materials*, 23, e05037.

Ludovice, N. P. P., Matus, K., Redonnet, S., Zeng, X., Zhang, Y., Loh, E. T., Zhang, Y., & Chow, J. (2025). Towards a holistic and reflexive assessment of green buildings and technological landscapes in Hong Kong. *Energy Research & Social Science*, 127, 104235.

Meng, T., Wei, H., Dai, D., Liao, J., & Ahmed, S. (2022). Effect of brick aggregate on failure process of mixed recycled aggregate concrete via X-CT. *Construction and Building Materials*, 327, 126934.

Murali, G., Hassas, N., & Abdelgader, H. S. (2025). Ceramic Waste as a Sustainable Cementitious Resource: Pathways to Cleaner and High-Performance Concrete. *Cleaner Materials* 18, 100352.

Olawade, D. B., Fapohunda, O., Wada, O. Z., Usman, S. O., Ige, A. O., Ajisafe, O., & Oladapo, B. I. (2024). Smart Waste Management: A Paradigm Shift Enabled by Artificial Intelligence. *Waste Management Bulletin*, 2, 244–263.

Oyguc, R. (2025). Seismic Behavior and Vulnerability of Masonry Dwellings in Eastern Türkiye: A Comprehensive Analysis. *Applied Sciences*, 15(10), 5490.

Popa, M., Glevitzky, M., Dumitrel, G.-A., Popa, D.-V., Glevitzky, I., & Vîrsta, A. (2025). Energy efficiency of agricultural technologies through the creation of a sustainable model: A case study of greenhouses. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, 25(2), 619-632.

Rabiu, B. O., & Damdelen, O. (2023). Application of Brick Dust and Sawdust in Concrete: A Movement to Sustainability. *Journal of Civil Engineering and Construction*, 12(3), 152–166.

Raimondo, M., Dondi, M., Gardini, D., Guarini, G., & Mazzanti, F. (2009). Predicting the initial rate of water absorption in clay bricks. *Construction and Building Materials*, 23(7), 2623–2630.

Robert, U. W., Etuk, S. E., Agbasi, O. E., & Ambrose, P. D. (2024). Development of lightweight sawdust-based composite panels for building purposes. *International Journal of Lightweight Materials and Manufacture*, 7(5), 631–640.

Sălcudean, M., & Popa, M. (2025). The Integration of Ceramic Waste As A Of Natural Aggregates In Expperimental Concrete Recipes.*Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering* 14: 594–600. https://landreclamationjournal.usamv.ro/pdf/2025

Sarner, S., & Guillon, O. (2025). A Perspective on Ceramic Recycling. *Journal of the European Ceramic Society*, 45, 117511.

Silvestre, R., Medel, E., García, A., & Navas, J. (2013). Using ceramic wastes from tile industry as a partial substitute of natural aggregates in hot mix asphalt binder courses. *Constr. Build. Mater*. 45, 115–122.

Soave, F., & Ferrara, L. (2025). A durability-based design approach for structural applications with advanced cement-based materials. *Case Studies in Construction Materials*, 22, e04294.

SR EN 771-1: Elements for burnt clay masonry (brick) https://magazin.asro.ro/ro/standard/237734.

Velenturf, A. P. M., & Purnell, P. (2021). Principles for a Sustainable Circular Economy. *Sustainable Production and Consumption* 27, 1437–1457.

Vidak Vasić, M., Muñoz Velasco, P., Bueno-Rodríguez, S., Netinger Grubeša, I., Dondi, M., Pérez Villarejo, L, Eliche-Quesada, D., & Zanelli, C. (2024). State and perspectives of sustainable production of traditional silicate ceramics. *Open Ceram.* 17, 100537.

Zhang, H., Shi, S., Zhao, F., Hu, M., & Fu, X. (2024). Integrated Benefits of Sustainable Utilization of Construction and Demolition Waste in a Pressure-State-Response Framework. *Sustainability*, 16(19), 8459.