

Review Research**REVIEW OF RECYCLING NATURAL AND INDUSTRIAL MATERIALS EMPLOYMENTS IN CONCRETE****Dalia Adil Rasool¹****Harith H. Al-Moameri^{1,2}*****Mais A. Abdulkarem¹**

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Abstract: Concrete is the most commonly used and dependable substance and the most consumed among all other construction materials. However, the construction industry's insatiable need for building supplies has led to the widespread exploitation of natural resources like river sand and stone. However, one of the most pressing problems in the construction industry and others nowadays is excessive waste and byproducts. Promoting ecological control and the goal of sustainable progress has put environmental pressure on all businesses, including construction, to embrace eco-friendly practices. Environmentalists' concerns about the dangers posed by the widespread use of natural resources in building construction are growing. In some instances, construction debris may be harmful to the environment. Global building growth and redevelopment plans have worsened demolition in the construction industry. The demand for construction materials is increasing yearly due to urbanism, but their costs are rising simultaneously. Using industrial waste like polymers and rubbers and natural waste like olive stones and pumice stones to replace cement, fine aggregate, and coarse aggregate to reduce building costs conserves natural resources from exhaustion and protects the environment from waste impact and risks. The current research shows how waste can be used to replace materials on construction sites and the impact of the properties of these materials on the quality of concrete.

Keywords: *Recycled materials; olive stone; plastic bottle; PET; environmental concerns; pumice stone; rubber.*

1. Introduction

Due to urbanization, net immigration, and rising standard of living, advanced countries produce a large amount of natural and industrial solid waste [1]. On the other hand, solid wastes are unwanted or wasted material that is not even gas or liquid. Plastic bottles, paper, porcelain, glass, olive stone, wood, and clothing can be classified as recyclable resources [2]. Environmental trash types include destruction and building, including waste timber and waste concrete [3]. Greater production means more waste disposal. Greater waste disposal means more environmental issues and dangerous threats. This happens especially in metropolitan regions where rubbish wastes such as containers, food packaging materials, plastic shopping bags, bottles, and other non-biodegradable objects pollute the environment [4]. Using waste resources in unique products is one of the most cost-effective and appropriate solutions to such a problem. Using solid waste as a partial replacement for cement and fine aggregate in concrete and cement mortar mixture can reduce the demand for natural resources

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while reducing the high burden on landfills [5]. Wood, pumice stone, brick, concrete, polymers, glass, and paper have all been used in the construction industry as waste materials. The topic of this investigation is the environmental harm caused by the everyday usage of many waste items that are difficult to dispose of. PET bottles, ceramic, olive stone, and pumice stone are solid materials with suitable properties that can be used to change construction components. The materials mentioned above could be used in a variety of construction projects. Cement and fine or coarse aggregate could be replaced with them. The possibilities for employing these materials are demonstrated in this study.

1.1, PET Plastic Bottle

Polyethylene terephthalate (PET) is the principal component of a plastic bottle. PET has grown in popularity over the previous decade as a safe, long-lasting, and acceptable packaging material. PET is a rigid, stiff, strong, dimensionally stable polymer that absorbs very little water. It has strong chemical resistance and gas barrier qualities. PET trash does not decompose. Construction waste disposal in landfills will be harmful to the environment. As a result, recycling is the only option for disposing of post-industrial and post-consumer PET trash [6-7].



Figure 1. PET plastic bottle [6]

Pelisser et al. [8] employed PET fibers of varying lengths in lieu of varying amounts of concrete. The author discovered a rise in the toughness index of 0.18% after 14 days of curing and 0.3%

after 28 days. However, it was found that the toughness index enhancement was no longer apparent after 150 days of age, owing to the degradation of the fibers in the alkaline environment of concrete.

Nibudey et al. [9] investigated the effectiveness of PET bottle fiber in reinforcing regular concrete. 35:50 and 50:35 fiber aspect ratios. The volume of the concrete was adjusted by adding fibers at various rates, from 0% to 3%. In this study, the researchers selected the M20 and M30 grades. The strength of this analysis was to compare the grades' compressive strengths throughout a range of aspect ratios and volume fractions. The results showed that the M20 grade of concrete had the highest compressive strength at an aspect ratio of 50 with a 1vol% fiber. The rate of rise for the M30 grade was lower than that of the M20 grade.

Using a range of dosages, from 0% to 3%, in increments of 1%, Rathnayaka et al.[10] investigated the viability of using standard-sized PET fibers to replace steel bars in reinforced concrete pipelines with (w/c) of 0.3 and 0.45. The findings demonstrated the feasibility of making and casting PET-fibre concrete using conventional concrete-style molds. Since they cost less than traditional reinforced concrete pipes, PET-fibre concrete pipes are the more financially sound option.

Compressive strength was measured for concrete blocks with empty 500 ml PET bottles sandwiched in between and hollow concrete blocks purchased from a local store by Safinia and Alkalbani [11]. Increasing demand for concrete samples reinforced with bottles has led to a 57% decline in the market for concrete blocks.

The impact of replacing fine aggregates with (PET) fibers was investigated by Kumar and

Daule [12], who found that the characteristics of concrete improved from 0.5 percent to 2 percent in increments of 0.5 percent. For this experiment, we used a water-to-cement ratio of 0.40. At 1.5% replacement, they felt their strength was at its highest. Compressive strength rose by 4%, split tensile strength by 8%, and flexural strength by 59%.

Isah and Shruthi [13] compared plain concrete beams to those strengthened with steel or PET bottle hollow bars. The PET bottles were cut longitudinally, folded, and pinned to create 48 cm long bars that would serve as hollow bars. Even though the flexural strength of a beam was greatest when reinforced with steel, the flexural strength of a beam strengthened with hollow PET bars practically doubled when compared to a control beam with no reinforcement.

The effects of WPET pieces on the fresh, physical, and mechanical characteristics of self-compacting concrete have been studied by Alzohbi [14]. The percentages of coarse aggregates that were substituted with waste PET aggregates (WPET) were 5–20% by volume. This research demonstrates that recovered waste PET particles may be used as aggregates to make self-compacting concrete. A reduction in compressive strength, split tensile strength, flexural strength, workability, and UPV are just a few of the negative impacts of adding waste PET to SCC. On the other hand, using waste PET particles as coarse aggregates has advantages as well since it makes SCC tougher and more flexible, decreases the self-weight of concrete due to its low weight, and minimizes environmental pollution.

Almeshal et al. [15] proposed using PET waste of 0.075 mm as a variable of fine aggregate by volume to evaluate the compressive strength, unit weight, and workability of concrete. The

workability of the blend appeared to be adversely influenced by expanding PET condensation, as proven by a droop index of 10 mm for the 50% PET concrete examples versus 90 mm for the control specimens. The higher thickness of conventional sand caused lower workability compared to PET. This hypothesis was extended to incorporate the compressive quality of PET concrete illustrations. Expanded PET substance within the blend was in reverse relationship to compressive strength, which diminished by 31% and 60%, individually, when differentiated to controls for 40% and 50% PET concrete mixes.

Concrete containing 0%, 2%, 4%, 6%, and 8% of river sand and 5% of Nano silica replaced by cement was studied by Pawaskar et al. [16] to see whether PET bottle waste may be used as a partial substitute for fine aggregate. The concrete is subjected to slump, compaction, compressive, and flexural strength testing during the curing process. The outcomes are compared to conventional concrete. The study's primary goal is to reduce plastic waste and increase environmental sustainability.

Dawood et al. [17] looked at the mechanical and physical parameters of concrete utilizing cracked PET unused as per a fragmentary volumetric change of fine particles ranging from 5% to 20%. Though PET fibers and fine aggregates were smaller than 4.75 mm in size, their shades (0–4.47 mm) varied significantly, with most PET fibers alternating from 2.36 to 1.18 mm, although the sand was equally scattered. They discovered that the amount of shredded PET waste in concrete specimens had an inverse relationship with their workability. The sample contains 20% and has a workability of 62.5% lower than the control. They approved it for shredded PET waste particles, which have a larger surface area than sand particles. They also found that the compressive strength increased from 0% to 15%

PET substitution. It gained 7.5% for the concrete with 12% PET compared to the control before it went down.

To substitute fine aggregate in concrete, Mohammad Eyni Kangavar [18] investigated recovered PET waste in granular form. 0–50% of the fine aggregate was replaced. Along with microstructural observations, essential things like density, workability, elastic modulus, crack opening displacement, and tensile, compressive, and flexural strengths were also examined. The trials' findings demonstrated that the volumetric replacement of fine particles with 10% recycled PET granules improved the properties of the concrete. The experiments also showed that using recycled PET grains in concrete improved its elasticity. However, concrete with a 10% or higher PET granule concentration had the most significant effect. Furthermore, compared to other concretes discussed in the literature, this one performed very well in terms of mechanical qualities, particularly the concrete in which fine aggregate was substituted with PET granules at a 10% volume percentage. It has been examined if using PET plastic waste in concrete production may result in sustainability via cost savings, higher quality, and fewer environmental consequences.

1.2. Crumb Rubber

Shredding discarded tires produces crumb rubber, one of the few products without steel or fiber. Rubber particles of various shapes and sizes were graded and identified. Crumb rubber is quantified or characterized using a sieve size or mesh screen that passes through during manufacturing. In general, lowering the size of the tires is critical for producing crumb rubber. Crumb rubbers were made using cryogenic and ambient grinding [19].



Figure 2. Rubber waste [19]

The waste tier's chemical composition included Wire, fabric, natural and synthetic rubber, carbon black, and various chemical compounds are some of the materials used. Using waste tires as an addition to cement-based materials might alleviate the challenging issue of waste tire organization, which has an adverse effect on the material, public health, and aesthetics. Even though the tire rubber's compressive strength was diminished, it was used in engineering constructions due to its improved flexibility and elasticity after mixing with cement. Inactive asphalts, steel-concrete composite bars, and airport asphalt utilize rubber concrete [20].

Research on the long-term performance of rubber concrete with a maximum of 30% rubber contents was conducted by Yang et al. [21]. The carbonation depth of rubberized concrete was higher than that of regular concrete, which increased with the rubber percentage, suggesting a higher sensitivity to corrosion. The research indicates that structural components may have enough strength and service life when made with rubberized concrete, with a rubber percentage of up to 15%.

Banerjee et al. [22] examined tire utilization as a total substitution in concrete. To analyze the compressive strength at different exposure of heat, acid, and salt, samples were cast with 0%, 5%, 7%, and 10% substitutions of sand utilizing tire dust and tried for various curing times like seven days. The perfect rate of tire dust

is decided by considering the significance of the compressive strength of concrete.

Compressive strength predictions for rubberized concrete were made utilizing Gaussian process regression (GPR) models and support vector machine (SVM) by Gregori et al. [23]. Previous studies were analyzed for compressive strength data. The formulas for two strength reduction factors (SRF) were created so that the compressive strength of rubberized concrete could be predicted in advance based on the cement content, the percentages of fine and coarse aggregate replacement, and the water-to-cement ratio. When forecasting the compressive strength of rubberized concrete, they discovered that the GPR model performed much better than the SVM.

According to Tang et al. [24], modified recycled aggregate concrete has become essential for sustainability and waste tire recycling. Rubber particles could significantly reduce mass loss, resulting in material weakness. As a result of the investigation, it was determined that a 4% rubber component in rubberized concrete would be optimal.

Kaurav et al. [25] investigated waste tire crumb rubber as a fine natural aggregate replacement and examined the mechanical characteristics of M30 grade concrete according to IS 10262-2009. Rubberized concrete was tested for compressive strength, flexural strength, and split tensile strength. When the proportion of rubber material in the mix increases, the compressive strength, split tensile strength, and flexural strength all drop, according to the test results. The percentages of fine natural aggregate replaced by crumb rubber were 5%, 10%, and 15%, respectively.

Kamel et al. [26] investigated the benefits and effects of employing discarded tires as an

aggregate substitute for coarse and fine aggregates in concrete and explored concrete production at 5 up to 25% percentages. The results of this method have the waste to lessen the impact and hazard of used tires. The tests showed a decrease in flexural, workable, and compressive tenets as the rubber exchange rate rose. Other properties, such as thermal conductivity and density, have also improved.

In an experiment by Choi et al., non-destructive and destructive testing methods were used on concrete samples with fine rubber particles [27]. Concrete's compressive and breaking tensile strengths were lower after 14, 28, and 56 days after fine-rubber particles were used to replace fine aggregates in the strength. Generally, using more than 20% rubber particles as a fine aggregate substitute in structural concrete is not advised.

The mechanical and durability properties of crumb rubber concrete were investigated by Ataria and Wang [28]. While rubberized concrete's decreased mechanical qualities were noticed, its increased durability was a welcome surprise.

Self-compact concrete (SCC) with crumb rubber (CR) was changed utilizing fly ash and calcium carbide waste, and its durability qualities were studied by Kelechi et al. [29]. (CCCW). This study compared two types of mixtures: one with no fly ash content and one in which fly ash was substituted for 40% of the cement. Fine aggregate was substituted in the mixes with CR at a volumetric percentage of 0%, 10%, and 20%. A 23% increase in resistance to acid (H_2SO_4) and salt ($MgSO_4$) was seen in the mix, including fly ash, compared to the mix without fly ash. More and more CR was used to substitute fine aggregate, which led to a decline in the material's resilience to acid attacks. Those who subjected

themselves to higher temperatures saw more weight reduction due to their efforts. Similarly, there was a small increase in compressive strength at ambient temperature (27°C), and the most significant decrease occurred between 300 and 400 C. The mix with 20% CR had the largest water absorption, at 2.83%, whereas the blend with 0% CR and 40% fly ash had the lowest absorption, at 1.68%. Above 200 degrees Celsius, CR weakens SCC's heat resistance.

1.3. Olive Waste

The olive oil industry produces garbage called olive waste. Solid olive waste accumulates in large quantities, causing extensive harm due to the organic minerals it contains. Because of the environment, it reacts with heat and humidity, which poses a chemical risk. For instance, the breakdown of chemicals like carbolic acid and others that might be fatal results in solid scents. Lack of effective waste management options, such as recycling or reusing waste in a beneficial or profitable, ecologically friendly manner, has led to alarming rates of waste accumulation, increasing pollution risks and complicating waste disposal [30].



Figure 3. Olive stones waste [30]

Al-Akhras and Abdulwahid examined that as more cement was substituted by (OWA), the flexural and compressive strength of the mortar failed. In addition to the decrease in the setting time and workability of the mortar as the OWA content rises. The mechanical qualities rose when

OWA was used as a partial replacement for sand [31].

Olive seed ash was used in a study by Eisa [32], who evaluated the workability and compressive strength of fresh and cured concrete. In this study, we found that the workability of fresh concrete was significantly affected when cement was substituted with olive seed ash. Compared to control mixtures, the compressive strength of mixtures containing olive seed ash decreased by 45 to 75 %.

As a means of conserving the environment and lowering Portland cement usage, Alkheder et al. [33] substituted olive waste for Portland cement in cement paste. Regular consistency, setting time, soundness, and compressive strength were measured and analyzed. Cement pastes made with varying percentages of olive waste were found to have a somewhat lower consistency than regular cement paste, and this effect was seen across all tested percentages. The results showed that the compressive strength of hardened blended cement paste containing different percentages of olive waste decreased slightly with olive waste content at 3, 7, and 28 days.

The possibility of using waste from the olive industry as a replacement for the most popular lightweight aggregates used in Spanish building projects in cement mortars was investigated by Merino et al. [34]. An experimental mixture was developed to test the practicability of the proposed substitute. This blend was designed to include all three olive stone forms (whole, crushed, and calcined) into cement mortars. The findings indicate that olive stone waste may be used as a suitable substitute for expanded clay, yielding mortars with up to 30% lower densities and up to 20% better compressive strength than lightweight expanded clay mortars.

Research on concrete was performed by Adwan and Maraqa [35] utilizing OWA. By weight, OWA was added to, or used in place of, cement at a rate of 10, 20, 30, or 40%. The compressive strength diminishes when the fraction of OMW is substituted.

Cheraghizadeh and Akcaoglu [36] studied the impact of olive waste ash (OW) and sea sand powder (SS) in varying concentrations on certain mechanical parameters of SCC. In addition to measuring compressive strength and volume changes due to hydration, X-ray computed tomography has been used to assess porosity. In addition, comparisons of mixtures, including limestone powder (LS), were made. The results demonstrated that volumetric shrinkage is of paramount relevance, even though there is little to no change in compressive strength and porosity when employing SS instead of LS. OW also increases the volumetric changes and decreases the compressive strengths of freshly made SCC while increasing its viscosity. In comparison, when compared to LS mixtures, the porosity is clearly visible.

The waste materials effluence (pumice stones and olive pits) on cement mortar properties was studied by Abdulkarem et al. [37]. Cement mortar's fine aggregates were partly replaced with olive and pumice stones, with concentrations ranging from 10% to 30%. Cement mortar's compressive strength and workability were improved with a superplasticizer's help. Mortar mixes were tested for compressive strength, thermal conductivity, density, and water absorption before and after being treated with olive and pumice stones. The results demonstrate that cement mortar containing 30% olive and pumice stones increased thermal insulation and compressive strength compared to regular mortar.

Tayeh et al. [38] investigated olive waste ash as a partial alternative for cement in concrete production. The impact of utilizing olive waste ash in concrete mixtures on their physical and mechanical qualities has been studied. It is accomplished by conducting tests in which various amounts of OWA are added to cement (0%, 5%, 10%, and 15%). This research claims that increasing the amount of OWA decreases compressive strength and workability but increases durability in extreme weather and temperatures.

In order to determine how olive waste ash influences the mechanical and fracture characteristics of self-compacting concrete, Cheraghizadeh et al. [39] conducted an analysis. For this purpose, three quantities of olive waste ash were used to make two different superplasticizer doses of self-compacting concrete mixes. Not only were the compressive and tensile strengths of each mixture determined but also they were subjected to a battery of three-point bending tests on notched beams. The results revealed that the two different contents of the superplasticizer had the most significant impact on the tensile strength and fracture energy of self-compacting concrete made from olive waste ash.

The proportion of ground olive stone in a lightweight mortar was investigated by Cabello et al. [40]. Next, they looked at how well these materials performed mechanically and whether or not they might be utilized to create lightweight pieces for the construction industry. The amount of ground olive stone that could be successfully blended into the material was determined by testing its density, consistency, flexural strength, and compressive strength. Comparing mortar with and without ground olive stone, we find that using 30% ground olive stone reduces density by 15%. At each of the evaluated dosages, the

compressive strength remained at or above 70 percent of mortar made without ground olive stone. The results for bending behavior were much lower, at roughly 50%. Stronger cement included a greater strength of ground olive stone in its composition. The research demonstrates the technological feasibility of the materials developed.

Olive waste ash (OWA) and rice husk ash (RHA) were used to substitute cement partially in an investigation performed by Hakeem et al. [41]. The researchers tested the effects of utilizing RHA and OWA in a range of percentages (i.e., 0% to 25% for RHA and 0% to 7.5% for OWA) to see how they affected concrete strength. Slump values and mechanical properties were used to represent the properties of the material in its fresh state. These properties included flexural strength, splitting tensile strength, bond strength, modulus of elasticity, and compressive strength. Seven days and 28 days were used to measure compressive strength, but only 28 days were used to measure the other mechanical parameters. The findings suggest that 20% RHA and 5% OWA are optimal. Compressive strength is increased by around 58.7 percent when 20% RHA is combined with 5% OWA.

1.4 Pumice Stones

In addition to their positive physical, chemical, and mechanical properties, pumice stones are also very lightweight to transport. They mix it with Portland cement, and water yields the finished product. Insulating, thermal, and acoustic properties combined in a very lightweight mortar cement [42].



Figure 4. Pumice stones [39]

Lightweight concrete (i.e., lighter-weight fine and coarse particles and natural coarse aggregates with fines) and their physical and mechanical characteristics were analyzed. Parhizkar et al. [43] researched on the qualities of concrete with pumice aggregates. The findings show that lightweight concrete specifications for compressive and tensile strength and drying shrinkage were met.

Concrete made using lightweight aggregates; M20 was the subject of Sivalinga and Rao's [44] research. The results revealed that by substituting 20% pumice aggregates for coarse aggregates, the M20 concrete gained a lot of strength. There is also success with 40% pumice and 5% fiber blends.

The effects of including pumice stones in mortar cement on its characteristics were investigated by Rashiddadash et al. [45]. Using pumice stones helped eliminate weak spots in the concrete caused by porosity.

Self-compacting mortars (SCMs) made using ground pumice powder (GPP) as a mineral component were the focus of research by Karataş et al. [46], who looked into the SCMs' mechanical qualities and durability. To that end, we made eight different series of SCMs, including a control mix, with varying percentages of ground pumice powder added to the cement: 5%, 10%, 15%, 20%, 25%, 30%, and

35%. Compared to the control samples, the ones with 10% and 25% GPP showed the most significant strength increase. GPP15's pozzolanic activity is strongest between the ages of 28 and 90 days after curing. Mortars in which GPP was substituted for cement at concentrations between 10 and 20 percent had lower water absorption, sorptivity, and porosity than the control mortar.

Microstructural and durability impacts of pumice and metakaolin (MK) in self-compacting concrete were investigated by Khotbehsara et al. [47]. (SCC). Distinct amounts of pumice [0-15 wt.%] and MK [0-10 wt.%] were used as cement substitutes to create 10 different combinations. Pumice-and-MK-based SCC mixes met the criteria for workability in their fresh condition. Compressive strength reduced after 28 days when pumice was added but rose dramatically at 90 days. At both 28 and 90 days, most binary mixes showed strength enhancement over the control mix, with the improvement being more pronounced at 90 days. The SEM micrographs showed that the MK and pumice samples had a packed pore structure, which increased their strength and durability. The findings indicate that a replacement ratio of 10% pumice to 10% MK is optimal for improving SCC's durability and mechanical qualities.

Pumice was investigated by Rashad [48] as an example of a lightweight natural aggregate with a number of desired properties. Pumice is a common ingredient in concrete and mortar because of the benefits it provides in these materials, including reduced expansion due to the alkali-silica reaction (ASR), freeze/thaw resistance, chemical resistance, fire resistance, and thermal insulation. The insertion of pumice aggregate into the matrix had a negative impact on the material's mechanical strength, drying shrinkage, water absorption, and workability.

The damaging effects of pumice aggregate on the matrix might be lessened by using certain techniques. This study analyzes how employing pumice aggregate affects the fresh and hardened characteristics of regular concrete and mortar and the many methods for correcting the drawbacks of working with this material.

Concrete's strength qualities were studied by Idi et al. [49], who used pumice aggregate as a partial substitute for coarse aggregate in their experiments. This research aimed to determine whether pumice aggregate could be substituted for regular aggregate in structural concrete without compromising the concrete's strength. Compressive, tensile, and flexural strengths were marginally lower in the pumice aggregate content group compared to the control concrete group. At 28 days, the strength of concrete made using pumice as the coarse aggregate is sufficient. At 28 days, the compressive strength of the control concrete was 1.05 percent greater than that of the concrete with 5% pumice aggregate. At 28 days, the tensile strength of control concrete was 0.59 percent greater than that of concrete with 5% pumice aggregates. It was recommended that the coarse pumice aggregate in concrete be kept at 5% during the curing process to reach the required level of strength in 28 days. However, this number may be increased to 15% if necessary. This is in contrast to the control concrete, which had a flexural strength of 4.41% at 28 days. Admixtures are advocated for in this research as a means of increasing concrete's overall quality.

Concrete, the material selected to build a construction material, was the subject of research by Naveenkumar et al. [50]. Fine and coarse aggregate comprise the bulk of the concrete in the mixture. Pumice stone is used to replace the coarse aggregate at a 5-10% and 15-30% ratio, respectively. Testing a concrete specimen is the

only way to learn its mechanical characteristics. The optimal proportion of pumice stone, which can substitute coarse aggregate, was found to be 15% based on the results of the tests.

Pumice aggregate was employed as a partial replacement for coarse aggregate in three different percentages of lightweight concrete in a study by Karthika et al. [51]. Pumice lightweight aggregate concrete and traditional concrete may be made by combining M30 with the Conplast SP430 addition. Pumice lightweight aggregate concrete's mechanical and durability features are compared to conventional concrete using a destructive and non-destructive test. The latter is determined to be a viable option.

Jahanzaib et al. [52] considered ordinary and lightweight concrete overall significant when using the M25 blend. Lightweight cement is manufactured by partially replacing coarse aggregate with different pumice stones quantities, ranging from 50% to 70%. This study aims to determine the strength limits of lightweight complete cement to find a suitable replacement for the previously described alternatives. The results are compared to ordinary cement.

Sathish et al. [53] studied to find various properties of concrete with the replacement of cement by pumice stone powder. This work partially replaced pumice stone powder as cement in 10%, 20%, 30%, and 40%. The fresh and hardened properties of concrete with a pumice stone are to be compared with conventional concrete. Using pumice powder in concrete has the dual benefit of decreasing building expenses and solving the issue of where to put all the waste afterward. Investigating the effects of pumice powder on the strength of pozzolan concrete is the main concern of this research. The findings show that the adjusted

mix, including pumice stone powder, has significantly enhanced fresh and toughened qualities. In addition to enhancing concrete's compressive and tensile strength, pumice powder may be used as a cement replacement in the concrete mix.

Pumice's use in the high-cement-content mortar was investigated by Rahman et al. [54]. Specimens of mortar were tested to see how it affected their mechanical and durability characteristics and microscopic microstructure. This was accomplished by substituting pumice for cement in varying concentrations (up to 40%). The material is put through its paces, with tests measuring its compression strength, flexure strength, porosity, and acid attack resistance, among others. The findings demonstrate that after 90 days of curing, the C80-P20 sample (80% cement and 20% pumice) had 36% lower porosity and 9.8% stronger compressive strength than the control group. The addition of pumice increased the sample's resistance to acid attack; whereas the control sample degraded significantly and lost around 30% of its mass, the C60P40 sample lost just 10%. The pozzolanic reactivity of pumice may explain the increased durability and mechanical characteristics of pumice samples.

This article deals with a diversity of natural and industrial waste utilized for different construction purposes. Table 1 outlines the waste materials, their replacement in the building materials, and their influence on strength, as it is an essential quality in the building material.

Table 1. The results of this review on some waste utilized in construction materials.

Waste	Replacement	Strength
Plastic Bottle (PET)	Cement or fine or coarse aggregate	Improved
Crumb rubber	fine or coarse aggregate	Low
Olive waste	Cement or fine or coarse aggregate	Low
Pumice stones	Cement or fine or coarse aggregate	Improved

2. Conclusion

The sustainability of resources has become a global problem, especially construction and building materials, particularly with the increasing global population. Significant enhancements, such as reduced environmental effects, have been investigated. Disposal hazards and future piles of natural and industrial wastes can be minimized/eliminated by employing these wastes as a replacement for cement, fine or coarse concrete aggregates. According to recent studies, PET-added concrete might be helpful for utilities that need a significant increase in conventional concrete. Using PET, which can be made by grinding and cutting plastic waste, could make concrete much stronger, harder, and more elastic. Incorporating rubber particles into concrete mixes resulted in a general decline in mechanical characteristics compared to those made without rubber particles. As an alternative, rubberized concrete fared better under impact loading and might be used to repair fractures in already-existing concrete. Rubber's application also boosts a material's density and thermal conductivity. Also, olive waste reduces mechanical properties, improves thermal properties, and increases workability and durability in extreme weather and concrete temperature. While pumice stones improve their mechanical properties when replaced with cement and fine aggregates but exhibit drops in mechanical properties when replaced with coarse aggregate. Natural aggregate pumice was an

excellent lightweight material with many desirable qualities. Because of its many valuable properties, such as its resistance to alkali-silica reaction (ASR) expansion, chemical resistance, fire resistance, freeze-thaw resistance, and thermal insulation, so recycling these materials may help cut down on construction costs and generate lighter concrete.

Conflicts of Interest

The authors declare no conflict of interest.

Author Contribution Statement

All authors contributed in writing and editing this manuscript. Author [Dalia Adil Rasool, Mais A. Abdulkarem] proposed the research problem and supervised the findings of this work. All authors developed the introduction and the manuscript pattern, Also discussed the results and contributed to the final manuscript.

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