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# PARTIAL REPLACEMENT OF CLAY BY TYRE CRUMB RUBBER IN MASONRY BRICKS: A REVIEW

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## ABSTRACT :
In India, the booming automobile sector has led to a surge in tire demand, resulting in significant tire waste accumulation after their lifespan. To address this issue, researchers are exploring the utilization of waste tire rubber in the construction industry, particularly in the production of lightweight masonry bricks. This study focuses on incorporating waste crumb rubber as a partial replacement for fine aggregates in brick manufacturing, aiming to support environmental sustainability. Various percentages of crumb rubber (5%, 10%, 15%, 20% by volume of fine aggregates) were used to develop bricks while maintaining a consistent water/cement ratio across all mixes. The influence of crumb rubber on both fresh and hardened bricks was examined, including properties such as slump, density, compressive strength, tensile strength, and impact resistance. The study found that as the percentage of crumb rubber increased, slump and water absorption rose linearly, while compressive and tensile strength decreased. Additionally, energy absorption significantly increased in the CR20 mix compared to conventional bricks. Empirical relations were established to predict tensile strength accurately.

## INTRODUCTION :
The increasing emphasis on sustainable development and environmentally friendly construction materials within the construction industry has prompted a closer look at utilizing waste materials to benefit both the environment and adhere to established standards. Waste generated from industrial and agricultural activities presents a viable solution to mitigate global warming and promote eco- friendly building designs. Bricks, a fundamental construction material for wall construction, contribute significantly to solid waste production due to the extensive use of raw materials by the brick industry. Researchers are exploring various waste materials like fly ash, ground granulated blast slag, EPS beads, glass powder, crumb rubber, and PET fibers to develop lightweight building materials. Among these, waste rubber tires offer versatility for incorporation into concrete products. The substantial accumulation of worn tires, considered non- degradable and often dumped in landfills, poses environmental hazards globally. Efforts to address this issue include repurposing tire waste in industries like cement production and ground rubber production, albeit with so environmental concerns. Civil engineering applications, utilizing as low as 8% of total scrap generated, offer a safer and more environmentally friendly disposal method for waste tires. Traditionally, waste tires have been utilized as lightweight backfilling material and in asphalt concrete pavements. However, advancements in materials and new guidelines now explore their use as alternatives to normal aggregates in concrete production. Rubberized concrete, classified by particle size as chips, crumb rubber, and powder rubber, is derived from recycling scrap tires, resulting in granular crumb rubber typically black in color.

## LITERATURE SURVEY :
**Abhishek Dikshit et al, 2014** Describe that Municipalities worldwide grapple with a significant environmental dilemma: the disposal of worn-out automobile tires. Addressing this issue, numerous studies explore alternative applications of tire rubber (crumb rubber). Civil engineers seek cost-

effective solutions while conserving precious resources like sand and aggregate. Presently, traditional aggregates used in concrete manufacturing are diminishing, prompting a search for substitutes. India's burgeoning multistory complexes emphasize lightweight materials, prompting concrete technologists to innovate. Materials like blast furnace slag, fly ash, and scrap tires are under scrutiny for their potential to enhance concrete properties. Although these materials offer promise, their widespread adoption in India remains limited, possibly due to insufficient evidence and awareness. Research suggests that repurposing tires as construction materials rather than burning them can capitalize on their unique properties. To this end, an experimental study proposes utilizing crumb rubber as a partial sand replacement in cement concrete. Although rubberized concrete exhibits lower compressive strength compared to normal concrete, it demonstrates enhanced ductility. Rubberized concrete holds promise for various applications, including structural and nonstructural uses like lightweight walls and sound barriers. Its potential in highway construction as a shock absorber and in earthquake-resistant buildings is particularly noteworthy.

**A. sofi et al, 2015** The disposal of waste tire rubber poses a significant global environmental concern, endangering ecosystems worldwide. A potential remedy lies in incorporating scrap tire rubber into concrete to substitute some natural aggregate. With an estimated 1000 million tires reaching the end of their lifespan annually and projections of 5000 million more discarded by 2030, the issue is urgent. Currently, only a fraction of tires are recycled, leaving millions stockpiled, landfilled, or buried. The accumulation of polymeric waste, including tire rubber and PET bottles, is escalating rapidly. This review examines tests assessing the compressive and flexural tensile strength, water absorption, and penetration of rubberized concrete samples. While rubberized concrete showed lower compressive and flexural strengths compared to control mixes, it displayed improved abrasion resistance andwater absorption up to 10% substitution. The study also evaluates concrete mixes incorporating 5%, 7.5%, and 10% discarded tire rubber as aggregate or cement replacements. While numerous projects focus on aggregate replacement, limited data exist on cementitious filler addition. Therefore, two sets of concrete specimens were prepared to investigate the characteristics of tire crumb-containing concrete, one substituting chipped rubber for coarse aggregates and the other using scrap tire powder as a cement replacement. Standard durability and mechanical tests were conducted and analyzed to assess performance. from cement manufacturing. This review highlights the utilization of recycled waste materials—rubber tires, crushed glass, and crushed clay brick—in concrete, replacing fractions of aggregates and cement to develop eco-friendly lightweight construction materials. Incorporating these materials led to significant reductions in dry concrete density, with waste rubber showing favorable results in sulfate, thermal, and impact resistance. Additionally, glass powder and crushed clay brick improved mechanical properties and thermal resistance. Utilizing these lightweight materials can efficiently produceconcrete for various applications like road engineering, flooring, barriers, and insulation. **Asena Karslıoğlu Kaya, 2019** They Described Traditional brick production from clay or cement contributes to high energy consumption and carbon dioxide emissions, posing environmental challenges. Moreover, the indiscriminate depletion of non-renewable natural resources inflicts social, economic, and environmental harm globally. To address these issues, researchers explore utilizing waste materials in brick manufacturing to foster sustainable development, balancing environmental, material, and economic concerns. This study presents recent literature examining the incorporation of waste rubber (WR) and polyethylene terephthalate (PET) in brick production, focusing on.

**R. N. Patil,et al, 2016** They concluded Concrete remains their thermal and sound insulation properties. The building material, with its usage and applications steadily increasing in the construction industry. To mitigate cost sand address the depletion of natural coarse aggregates sourced from quarries, alternative materials are sought. The reliance on quarries for aggregates may lead to their depletion within decades if consumption rates persist. Hence, a sustainable solution is imperative. Recycling tire rubber and broken bricks as coarse aggregates offers a potential remedy, contributing to environmental preservation. This research investigates the incorporation of tire rubber and broken bricks, replacing 30% of conventional aggregates in concrete. The compressive strength of the concrete is evaluated at 7, 14, and 28 days, with a comparative analysis between waste tire rubber and broken bricks. After 28 days, the preferred replacement material, offering higher strength, is determined for sustainable aggregate use in concrete production. review underscores the potential of these raw materials to replace traditional constituents when resulting bricks meet established standards, indicating a promising avenue for sustainable brick manufacturing.

**Ankush Thakur, 2020** In India, They Described the rapid growth of the automobile sector has led to a surge in tire demand, resulting in substantial tire waste post-service. Addressing this, research has explored integrating waste crumb rubber into construction, particularly in lightweight masonry brick production. This study aims to utilize tire waste, specifically crumb rubber, to create sustainable bricks. Bricks were developed with varying crumb rubber percentages (5%, 10%, 15%, 20% by volume of fine aggregates) while maintaining a consistent water/cement ratio. Fresh properties like slump and density were evaluated, alongside mechanical properties such as compressive strength, tensile strength, and impact resistance. Regression analysis was.

**Sherif H. Helmy 2018** They Described, Globally, waste conducted to estimate tensile strength. Results indicate are generated annually, often ending up in landfills or incinerated, with detrimental environmental consequences. Recycling waste materials emerges as a prominent solution to mitigate environmental harm. Incorporating scraps into concrete production offers a viable method to manage waste, enhance concrete properties, diminish natural aggregate consumption, and serve as cementitious materials, reducing CO2 emissions that as crumb rubber percentage increases, slump and water absorption rise linearly. Initial water absorption rate increases up to 10% crumb rubber, then decreases. Compressive and tensile strength exhibit a linear decrease with higher crumb rubber content. Energy absorption significantly increased in CR20 mix compared to traditional concrete. Empirical relations effectively predict tensile strength, demonstrating alignment with observed data. clay, exacerbate resource depletion and environmental.

**Gauri Rajaram Hiwale, Mahesh Bangad, 2020** To counteract this, efforts focus on leveraging Concluded that rapid expansion of the automobile industry has led to a significant increase in tire production, yet the lack of reuse options poses a pressing environmental concern. Recent events, such as the tire fire in Kuwait's Sulaibya on August 4th, underscore the urgent need to address tire disposal challenges. This analytical research explores an innovative approach to tire recycling by integrating them into concrete construction, aiming to introduce environmentally friendly practices. The study investigates the optimal utilization of waste tires as coarse aggregate in concrete, exploring methods to enhance bonding between rubber and cement. Physical and chemical treatments of rubber aggregate will be examined to improve adhesion to cement paste. Additionally, the research explores the efficacy of synthetic rubber adhesives and polytan Crete super plasticizing concrete admixture in enhancing compressive strength. Ultimately, the goal is to design aesthetically pleasing and eco-friendly paver blocks. Keywords: Tyre Rubber, Rubberized Concrete, Compressive Strength, Synthetic Rubber Adhesives, Polytan Crete Super Plasticizing Admixture waste plastic and laterite quarry residue, along with a small amount of bitumen, to produce alternative building materials such as bricks. These bricks exhibit minimal water absorption and satisfactory strength, serving as a viable substitute for traditional laterite stone amidst rising demand. Incorporating MPW into brick production signifies a promising stride toward sustainable resource management. Further research is necessary to optimize durability,

quality, and cost-effectiveness, ensuring a balanced approach to utilizing plastic waste in construction.
**Sherif H. Helmy, 2023** They Described Globally, immense volumes of waste are annually relegated to landfills or incinerated, posing severe environmental repercussions. Recycling waste materials emerges as a prominent solution to mitigate environmental harm. Integrating scraps into concrete production offers a viable method to manage waste, enhance concrete properties, and diminish natural aggregate consumption. These scraps can also serve as cementitious materials, reducing CO2 emissions from cement production. This review highlights the utilization of recycled waste materials—rubber tires,
**Aneke Frank Ikechukwu, 2021** They concluded that of crushed glass, and crushed clay brick—in concrete, environmental pollution and the energy-intensive nature of construction material production, this study offers a systematic strategy for transforming waste into energy- efficient building materials. Focusing on waste masonry bricks (WMB), the research utilizes PET plastic waste (PPW) and recycled crushed glass (RCG) to develop sustainable construction components. Various ratios of RCG (20%, 30%, and 40% of dry mass) were incorporated into the bricks. Compressive and tensile strength tests were conducted according to South African National Standard SANS 227 to assess load-bearing capacity and durability. The WMB exhibited notable improvements in strength, with an average increase of 70.15% in tensile and 54.85% in compressive strength compared to conventional clay bricks. Despite exposure to acidic environments and wet- dry cycles, WMBs maintained mass and demonstrated superior tensile strength. This study underscores a viable approach for producing environmentally friendly masonry bricks compliant with load-bearing structure standards.
**IRFAN BASHIR et al, 2021** They concluded This report delves into the integration of municipal plastic waste (MPW) into construction practices, addressing the environmental challenges posed by non-biodegradable plastics, which contribute to land and water pollution over extended periods. The accumulation of plastic waste, particularly polyethylene (PE), within Municipal Solid Waste (MSW) is escalating, with a doubling rate every decade. Conventional construction materials, like earth- based partially replacing aggregates and cement to craft eco- friendly lightweight construction materials. Incorporating these materials led to substantial reductions in dry concrete density: 4%, 21.7%, and 31.7% for crushed glass, clay brick, and rubber tires, respectively. Waste rubber exhibited favorable results in sulfate, thermal, and impact resistance, while glass powder and finely crushed clay brick enhanced mechanical properties and thermal resistance compared to traditional concrete. Utilizing these lightweight materials efficiently produces concrete for diverse applications like road engineering, flooring, barriers, and insulation.
**Eman N. Shaqour, 2023** They Described This study explores the impact of integrating steel filings, sourced from blacksmith workshops' waste, into clay brick mixtures to enhance compressive strength while concurrently reducing workshop waste through recycling, promoting resource preservation and sustainability. Various proportions of steel filings (1%, 2%, 3%, and 4% by weight) were added to red clay brick prototypes in a laboratory setting. Pre- and post-addition of steel filings, several properties were assessed, including dimensions, weight, density, water absorption, and compressive strength. Results indicate a correlation between increased steel filings ratios and enhanced compressive strength, with the specimen containing 3% steel filings exhibiting the highest increase at 84%. Results
**Abhishek Dikshit et al, 2014** The study reveals the potential of integrating waste tyres into concrete mixes (0-10%). While rubber content reduces concrete strength, lower weight meets light concrete criteria. Higher rubber percentage enhances toughness. Modified concrete exhibits increased slump (1.08%) with 1-5% rubber. Energy generation is primarily plastic, showcasing higher toughness in rubberized concrete. Compression and split tension failures demonstrate rubberized concrete's superior toughness. Substituting 20% sand with rubber decreases split tensile (30%), flexural (69%), and compressive (37%) strengths. Moreover, compressive strength gain rate diminishes for higher rubber

percentages.
**A.Sofi et al, 2015** Increasing crumb rubber content in concrete gradually decreased compressive and flexural values. Despite this, mixes with 0–12.5% rubber still exceeded 60 MPa in compressive strength. Rubberized concrete displayed superior abrasion resistance but higher water penetration. Concrete with up to 12.5% rubber showed comparable or lower water absorption, suitable for high-strength applications.
**R. N. Patil,et al, 2016** This study advocates for utilizing specified waste materials in concrete production, offering partial substitutes for natural aggregates or cementitious materials, thereby conserving natural resources. Summarizing prior research on sustainable lightweight concrete made from waste, key points include: waste substitution for aggregates aids decomposition; rubber inclusion reduces workability, while glass and crushed clay brick enhance it; mechanical strength generally decreases with increased waste content, except for finely ground clay brick and glass powder, due to their higher crushing index and weak bond with cement paste. Additionally, compression strength increases under high temperatures.
**Sherif H. Helmy 2018** This study advises using specified waste materials in concrete manufacturing to partially replace natural aggregates or cementitious materials, conserving resources. Sustainable lightweight concrete, synthesized from waste, presents notable characteristics: waste as aggregate aids decomposition; waste tire rubber decreases workability, while glass and crushed clay brick enhance it; mechanical strength typically decreases with increased waste content, except for finely ground clay brick and glass powder due to their higher crushing index and weak bond with cement paste. Compression strength of glass concrete increases under high temperatures, while crushed clay brick concrete improves when clay brick is added as a powder. Concrete density decreases as rubber tire, crushed clay brick, and crushed glass content increases, with reductions reaching 4%, 21.7%, and 31.7%, respectively, due to the lower specific gravity of waste materials. All studied waste greatly reduces concrete's thermal conductivity, with rubber tires most effective, followed by crushed glass and crushed clay bricks. Highest shrinkage occurs in rubberized concrete, while crushed clay brick concrete exhibits the lowest due to its pozzolanic reaction. Water absorption in glass concrete decreases with increasing glass content, contrasting with crushed clay brick and rubberized concrete.
**Asena Karslıoğlu Kaya, 2019** The reviewed articles suggest advantageous ways to reuse the waste source (WR-PET) that causes environmental pollution. Based on a review of several studies on brick containing waste rubber and PET, the following conclusions can be drawn The commercial production and use of building materials produced in this way is still very limited, despite of positive outcomes of research on the use of these waste materials in brick production. Lightweight construction materials, which significantly reduce the dead load of the building, reduce the vibrations caused by earthquakes, thanks to their hollow structures. Therefore, bricks using waste NR and PET can be used especially in earthquake zones.The available studies on the production of bricks with waste PET is far less than the use ofWR.
**Ankush Thakur 2020** The influence of crumb rubber and development of brick was investigated using various percentage of crumb rubber and the results such as slump, water absorption, initial rate of water absorption, compressive strength, tensile strength and impact resistance were recorded and following constructive conclusions It was observed that the Slump and water absorption increased linearly with increase in percentage of crumb rubber whereas density of the brick was found to decrease with increase in water content.
**Gauri Rajaram Hiwale, Mahesh Bangad, 2020** The articles suggest beneficial methods for repurposing waste sources like WR-PET, mitigating environmental pollution. Despite positive research outcomes, commercial utilization of building materials from these wastes remains limited. Lightweight

construction materials, incorporating waste WR and PET, reduce building dead load and earthquake vibrations, making them suitable for seismic zones. Studies on bricks with waste PET are fewer compared to WR.

**Aneke Frank Ikechukwu, 2021** The overall result of this study and literature review shows that it is possible to use recycled tire waste as aggregate in concrete but as partial replacement to mineral coarse aggregates but it cannot be used in construction however, it can be used in manufacturing paving blocks. It is noted that, the compressive strength of rubberized concrete decreases with the increase of rubber content. This paper suggests that using different methods like using suggested admixtures, adhesives and some physical treatment to rubber aggregate can help to gain straight while replacing a higher percentage of mineral coarse aggregate with rubber.

**IRFAN BASHIR et al, 2021** This study evaluates the strength and durability of masonry bricks made from waste plastic and recycled crushed glass, aiming to reduce pollution and plastic litter. Bricks with a mix ratio of 70%:30% and 60%:40% glass to plastic show satisfactory performance. They meet specifications for load-bearing structures like retaining walls, with compressive strength exceeding fired clay bricks. The bricks exhibit ductile behavior due to PET plastic's viscoelastic properties, offering high strain energy under load. They resist sodium sulphate exposure with zero mass loss and endure long-term acidic soaking. Particle size of recycled glass affects brickstrength, with smaller particles yielding higher strength.

**IRFAN BASHIR et al, 2021** The study investigated the impact of adding steel filings to fired clay bricks on density, water absorption, and compressive strength. It explored leveraging waste from blacksmith workshops to enhance building materials and conserve resources. Increasing steel filings in the mixture raised compressive strength, with the highest increase (84%) at 3% steel filings. Options to utilize increased compressive strength include adjusting sand ratio, reducing silt-clay soil, studying thinner clay brick widths, and exploring multi-storey buildings with load-bearing clay walls.

**Sherif H. Helmy, 2023** Substituting natural resources with waste as aggregate aids decomposition. Waste tire rubber reduces workability, while glass and crushed clay brick enhance it. Sustainable lightweight concrete's mechanical strength decreases with increased waste, except for finely ground clay brick and glass powder due to higher crushing index and weak bond with cement paste. Compression strength of glass concrete rises with high temperatures; for crushed clay brick concrete, it increases when used as a powder additive. Density of sustainable concrete decreases with higher rubber tire, crushed clay brick, and crushed glass content, with reductions of 4%, 21.7%, and 31.7%, respectively, attributed to lower specific gravity of waste materials. All waste significantly reduces concrete's thermal conductivity, with rubber tires most effective, followedby crushed glass and crushed clay bricks.

**Eman N. Shaqour, 2023** The project aims to tackle plastic waste by converting it into a valuable construction material using an extruder machine, devoid of environmental risks. This method reduces reliance on natural resources and kiln pollution, yielding stronger, lighter bricks with higher water absorption. It offers versatile applications beyond bricks, including floor tiles and sleepers, proving more economical than traditional methods.

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