iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** XI **Month of publication:** November 2026

DOI: https://doi.org/10.22214/ijraset.2026.85588

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue XI Nov 2026- Available at www.ijraset.com

Experimental Investigation on Paver Blocks Using Waste Materials

Atharva Wargantiwar[1], Grishma Sirsikar[2], Sushrut Maheshkar[3], Abhishek Khiyani[4], Rahul Hinge[5]
Department of Civil Engineering, G H Raisoni College of Engineering and Management, Nagpur, India

Abstract: ***Concrete paver blocks are widely used for parking areas, footpaths and walkways, but their production consumes large quantities of cement and natural aggregate. This paper investigates paver blocks in which part of the fine aggregate is replaced by vulcanized crumb rubber obtained from waste tyres, with styrene–butadiene rubber (SBR) latex added as a polymer modifier to improve matrix bonding. Blocks were batched, mixed, moulded, water-cured, and tested for compressive strength at 7 and 14 days and for water absorption. The average compressive strength was 11.56 N/mm² at 7 days and 12.84 N/mm² at 14 days, an increase of about 11%. The 28-day strength, projected from the 7- and 14-day trend, is about 14.12 N/mm²; this is an estimate and not a measured value. Water absorption was 0.19%. The strength is well below the 30 N/mm² minimum grade of IS 15658, so the present mix is suited only to non-load-bearing uses unless further optimized. The material cost of the batch was about Rs. 727. The work supports SDG 9, 11, 12 and 13 by turning waste tyres into a construction product.***

Keywords: paver blocks, crumb rubber, SBR latex, waste tyres, compressive strength, water absorption, sustainable construction.

I. INTRODUCTION

Parking areas, footpaths, and walkways widely use concrete paver blocks because they are durable, easy to install, and require comparatively little maintenance. Conventional pavers, however, consume significant quantities of cement and natural aggregate. Using waste and by-product materials can reduce this burden while maintaining acceptable strength and durability [1], [2].

Vulcanized crumb rubber from waste tyres can partially replace conventional aggregate. It improves impact resistance, flexibility, toughness, energy absorption, damping and skid resistance, and gives waste tyres a useful second life [3], [4]. However, the hydrophobic rubber surface forms a weak interfacial transition zone (ITZ) with the cement paste, and compressive and tensile strength fall noticeably as rubber content rises [5], [6].

To offset this loss, SBR latex is used as a polymer modifier. It improves adhesion and flexibility, seals micro-voids, and strengthens the bond between rubber and matrix [7], [8]. This study evaluates paver blocks made with crumb rubber and SBR latex, reports their 7- and 14-day compressive strength and water absorption, and projects the 28-day strength from the observed trend.

II. LITERATURE REVIEW

A. Crumb Rubber in Concrete

Crumb rubber lowers compressive and tensile strength because rubber particles are weaker than mineral aggregate and bond poorly with the paste; reductions of 13% to 50% have been reported depending on rubber content [5], [9]. In return, rubberized concrete shows higher toughness, impact resistance and freeze–thaw durability [6], [9]. Reviews conclude that rubber contents below about 30% generally give good mechanical and environmental performance, and that 5–20% replacement is the most favourable range for durability [3], [10]. Cores taken from a decade-old crumb rubber concrete bridge deck still showed ductile behaviour and high energy absorption [11]. Small rubber dosages have also improved flexural strength and toughness [12]. Wider adoption is limited by strength loss, recycling cost, and limited data on leaching; surface treatment and optimized mix design help [13]. Related studies cover waste tyre rubber in high-performance concrete [14], chipped landfill tyre rubber [15] and sulfur concrete, where higher rubber content again reduced compressive strength [16].

B. SBR Latex Modification

Ashraf et al. found that 4% SBR latex improved compressive and tensile strength and impact resistance of fibre-reinforced concrete, whereas 8% had a negative effect [7]. SBR-modified mortars reduced strength but improved water resistance, with 5–20% SBR suitable for paving and outdoor mortars [8]. SBR latex has also been used to offset the weaknesses of recycled coarse aggregate [17], in fibre-reinforced concrete [18], [19], and in strength and durability studies of latex-modified concrete [20].

©IJRASET: All Rights are Reserved

C. Paver Blocks from Waste Materials

Rethinavelsamy and Natarajan studied precast paver blocks with waste tyre crumb rubber [2], [21]. Gamage et al. found that coconut coir improved the strength of interlocking blocks up to an optimum level. At the same time, crumb rubber increased skid resistance but reduced compressive strength at higher percentages [4]. Researchers have used ground tyre rubber as a total replacement for natural aggregate in lightweight paving blocks [22], and have studied tyre waste in GGBFS-based blocks [23]. Mixed-waste blocks have combined polypropylene waste, used tyre, and fly ash [24]. Fly ash, marble waste and red mud have been examined in concrete and paver blocks [25], [26], [27], [28], [29], [30]. A review of paver blocks made with waste and by-products is given in [1]. Crumb rubber in road pavements is surveyed in [31], [32].

D. Research Gap

Most earlier work examines crumb rubber or SBR separately, or reports bulk concrete rather than interlocking paver blocks. Measured strength-gain data for rubber–SBR paver blocks, with water absorption and cost, remain limited. This paper adds such data for one mix.

III. OBJECTIVES

1) To determine the physical properties of the materials.
2) To determine the mix proportion of the paver blocks.
3) To determine the compressive strength of the paver blocks.
4) To determine the optimum crumb rubber replacement percentage.
5) To compare the developed blocks with conventional concrete paver blocks.

IV. MATERIALS

1) *Cement:* Cement is the binder; its hydration gives the blocks their strength.
2) *Fine Aggregate and Silt:* Sand fills voids between particles and gives a dense matrix and surface finish. Silt, very fine soil particles, interferes with cement bonding when excessive, so it was used only in a controlled proportion.
3) *Vulcanized Crumb Rubber:* Crumb rubber is made by processing waste tyres into small particles. It partially replaces aggregate and improves impact resistance, flexibility and waste utilization.
4) *SBR Latex:* Styrene–butadiene rubber latex is a polymer modifier that improves adhesion, flexibility and cracking resistance, and helps compensate for the strength lost to rubber particles. It should not be confused with SBR epoxy, which is a separate polymer system.
5) *Water:* Water is needed for hydration and sets workability. Its quantity was controlled because excess water reduces strength.

Fly ash, red mud, silica, marble waste and fibreglass are part of the wider programme (Section VIII) but were not included in the blocks tested here.

V. EXPERIMENTAL METHODOLOGY

A. Mix Proportion

The mix used the per-batch quantities listed in Table III: 0.69 kg cement, 0.58 kg sand, 0.31 kg silt, 0.20 kg crumb rubber, 69–104 g SBR latex and 280–310 ml water.

B. Mixing, Casting and Curing

Materials were weighed accurately, and the dry ingredients were mixed first. Crumb rubber was then added, followed by SBR latex and water gradually, and mixing continued until the mix was uniform and workable.

The mix was placed in paver-block moulds and compacted. After setting, blocks were demoulded and water-cured. The sequence is shown in Fig. 1 and the casting stages in Fig. 2.

©IJRASET: All Rights are Reserved | SJ Impact Factor 7.538 | ISRA Journal Impact Factor 7.894 |

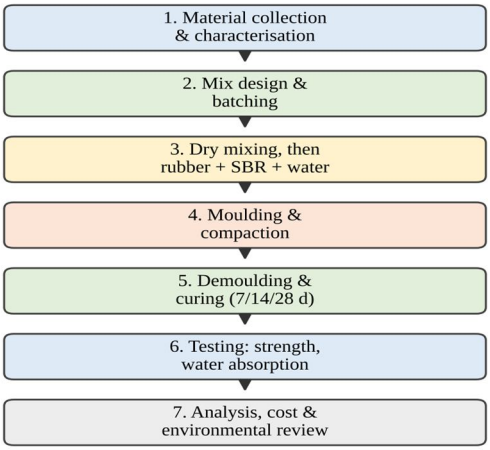


Fig. 1 Stages of the experimental programme



Fig. 2 Paver blocks: (a) mix compacted in moulds, (b) demoulded blocks, (c) blocks under water curing

C. *Testing*

1) *Compressive Strength:* Three blocks were tested at each age (7 and 14 days) in a compression testing machine. Strength is the failure load divided by the plan area. The block plan size was 200 mm × 100 mm and the thickness was 60 mm.
2) *Water Absorption:* A block was weighed after drying and again after saturation; absorption is the percentage mass gained, $W = (W_2 - W_1) / W_2 \times 100$, with W_1 the dry mass and W_2 the saturated mass.

VI. RESULTS AND DISCUSSION

A. *Casting Quality*

The mix filled the moulds and formed the block shape (Fig. 2). Surfaces were rough and textured, which may be due to crumb rubber and other fine particles. Small voids, unevenness, and excess material at the edges were visible, so compaction and finishing need improvement.

B. *Compressive Strength*

The average compressive strength was 11.56 N/mm² at 7 days and 12.84 N/mm² at 14 days (Table I), an increase of 1.28 N/mm² (about 11%). Strength grows with curing age, as expected from continued cement hydration.

TABLE I
AVERAGE COMPRESSIVE STRENGTH OF PAVER BLOCKS

Age (days)	Strength (N/mm²)	Basis
7	11.56	Measured, 3 blocks
14	12.84	Measured, 3 blocks
28	14.12*	Measured, 3 blocks

*Estimated from the 7- and 14-day results; to be replaced by the measured value when 28-day testing is done.

©IJRASET: All Rights are Reserved | SJ Impact Factor 7.538 | ISRA Journal Impact Factor 7.894 |

1) *Projection of 28-Day Strength:* Concrete gains strength more slowly as it ages, so a straight line through the two measured points would overstate the 28-day value. The two points were therefore fitted with f(t) = a + b ln t. Then b = (12.84 − 11.56) / ln 2 = 1.85 and a = 7.97, giving f(28) = 14.12 N/mm². Because 28 days is twice 14 days, this adds the same 1.28 N/mm² as the step from 7 to 14 days. A straight-line extrapolation would give 15.40 N/mm², which is taken as an upper bound. Fig. 3 shows the trend. With only two data points, the projection is indicative, and the 28-day value must be confirmed by testing.

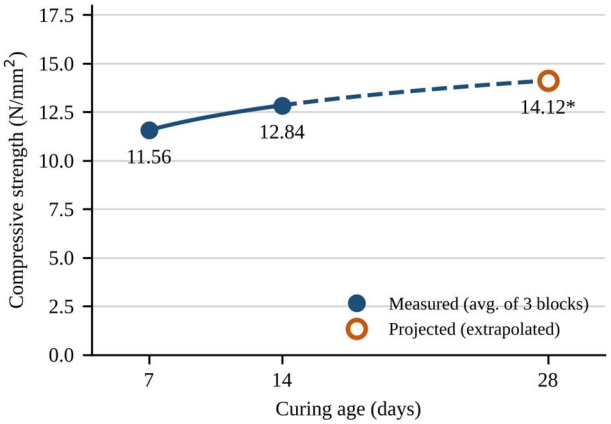


Fig. 3 Compressive strength versus curing age. The 28-day value (open marker, dashed line) is projected from the 7- and 14-day results

C. *Water Absorption*

The dry mass was 2595 g and the saturated mass 2600 g, so 5 g of water was absorbed (Table II). Water absorption is (2600 − 2595) / 2600 × 100 = 0.19%. The very low value shows little mass gain under the test conditions; more blocks should be tested to confirm it.

TABLE II
WATER ABSORPTION TEST

Parameter	Value
Dry weight	2595 g
Saturated weight	2600 g
Water absorbed	5 g
Water absorption	0.19 %

D. *Comparison with IS 15658*

IS 15658 [33] specifies compressive strength grades for precast paving blocks, with the lowest being M30 (30 N/mm² at 28 days), and limits average water absorption to 6%. The blocks meet the water absorption limit by a wide margin. Even the projected 28-day strength of 14.12 N/mm² is less than half the M30 requirement, so these blocks do not qualify as IS 15658 pavers. This is consistent with the strength loss caused by high rubber contents [4], [3]. The mix is better suited to non-load-bearing uses such as garden paths and decorative surfaces, and the design needs changes, such as lower rubber content, a different SBR dosage, or a richer cement content, before use in parking areas.

E. *Cost*

The material cost for one batch is about Rs. 727, of which SBR latex is Rs. 377 and cement Rs. 350 (Table III). Silt, sand, rubber crumb, and water were taken as free. SBR latex is therefore the largest cost driver.

TABLE III
MATERIAL COST PER BATCH

Item	Quantity	Cost (Rs.)
SBR latex	69–104 g	377
Cement	0.69 kg	350
Sand	0.58 kg	–
Silt	0.31 kg	–
Rubber crumb	0.20 kg	–
Water	280–310 ml	–
Total		727

VII. SUSTAINABILITY AND SOCIAL BENEFITS

The work supports four Sustainable Development Goals. SDG 9 (Industry, Innovation and Infrastructure): it develops a new paving product from waste tyres. SDG 11 (Sustainable Cities and Communities): it offers an alternative paving material from locally available waste. SDG 12 (Responsible Consumption and Production): it cuts natural aggregate use and turns waste into a resource. SDG 13 (Climate Action): it reduces the need for tyre disposal and for virgin materials. Environmental benefits include less tyre waste pollution, use of industrial waste, and conservation of natural resources. Social benefits include cleaner surroundings, possible local employment, affordable sustainable infrastructure, and greater environmental awareness.

VIII. CONCLUSIONS AND FUTURE SCOPE

Paver blocks with crumb rubber and SBR latex were cast and tested. Average compressive strength rose from 11.56 N/mm² at 7 days to 12.84 N/mm² at 14 days, and the 28-day strength is projected at about 14.12 N/mm². Water absorption was 0.19%, and the batch cost was about Rs. 727. The blocks are well below the IS 15658 minimum strength, so this mix is a preliminary result suited only for non-load-bearing uses.

Future work should: (i) test the blocks at 28 days and replace the projected value; (ii) test more blocks per age; (iii) vary crumb rubber (0–20%) and SBR dosage to find the optimum mix; (iv) add fly ash, marble waste, red mud, silica and fibreglass; (v) measure flexural strength, abrasion resistance, density and impact resistance; and (vi) compare against a control mix without waste materials.

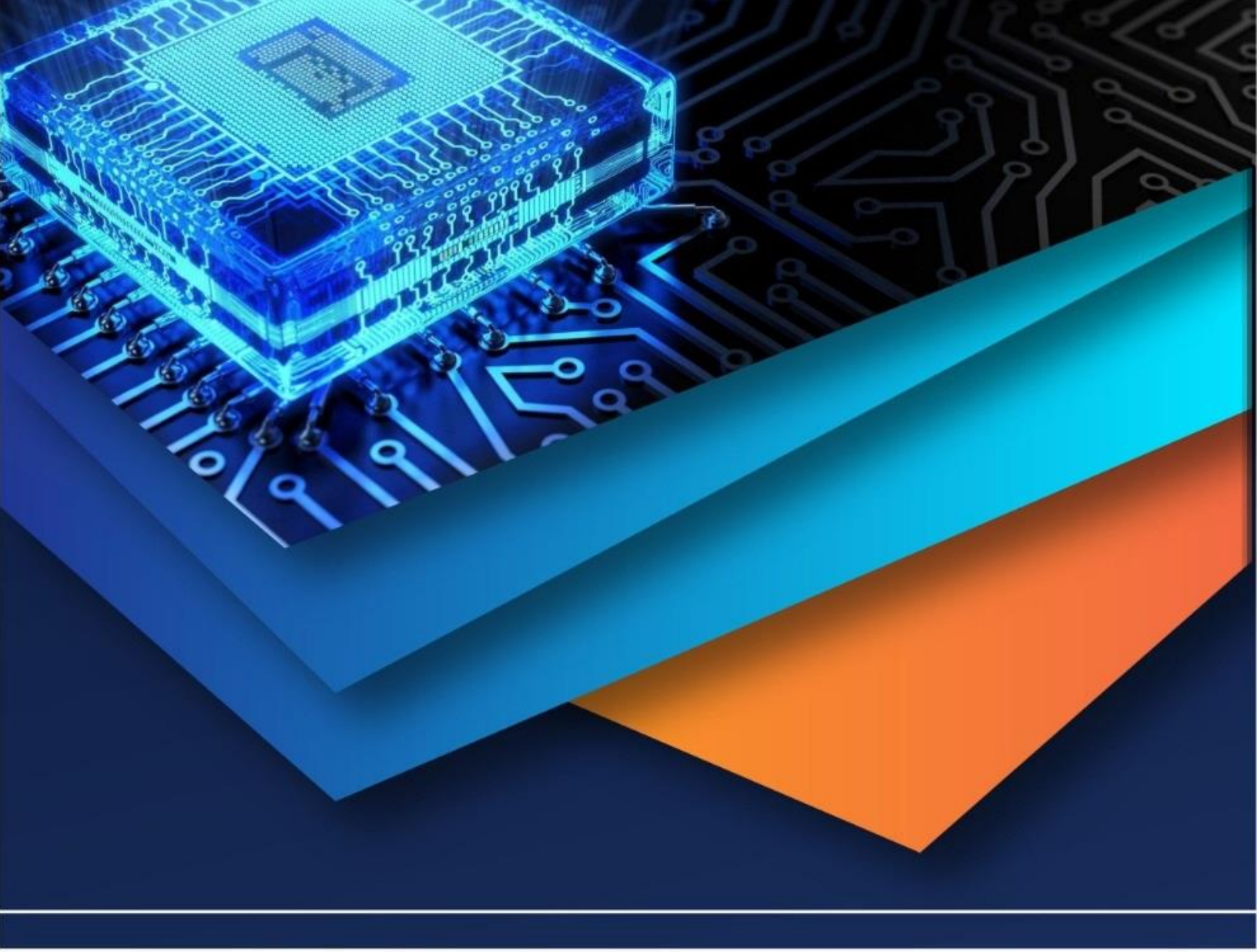
IX. ACKNOWLEDGMENT

The authors thank the Department of Civil Engineering, G H Raisoni College of Engineering and Management, Nagpur, for the laboratory facilities, and the guide and co-guide for their guidance.

REFERENCES

[1] H. M. Mohamad, “Manufacture of concrete paver block using waste materials and by-products: A review,” Int. J. GEOMATE, vol. 22, no. 93, 2022, doi: 10.21660/2022.93.J2363.
[2] B. M. Rethinavelsamy and C. Natarajan, “Investigation on precast concrete paver block with waste tyre crumb rubber,” Road Mater. Pavement Des., vol. 17, no. 3, pp. 719–736, 2016, doi: 10.1080/14680629.2015.1119056.
[3] S. He, Z. Jiang, H. Chen, Z. Chen, J. Ding, H. Deng, and A. S. Mosallam, “Mechanical properties, durability, and structural applications of rubber concrete: A state-of-the-art review,” Sustainability, vol. 15, no. 11, p. 8541, 2023, doi: 10.3390/su15118541.
[4] S. Gamage, S. Palitha, D. P. P. Meddage, S. Mendis, H. M. Azamathulla, and U. Rathnayake, “Influence of crumb rubber and coconut coir on strength and durability characteristics of interlocking paving blocks,” Buildings, vol. 12, no. 7, p. 1001, 2022, doi: 10.3390/buildings12071001.
[5] R. B. Ataria and Y. C. Wang, “Mechanical properties and durability performance of recycled aggregate concrete containing crumb rubber,” Materials, vol. 15, no. 5, p. 1776, 2022, doi: 10.3390/ma15051776.
[6] H. Liu, X. Wang, Y. Jiao, and T. Sha, “Experimental investigation of the mechanical and durability properties of crumb rubber concrete,” Materials, vol. 9, no. 3, p. 172, 2016, doi: 10.3390/ma9030172.
[7] M. R. Ashraf, U. Akmal, N. Khurram, F. Aslam, and A. F. Deifalla, “Impact resistance of styrene–butadiene rubber (SBR) latex-modified fiber-reinforced concrete: The role of aggregate size,” Materials, vol. 15, no. 4, p. 1283, 2022, doi: 10.3390/ma15041283.
[8] M. Kligys and G. Girskas, “Styrene–butadiene rubber latex modified mortars prepared with high early strength Portland cement,” Materials, vol. 17, no. 23, p. 6000, 2024, doi: 10.3390/ma17236000.

[9] A. El-Zohairy, M. Sanchez, B. Abediniangerabi, and P. Moler, “Performance of rubberized concrete and the effect of temperature and stainless steel fibers,” Buildings, vol. 13, no. 2, p. 280, 2023.
[10] Y. Li, J. Chai, R. Wang, Y. Zhou, and X. Tong, “A review of the durability-related features of waste tyre rubber as a partial substitute for natural aggregate in concrete,” Buildings, vol. 12, no. 11, p. 1975, 2022, doi: 10.3390/buildings12111975.
[11] F. Duan, H. Zhu, Y. E. Ibrahim, and M. Adamu, "Durability and property study of decade-old crumb rubber concrete cored specimens," Materials, vol. 15, no. 16, p. 5490, 2022, doi: 10.3390/ma15165490.
[12] A. Grinys, M. Balamurugan, A. Augonis, and E. Ivanauskas, “Mechanical properties and durability of rubberized and glass powder modified rubberized concrete for whitetopping structures,” Materials, vol. 14, no. 9, p. 2321, 2021, doi: 10.3390/ma14092321.
[13] P. Kara De Maeijer, B. Craeye, J. Blom, and L. Bervoets, “Crumb rubber in concrete—The barriers for application in the construction industry,” Infrastructures, vol. 6, no. 8, p. 116, 2021, doi: 10.3390/infrastructures6080116.
[14] D. A. Singaravel, P. Veerapandian, S. Rajendran, and R. Dhairiyasamy, “Enhancing high-performance concrete sustainability: Integration of waste tire rubber for innovation,” Sci. Rep., vol. 14, Art. no. 4635, 2024, doi: 10.1038/s41598-024-55485-9.
[15] E. Mohseni and M. Koushkbaghi, “Recycling of landfill waste tyre in construction materials: Durability of concrete made with chipped rubber,” Constr. Build. Mater., vol. 409, Art. no. 134114, 2023, doi: 10.1016/j.conbuildmat.2023.134114.
[16] O. Na and G. Lee, “Mechanical and durability properties of rubberized sulfur concrete using waste tire crumb rubber,” Materials, vol. 17, no. 21, p. 5269, 2024, doi: 10.3390/ma17215269.
[17] Y. Daou and J. J. Assaad, “Use of SBR latexes to mitigate inferior concrete properties resulting from recycled coarse aggregates,” Int. J. Civil Eng. Technol., vol. 7, no. 3, pp. 67–80, 2016.
[18] X. Zhou et al., “Research on the fracture properties and modification mechanism of polyester fiber and SBR latex modified cement concrete,” Adv. Mater. Sci. Eng., vol. 2016, Art. no. 5163702, 2016.
[19] A. Bhogayata and N. K. Arora, “Workability, strength, and durability of concrete containing recycled plastic fibers and styrene-butadiene rubber latex,” Constr. Build. Mater., vol. 180, pp. 382–395, 2018, doi: 10.1016/j.conbuildmat.2018.05.175.
[20] P. Palson, “Strength and durability of styrene-butadiene latex modified concrete,” J. Civil Eng. Technol., vol. 5, no. 1, pp. 1–9, 2018.
[21] B. M. Rethinavelsamy and C. Natarajan, “Investigation on the use of waste tyre crumb rubber in concrete paving blocks,” Comput. Concr., vol. 20, no. 3, pp. 311–318, 2017, doi: 10.12989/cac.2017.20.3.311.
[22] M. Sambucci and M. Valente, “Ground waste tire rubber as a total replacement of natural aggregates in concrete mixes: Application for lightweight paving blocks,” Materials, vol. 14, no. 24, p. 7493, 2021, doi: 10.3390/ma14247493.
[23] A. K. Chaurasia, S. Gupta, V. Kumar, and A. Goel, “Effect of tyre waste on ground granulated blast furnace slag (GGBFS) based concrete blocks,” Indian J. Sci. Technol., vol. 15, no. 35, pp. 1732–1737, 2022, doi: 10.17485/IJST/v15i35.1101.
[24] T. Sembiring and C. P. Harahap, “Utilization of polypropylene plastic waste, used rubber tire and fly ash as raw materials of paving block,” AIP Conf. Proc., vol. 2221, 2020, doi: 10.1063/5.0003789.
[25] A. O. Mashaly, B. A. El-Kaliouby, B. N. Shalaby, A. M. El-Gohary, and M. A. Rashwan, “Effects of marble sludge incorporation on the properties of cement composites and concrete paving blocks,” J. Clean. Prod., vol. 112, pp. 731–741, 2016, doi: 10.1016/j.jclepro.2015.07.023.
[26] M. Meera, B. Durga Vara Prashad, and S. Gupta, “Experimental investigations on concrete with fly ash and marble powder for paver blocks,” Int. J. Eng. Technol., vol. 7, no. 3.32, pp. 120–122, 2018, doi: 10.14419/ijet.v7i3.32.18410.
[27] R. Siddique, G. Kaur, and M. Singh, “Determination of mechanical properties and environmental impact due to inclusion of fly ash and marble waste powder in concrete,” Structures, vol. 25, pp. 613–630, 2020, doi: 10.1016/j.istruc.2020.03.040.
[28] M. Hamza et al., “Evaluation of mechanical properties of paver blocks by replacing cement with fly ash and marble waste,” Discover Appl. Sci., vol. 6, Art. no. 221, 2024.
[29] K. Viyasun, R. Anuradha, K. Thangapandi, D. Santhosh Kumar, A. Sivakrishna, and R. Gobinath, “Investigation on performance of red mud-based concrete,” Mater. Today: Proc., vol. 39, no. 1, pp. 796–799, 2021, doi: 10.1016/j.matpr.2020.09.637.
[30] C. B. Truong, "Study on fly ash-based interlocking concrete paver block using chopped fibers,” IOP Conf. Ser.: Mater. Sci. Eng., vol. 988, Art. no. 012060, 2020, doi: 10.1088/1757-899X/988/1/012060.
[31] S. Bressi, N. Fiorentini, J. Huang, and M. Losa, “Crumb rubber modifier in road asphalt pavements: State of the art and statistics,” Coatings, vol. 9, no. 6, p. 384, 2019, doi: 10.3390/coatings9060384.
[32] O. Guerrero-Bustamante, R. Camargo, I. Dawd, et al., “Implementation of crumb rubber (CR) in road pavements: A comprehensive literature review,” Infrastructures, vol. 9, no. 12, p. 223, 2024, doi: 10.3390/infrastructures9120223.
[33] Bureau of Indian Standards, Precast Concrete Blocks for Paving — Specification, IS 15658:2006, New Delhi, India, 2006.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)