International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 **Issue:** V **Month of publication:** May 2024

DOI: https://doi.org/10.22214/ijraset.2024.62625

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue V May 2024- Available at www.ijraset.com

Study on Replacement of Fine Aggregate with Light Weighted Super Absorbent Material in Internal Curing Concrete

Ankita Chatale[1], Dr. Mahesh Raut[2]

***Abstract:** The process by which concrete gradually acquires hardened qualities because of cement's continuous hydration in the presence of enough heat and water is known as "curing." In order to preserve concrete and get the desired results for concrete structures—that is, sufficient concrete strength, durability, and dimensional stability curing becomes necessary. Water is becoming a more scarce resource by the day, so research into ways to save water when creating concrete and building is desperately needed. In order for concrete to acquire the desired qualities in its early phases, it must be cured, or kept at a suitable moisture content. Good curing, however, is frequently impractical. Concrete's microstructure and pore structure are developed by curing, which enhances the material's performance and longevity. Although they cause a decrease in the strength of the concrete, lightweight particles can enable internal curing (IC) in concrete and lessen autogenously shrinkage and accompanying cracking. In order to determine the impact of internal curing using recycled materials, an experiment was carried out. Sawdust (SD), granite fines (GF), and powdered recycled clay (PRC) was used in part place of conventional fine aggregates.*
***Keywords:** Internal Curing Concrete, Powdered Recycled Clay, Saw Dust, Granite Fines and Recycled Fine Materials etc.*

I. INTRODUCTION

Over several years, concrete has been the most flexible building material. Concrete has an advantage over other building materials in that it can be formed into any shape for a number of applications, whether on-site or as a precast factory product. Concrete technology has advanced rapidly in the last two decades. It's difficult to picture a world without concrete. Infrastructure is built on concrete. Concrete is required to boost the structure's strength. Traditional concrete is a mix of cement, fine aggregate, coarse aggregate, and water that must set before it can be used. To attain the goals of appropriate hydration and muscle strength, a minimum of 28 days of treatment are required. Conventional concrete, which hardens naturally by retaining internal moisture (water content), might suffer from insufficient care.

A. Internal Curing Concrete

Previously, concrete was treated with external water. However, instead of the traditional heavy aggregates, shale and expanded clay are being used, which provide a source of moisture for internal hardening and encourage more complete hydration of various materials made by cement. It is feasible to add more curing water to the entire concrete mix through internal curing. To do this, some of the mix's regular aggregates are substituted. the water absorbed by the expanded shale or light clay aggregate. Concrete improvement is frequently referred to as "healing concrete from the inside out." Low water-cement ratio (w/cm) concrete benefits greatly from internal curing because the environment is naturally less permeable and external curing has less impact on the hydration of the concrete. Internal curing is "the process of pre-wetting a lightweight aggregate using a reservoir that will easily remove water needed for hydration or restore water lost through evaporation or self-drying," according to the American Concrete Institute.

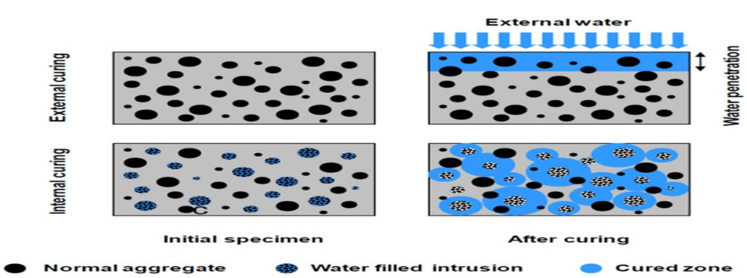

Fig. 1 Internal and external Curing process

B. Types of Curing

1) Water Retaining Techniques
2) Curing compound
3) Plastic Sheet
4) Water adding method
5) Internally Cured Concrete

C. Problem Statement

1) This investigation aims at exploring the influence of internal curing on the properties of high performance concrete. This is followed by a desire to transfer internal curing from research and lab to field experience.
2) Some parameters are selected to study like compressive strength, flexural strength and split tensile, ring test and water absorption test etc.
3) To enhance the effect of internal curing of concrete with waste aggregate and compare their result data to analyse them.

D. Objectives

1) The purpose to determine how lightweight, super-absorbent fine aggregate affects concrete's strength properties.
2) The aim is to study the mechanical property of concrete or compressive strength, by varying the proportion of cement to Sawdust (SD), Granite fines (GF), and powdered Recycled clay (PRC) for M30 grades of concrete from 0% to 35% by weight.
3) Assess internal curing using conventional methods and analyze its short- and long-term qualities to assess its advantages.
4) To investigate how absorber materials replace fine aggregate.

II. METHODOLOGY

In this research work, select internal curing concrete for study. Use *M30 grade* of concrete for experimental work. Three different materials like *GF, PRC* and *SD* used as replacement of fine aggregate. Compressive strength, split tensile and flexural strength are mainly study in this work on 7, 14 and 28 days with or without curing. Also consider ring test and water absorption test of samples.

A. Materials Used as aggregate replacement

1) Powdered Recycled Clay (PRC)
2) Saw Dust (SD)
3) Granite Fines (GF)

a) Powdered Recycled Clay (PRC) **b) Saw Dust (SD)** **c) Granite Fines (GF)**

Fig. 2 Some materials used as aggregate replacement

B. Experimental work on Concrete

1) Slump Flow
2) Compressive strength
3) Flexural Strength
4) Split tensile test
5) Water absorption

a) Slump flow b) Compressive strength c)Flexural strength

Fig. 3 Determine test on concrete soften or harden stage

1) Mix Formulation with Concrete Mix

Table 1 Mix Formulation of concrete with different materials

Mix	Cement	Sand	Aggregate	PRC
Standard	100%	100%	100%	0%
7 PRC	100%	93%	100%	7%
14 PRC	100%	86%	100%	14%
21 PRC	100%	79%	100%	21%
28 PRC	100%	72%	100%	28%
35 PRC	100%	65%	100%	35%
7SD	100%	93%	100%	7%
14SD	100%	86%	100%	14%
21SD	100%	79%	100%	21%
28SD	100%	72%	100%	28%
35SD	100%	65%	100%	35%
7GF	100%	93%	100%	7%
14GF	100%	86%	100%	14%
21GF	100%	79%	100%	21%
28GF	100%	72%	100%	28%
35GF	100%	65%	100%	35%

III. RESULT AND DISCUSSION

In this section of study, collect data generated during experimental work on samples at fresh stage and at harden stage. On harden stage test perform at *7, 14 and 28 days*. All data tabulated and graphs are prepared to understand the impact of material replacement in concrete.

A. *Slump Flow*

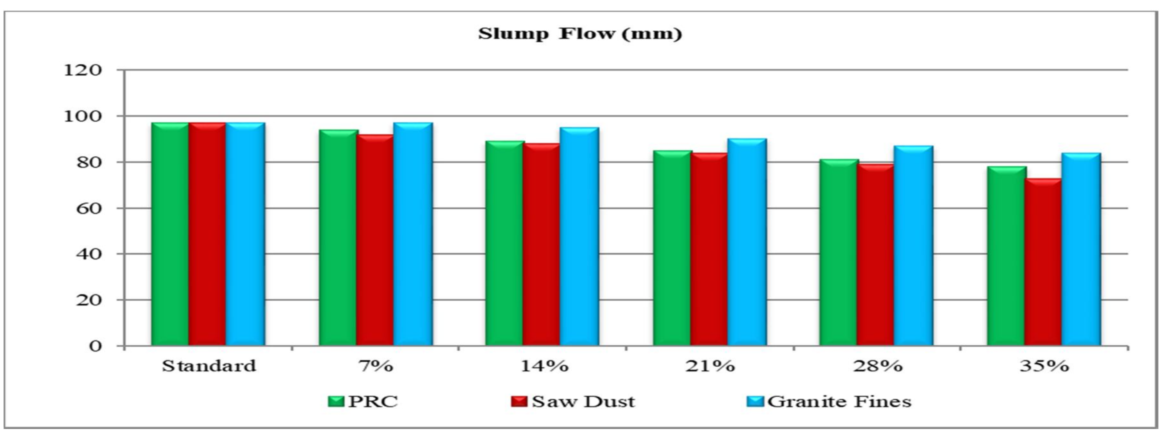

Fig. 4 Slump Flow Value of Different mix

B. Compressive Strength

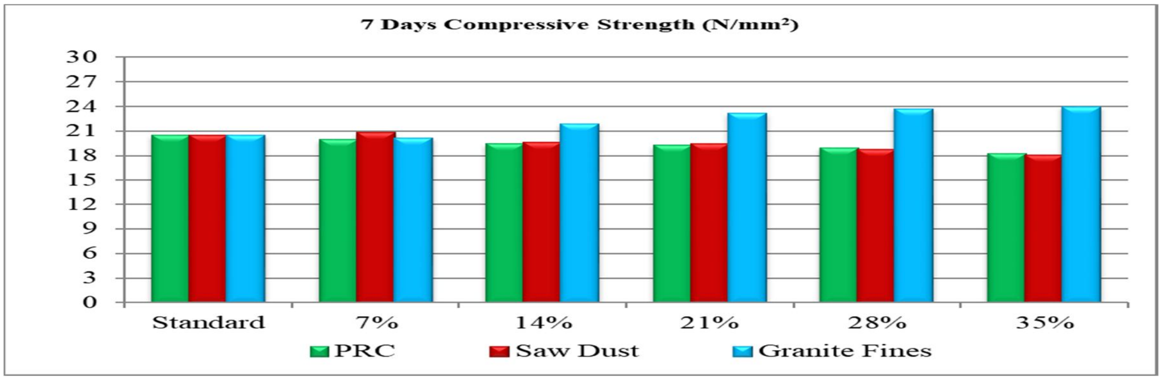

Fig. 5 Compressive strength of Different mix at 7 days

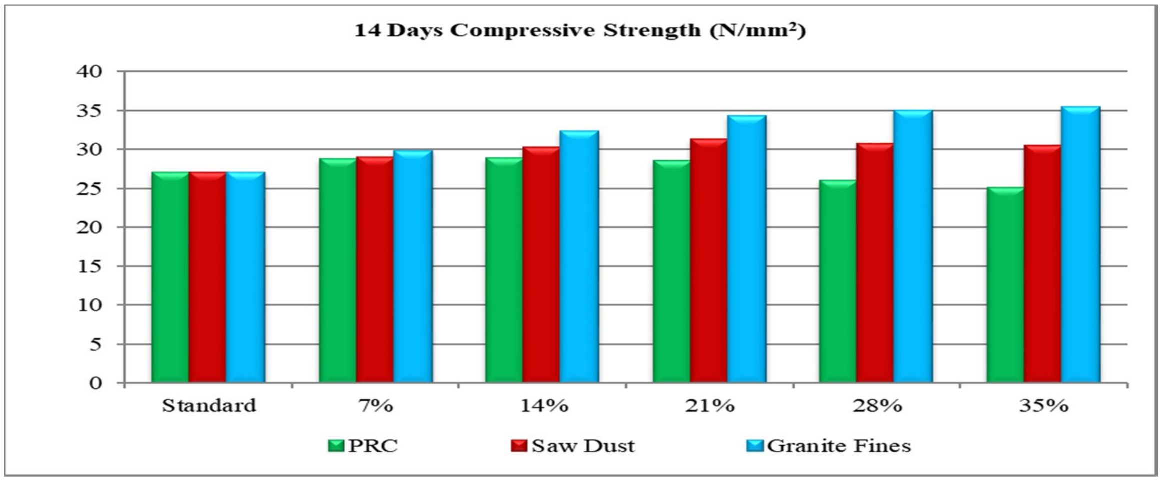

Fig. 6 Compressive strength of Different mix at 14 days

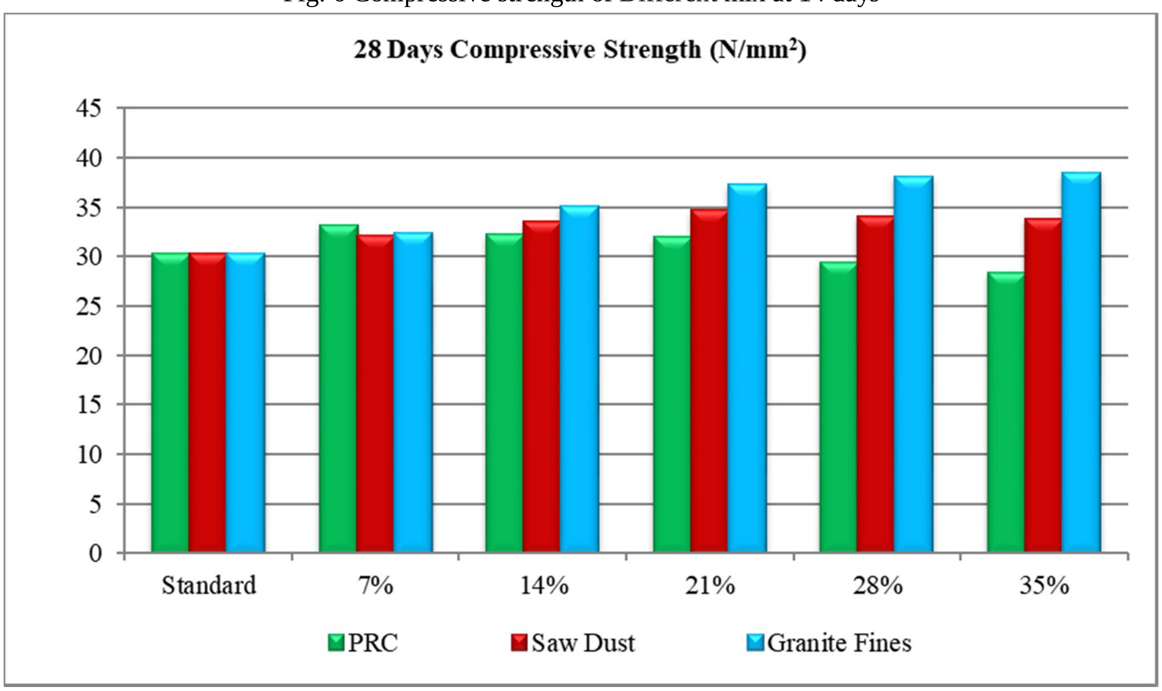

Fig. 7 Compressive strength of Different mix at 28 days

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue V May 2024- Available at www.ijraset.com

C. Flexural Strength

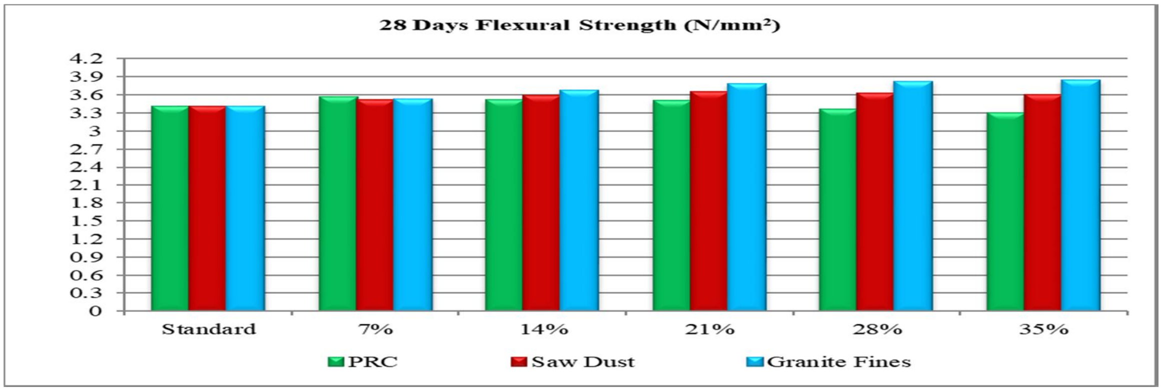

Fig. 8 Flexural strength of Different mix at 28 days

D. Split Tensile Test

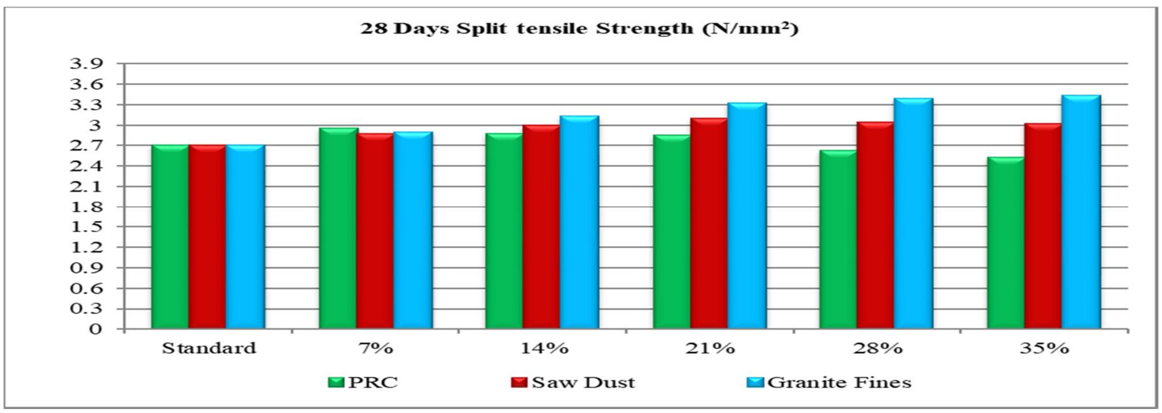

Fig. 9 Split tensile strength of Different mix at 28 days

E. Water Absorption

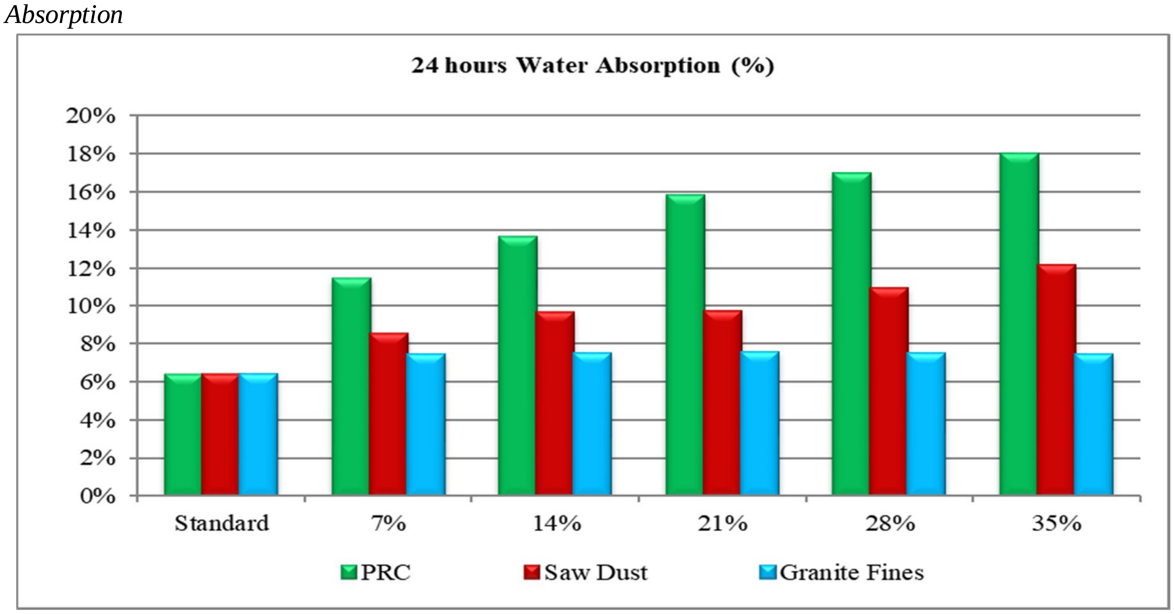

Fig. 10 Water absorption of Different mix at 24 hours

F. *Cost Comparison*

Table 2 Change in Weight effect Cost of Concrete

Mix	Compressive Strength (N/mm^2)	Water Absorption (%)	Mean Weight (kg)	% Reduction in Weight	Cost of Concrete (Rs.)	% Reduction in Cost
Standard	30.28	6.39	8.432	0.00	5437	0.00%
14%PRC	32.25	13.62	7.306	13.35	5176	4.80%
28%SD	34.10	10.92	6.815	19.17	5205	4.26%
21%GF	37.26	7.53	7.719	8.45	5082	6.53%

IV. CONCLUSIONS

The maximum value of slump flow for a normal concrete sample is 97mm. This slump value decreased linearly as sand was replaced with lighter-weighted materials. Using PRC in normal mix reduced slump flow by 19.58%. Using saw dust in regular mix reduced slump flow by 24.74%. Using Granite Fines in a normal mix reduced slump flow by 13.40%. After comparing all of the data, it is concluded that saw dust causes the most change while granite fines as the least change.

The maximum value of 7days Compressive strength for a normal concrete sample is 20.44N/mm2. This compressive strength decreased when PRC and saw dust replaced as sand and when Granite fines was replaced with sand compressive strength value continuously increased. Using PRC in normal mix reduced compressive strength by 10.91%. Using saw dust in regular mix reduced compressive strength by 11.79%. Using Granite Fines in a normal mix increased compressive strength by 17.03 %. After comparing all of the data, it is concluded that saw dust causes the least change while granite fines as the most change.

The maximum value of 14days Compressive strength for a normal concrete sample is 27.08N/mm2. This compressive strength decreased when PRC replaced as sand and when saw dust and Granite fines was replaced with sand compressive strength value continuously increased. Using PRC in normal mix reduced compressive strength by 7.42%. Using saw dust in regular mix increased compressive strength by 12.81%. Using Granite Fines in a normal mix increased compressive strength by 30.72%. After comparing all of the data, it is concluded that powdered recycled clay causes the least change while granite fines as the most change.

The maximum value of 28days Compressive strength for a normal concrete sample is 30.28N/mm2. This compressive strength decreased when PRC replaced as sand and when saw dust and Granite fines was replaced with sand compressive strength value continuously increased. Using PRC in normal mix reduced compressive strength by 6.34%. Using saw dust in regular mix increased compressive strength by 11.76%. Using Granite Fines in a normal mix increased compressive strength by 27.05%. After comparing all of the data, it is concluded that powdered recycled clay causes the least change while granite fines as the most change.

The maximum value of 28days Flexural strength for a normal concrete sample is 3.412N/mm2. This flexural strength decreased when PRC replaced as sand and when saw dust and Granite fines was replaced with sand flexural strength value continuously increased. Using PRC in normal mix reduced flexural strength by 3.22%. Using saw dust in regular mix increased flexural strength by 5.72%. Using Granite Fines in a normal mix increased flexural strength by 12.69%. After comparing all of the data, it is concluded that powdered recycled clay causes the least change while granite fines as the most change.

The maximum value of 28days Split tensile strength for a normal concrete sample is 2.701N/mm2. This tensile strength decreased when PRC replaced as sand and when saw dust and Granite fines was replaced with sand tensile strength value continuously increased. Using PRC in normal mix reduced tensile strength by 6.33%. Using saw dust in regular mix increased tensile strength by 11.77%. Using Granite Fines in a normal mix increased tensile strength by 27.06%. After comparing all of the data, it is concluded that powdered recycled clay causes the least change while granite fines as the most change.

The maximum rate of water absorption for a normal concrete sample is 6.39%. This water absorption rate increased linearly as sand was replaced with lighter-weighted materials. Using PRC in normal mix increment in water absorption rate by 1.818 times. Using saw dust in regular mix increment in water absorption rate by 0.899 times. Using Granite Fines in a normal mix increment in water absorption rate by 0.165 times. After comparing all of the data, it is concluded that Powdered recycled clay causes the most change while granite fines as the least change.

REFERENCES

[1] Kumar, K.S., Reddy, P.S. and Arunakanthi, E., 2022, March. An experimental study on mechanical and durable properties of self-curing concrete by using Ferro silica slag aggregate. In IOP Conference Series: Earth and Environmental Science (Vol. 982, No. 1, p. 012025). IOP Publishing.

[2] Faxiang, X., Dingpeng, C., Lin, J., Chuanlong, Z., Jing, R. and Xiao, L., 2021. Combined compression-shear performance and failure criteria of internally cured concrete with super absorbent polymer. Construction and Building Materials, 266, p.120888.

[3] Paul, Alvaro, et al., 2021. "The role of moisture transport mechanisms on the performance of lightweight aggregates in internal curing." Construction and Building Materials 268: 121191.

[4] Alaskar, Abdulaziz, Mohammad Alshannag, and Mahmoud Higazey, 2021. "Mechanical properties and durability of high-performance concrete internally cured using lightweight aggregates." Construction and Building Materials 288: 122998

[5] Cuevas, Karla, and Mauricio Lopez, 2021. "The effect of expansive agent and cooling rate in the performance of expanded glass lightweight aggregate as an internal curing agent." Construction and Building Materials 271: 121505

[6] He, Ziming, et al, 2021. "Research progress on recycled clay brick waste as an alternative to cement for sustainable construction materials." Construction and Building Materials 274: 122113.

[7] Nuaklong, Peem, et al., 2021. "Pre-and post-fire mechanical performances of high calcium fly ash geopolymer concrete containing granite waste." Journal of Building Engineering 44: 103265.

[8] Jones, Casey, Daniel Goad, and W. Micah Hale, 2020. "Examining soaking duration of coarse clay and shale lightweight aggregates for internal curing in conventional concrete." Construction and Building Materials 249: 118754.

[9] Liu, Qiong, et al., 2020. "Workability and mechanical properties of mortar containing recycled sand from aerated concrete blocks and sintered clay bricks." Resources, Conservation and Recycling 157: 104728

[10] Balapour, Mohammad, et al, 2020. "Potential use of lightweight aggregate (LWA) produced from bottom coal ash for internal curing of concrete systems." Cement and Concrete Composites 105: 103428.

[11] Ge, Zhi, et al., 2020. "Use of recycled fine clay brick aggregate as internal curing agent for low water to cement ratio mortar." Construction and Building Materials 264: 120280.

[12] Ozawa, Mitsuo, et al., 2019. "Preventive effects of polypropylene and jute fibers on spalling of UHPC at high temperatures in combination with waste porous ceramic fine aggregate as an internal curing material." Construction and Building Materials 206: 219-225.

[13] Ma, Xianwei, Jianhui Liu, and Caijun Shi, 2019. "A review on the use of LWA as an internal curing agent of high performance cement-based materials." Construction and Building Materials 218: 385-393.

[14] Dixit, Anjaneya, et al., 2019. "Waste Valorisation using biochar for cement replacement and internal curing in ultra-high performance concrete." Journal of Cleaner Production 238: 117876.