Coolcrete an Innovative Solution to Reduce Heating of Concrete

Ritik Jaware[1], Harshali Vibhandik[2], Rohan Khamkar[3] , Swara Gaikwad[4]

Mr.P.S.Bhoi[5], Mrs.K.H.Patel[6], Mr.P.S.Chaudhari[7], Mr.P.V.Suryawanshi[8]

[1234]Students, [5678]Lecturer

Department of Civil Engineering
K. K. Wagh Polytechnic, Nashik

---***---

Abstract – In our Project we are aiming to make a 'Coolcrete an Innovative Solution to Reduce Heating of Concrete', which contains Barium Sulphate in addition to cement, sand, aggregate and water. Barium Sulphate ($BaSO_4$) is an inorganic compound known for its high density, chemical inertness, and low thermal conductivity. When incorporated into concrete, it enhances its thermal and mechanical properties. Barium Sulphate ($BaSO_4$) has several uses including Medical Imaging, Drilling Fluids, Paints and coatings, Rubber and Plastics, Paper Industry, Glass Manufacturing and Electronics meaning the material ($BaSO_4$) has additional advantages that it reflects heat and reduces surface temperature of concrete. Coolcrete is an Innovative Solution to reduce surface temperature, Mitigate Urban Heat Island (UHI) effect where cities become significantly warmer than surrounding rural areas due to absorption of Heat by the pavement it helps for a cooler and more sustainable environment, it also Enhances durability of concrete, increases Energy Efficiency, Improve Safety of road users, requires more Time to Heat and provide High Strength.

Key Words: Coolcrete, Barium Sulphate, Low thermal conductivity, Reflects Heat, Reduces Surface temperature, Durability, Environment, High Strength.

1.INTRODUCTION

Coolcrete refers to as cool pavement or heat conductive concrete, is a novel material developed to counteract the Urban Heat Island phenomenon through the reduction of the heat absorbed and re-radiated by city surfaces. In contrast to regular concrete, which has the capacity to absorb and emit heat, leading to elevated surface and ambient temperature, heat-absorbing concrete utilizes specialty materials and additives to enhance the heat-dissipation capacity of the material. Some products employ phase-change materials, reflective aggregates, or specific polymers that reflect additional sunlight or store and release heat in a manner that cools the surface. This concrete is particularly useful in Urban Infrastructure like roads, sidewalks, and public spaces where temperature can impact comfort, public health, and energy use due to higher demand for air conditioning. Studies have demonstrated that heat-absorbing concrete can lower surface temperatures substantially, which in turn can potentially lower nearby air temperatures and reduce the severity of heat islands in urban areas.

2. KEY OBJECTIVES :-

- To Mitigate Urban Heat Island Effect
- To Lower the Surface Temperature of Concrete
- To Increase the Safety of Road Users by Reducing the Heating of Concrete
- To Enhance Energy Efficiency
- To Increase the Strength of Concrete

3. LITERATURE REVIEW :-

The literature review focuses on various innovative solutions to reduce heat absorption in concrete, highlighting research on thermal energy storage, heat-resistant materials, and sustainable alternatives. Studies on thermal energy storage (TES) in concrete emphasize the integration of phase change materials (PCMs) to enhance heat retention and efficiency. Self-compacting concrete (SCC) and geopolymer concrete (GPC) have been examined for their thermal performance, with GPC showing superior heat resistance and sustainability. Research on fly ash-based geopolymers and polystyrene concrete explores their roles in improving thermal insulation and reducing environmental impact. The addition of basalt fibers in concrete enhances mechanical properties and enables microwave-based de-icing applications. Heat treatment techniques improve the strength and durability of expanded polystyrene concrete. Studies on heat-resistant concrete for industrial applications reveal advancements in composition to withstand extreme temperatures. Research on mass concrete structures investigates the impact of ambient temperature on heat dissipation and cracking prevention. Pervious concrete is analyzed for its permeability and urban heat island mitigation properties. Additional research explores heat-reflective coatings using sol-gel technology, solar thermal collectors with optimized absorber surfaces, and thermal energy storage using latent heat materials. Collectively, these studies contribute to the development of energy-efficient and sustainable construction materials, addressing both thermal management and environmental concerns.

4. METHODOLOGY: -

Two Sets of Concrete Blocks were fabricated to assess their Suitability for Construction Applications. The first Set of Comprised of Standard 150x150x150 mm Blocks of M30 Concrete, while the second set Integrated BaSO4 [Barium Sulphate] into the mix, Maintaining the same dimensions. Both sets underwent 7, 14, 28 Days Curing period to ensure optimal strength Development and results. The primary focus to evaluate their temperature difference and compressive strength for potential use in concrete structures. Subsequently Destructive and Non-Destructive tests were conducted to evaluate their structural integrity. following the initial testing phase, the 7 days cured blocks were tested with temperature heating at sixty degrees Celsius and cooled at interval of 1 minute, 5 minutes. Same was performed with 14, 28 days cured blocks. Next the compressive testing was performed with the both sets of concrete cubes with addition of barium sulphate [BaSO4] and Normal cubes.

Mix Proportion For BaSO4 Blocks

Sr.no	Material	Weight	Unit
1	Cement	22	Kg
2	Aggregate	16.5	Kg
3	Sand	33	Kg
4	BaSO4	0.440	Kg

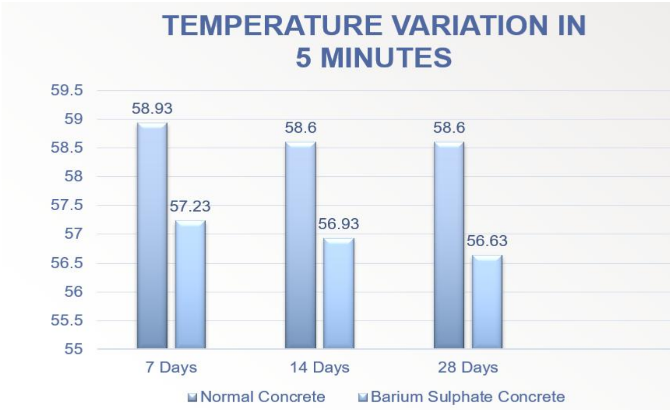
Table -1: Mix Proportion

5. RESULTS OBTAIN

All the cubes are heated at 60ºC (Average Road Temperature)

	Sr no	7 days		14 days		28 days	
		1 min	5 min	1 min	5 min	1 min	5 min
Normal cube	1	59.5	58.9	59.3	58.7	59.6	58.8
	2	59.6	58.8	59.2	58.5	59.4	58.6
	3	59.4	59.1	59	58.6	59.1	58.4
	Avg.	59.5	58.93	59.16	58.6	59.33	58.6
Barium sulfate	1	59	57.1	58.4	57.1	58.1	56.8
	2	58.9	57.2	58.5	56.8	58.5	56.6
	3	59.1	57.4	58.9	56.9	58.3	56.5
	Avg.	59	57.23	58.6	56.93	58.3	56.63
Difference of Average		0.5	1.7	0.56	1.67	1	1.97

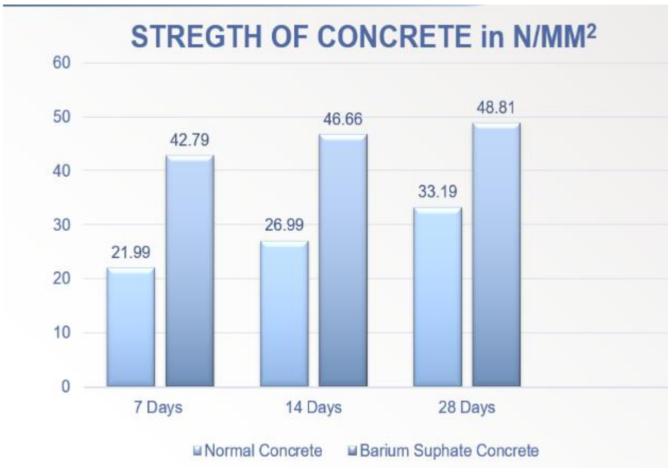
Table -2: Temperature Result

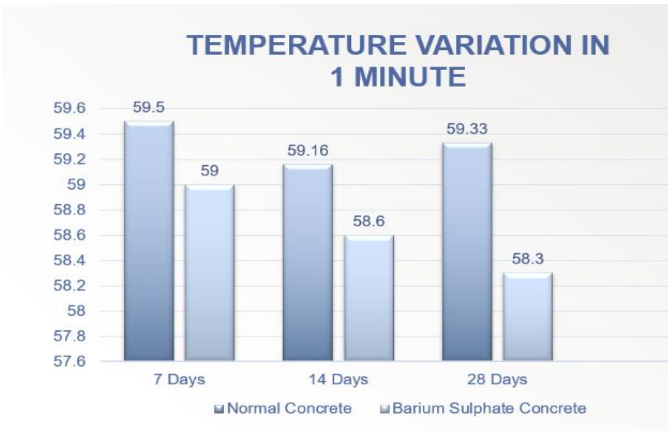


COMPRESSIVE STRENGTH RESULT

Compressive strength N/MM						
	Normal cubes			Barium cubes		
Sr.no	7 Days	14 Days	28 Days	7 Days	14 Days	28 Days
1	21.33	27.53	31.24	44.44	48.33	49.23
2	22.66	26.47	33.56	42.53	46.22	47.53
3	22	26.98	34.78	41.42	45.43	49.67
AVG.	21.99	26.99	33.19	42.79	46.66	48.81

Table -3: Compressive Strength





3. CONCLUSIONS

Coolcrete, a heat-reducing concrete solution, has shown immense potential in combating the urban heat island effect. With the use of specialized materials and optimized mix designs, Coolcrete accomplishes:

1. Lowered surface temperature: Maximum 25% reduction in surface temperature over regular concrete.
2. Enhanced thermal comfort: Increased pedestrian comfort and decreased heat stress.
3. Energy efficiency: Potential energy savings through lowering cooling requirements.
4. Environmental benefits: Support for reducing the urban heat island effect and enhancing air quality.

The success of Coolcrete in development and testing demonstrates the viability of innovative, sustainable solutions in concrete. As infrastructure growth is fueled by urbanization, Coolcrete provides an important instrument for building more livable, resilient cities. Through further developing and adopting Coolcrete, we can build more livable, sustainable cities for future generations.

ACKNOWLEDGEMENT

We take this opportunity our deepest sence of gratitude and sincere thanks to those who have helped us in completing our research. We express our sincere thanks to our guide Mr.P.S.Bhoi, our Co-guide Mrs.K.H.Patel, Mr.P.S.Chaudhari, Mr.P.V.Suryawanshi Lecturer in Civil Engineering Department of K.K.Wagh Polytechnic, as as they have guided us in achieving goal of our project by appropriate guidance.

REFERENCES

1. Salim Barbhuiyaa, Bibhuti Bhusan Dasb, Maria Idreesc. Journal of Building Engineering 85(2024) 108302.
2. Ahmed M Ebid[1], Kennedy C Onyelowe[2,3,4*], Denise-Penelope N Kontoni [4,5],Alberto Quintana Gallardo[6] and Shadi Hanandeh[7]. International Journal of Low-Carbon Technologies 2023, 18, 404–411
3. Mona Sando , Dietmar Stephan. Case Studies in Construction Materials 21 (2024) e03407
4. Rimma Niyazbekova[1],Gabit Mukhambetov[1], Rassul Tlegenov[2], Saule Aldabergenova[2], Lazzat Shansharova1, Vasiliy Mikhalchenko[1] and Michał Bembenek[3]. Energies 2023, 16, 4092
5. Aqing Jiang[1], Zihao Song[1], Xuancang Wang[1], Jing Zhao[1] and Junru Ren[2]. Sustainability 2023, 15, 15919.
6. Murat Rakhimov[1], Galiya Rakhimova[1], Tatyana Samoilova[1], Nurlan Zhangabay[2]. Technobius, 2024, 4(2), 0059.

7. Anatoly Grigoryevich Goltsev, Murat MametkulovichAlimkulov, MarzhanYessenbekovna Rakhymberdina, Valeriy Chernavin, Ayazhan Aitkazin. Research square posted 05 Mar, 2024
8. Jiaming Zhang[1,2], Hongshi Zhang[3], Yunpeng Zhao[1], Wenqiang Xu[1], Min Su[4], Jinyu Ge[2] and Sheng Qiang[1]. Materials 2024, 17, 2187.
9. Md Tushar Ali[1] and Md. Harunur Rashid[2]. 7th International Conference on Civil Engineering for Sustainable Development (ICCESD 2024), Bangaladesh.
10. Natalia Sapogova, Vladimir Bredikhin , Andrey Afanasiev, Vladislav Kamensky and Nikita Bityurin.
Photonics 2021, 8, 423
11. Abdelmoumene Messaoud[1], Mohammed Benatallah[2], Abderrahim Benmoussat[3], Nadjem Bailek[4], Ahmed Mediani[5].
Article in NeuroQuantology · November 2023
DOI: 10.48047/nq.2023.21.7.nq23051
12. Mikhajlov Mikhail Mikhajlovich (RU)
RUSSIAN FEDERATION RU 2 606 446 C1
13. Thomas Mayer-Gall [1,2], Leonie Kamps [1], Thomas Straube [3], Jochen S. Gutmann [1,2] and Torsten Textor [4,5]. Gels 2023, 9, 795
14. Exploring the Relationship Between Heat Absorption and Material Thermal Parameters for Thermal Energy Storage
Law Torres Sevilla and Jovana Radulovic
15. Tadahiro Wada, Shinichi Enoki
2021 12th International Conference on Mechanical and Aerospace Engineering
16. Menahil Mahmooda, Hadiya Ameena, Muhammad Farooq Zafarb, Syed Wilayat Husaina
Proceedings of 2019 16th International Bhurban Conference on Applied Sciences & Technology (IBCAST)
17. Natalia Demidenko, Levan Ichkitidze, Denis Murashko, Uliana Kurilova
978-1-7281-0339-6/19/$31.00 © 2019 IEEE
18. Masami Iio , Makoto Yoshida, Tatsushi Nakamoto , Kento Suzuki , Michinaka Sugano , and Toru Ogitsu
IEEE TRANSACTIONS ON APPLIED SUPERCONDUCTIVITY, VOL. 30, NO. 4, JUNE 2020
19. Kang Li, Yun Bai, Qiang Liu, Jinhui Li, Zhipeng Li, Wenxue Dai, Xuefan Wang, Guoping Zhang
2022 23rd International Conference on Electronic Packaging Technology (ICEPT) | 978-1-6654-9905-7/22/$31.00 ©2022 IEEE | DOI: 10.1109/ICEPT56209.2022.9872644
20. Dawod M. R. Al-qadasi, Ahmed S. Menesy, Ping Wang, Najib M. Alfakih, Qianjin Zhang, Mohamed I. Mosaad, Salah Kamel
2021 IEEE International Conference on Automation/XXIV Congress of the Chilean Association of Automatic Control (ICA-ACCA) | 978-1-6654-0127-2/21/$31.00 ©2021 IEEE | DOI: 10.1109/ICAACCA51523.2021.9465288