Sustainable Urban Infrastructure: Professional Perspectives on Self-Curing Concrete in Mumbai Metropolitan Region

Dada Subhash Patil[1], Fauwaz Abdul Majid Parkar[2]

[1,2]Associate Professor, Department of Civil Engineering, School of Engineering and Technology, Anjuman-I-Islam's Kalsekar Technical Campus, Panvel, Navi Mumbai-410 206, India
*Corresponding author email ID: dada.patil@aiktc.ac.in

Abstract. Conventional curing of structural concrete requires substantial volumes of potable water, creating sustainability concerns in water-scarce regions such as Mumbai Metropolitan Region (MMR). The continued reliance on such water intensive practices conflicts with the objectives of resource efficiency and urban resilience. Self-Curing (Internally Cured) concrete has emerged as an innovative alternative, capable of reducing external water demand during hydration. Its application directly contributes to sustainable development goals, particularly in water conservation and construction sustainability.

To assess professional perceptions, a structured questionnaire survey was designed targeting civil engineering practitioners. The instrument was circulated among professionals working within the MMR. A total of 105 valid responses were received, encompassing 15 multiple choice questions on awareness, applicability, and perceived benefits of Self-Curing concrete. The data set reflects the perspectives of practicing engineers engaged in diverse infrastructure projects across MMR. Further, M30 grade concrete mix was prepared. A set of 3 cubes (150 mm x 150 mm x 150 mm) was placed under water for 28 days' curing; three sets, each having 3 cubes with 0.3%, 0.4% and 0.5% dosages of Self-Curing additive Super Absorbent Polymer (SAP) were placed in an open air to self-cure.

Survey analysis revealed that over 95% of respondents strongly supported the inclusion of Self-Curing concrete in municipal and national codes. Respondents also emphasized its potential role in achieving sustainable infrastructure and smart city initiatives. The findings highlight a clear professional consensus on the necessity of adopting Self-Curing concrete in Indian construction practice. It is recommended that policy makers and municipal authorities integrate Self-Curing concrete into codes and guidelines to promote long term sustainability in urban infrastructure. 28 days' compressive strength test results on M30 grade concrete revealed that the SAP-incorporated samples exhibited strength on par with the water-cured sample.

Keywords: Self-Curing concrete, sustainable development, water conservation, smart city, standard codes

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1 Introduction

Concrete, the most widely used construction material, demands proper curing to ensure hydration of cementitious phases and development of strength and durability. The Indian Standard IS 6461-Part VII defines curing as the maintenance of adequate moisture and temperature in freshly placed concrete for a specified period to achieve satisfactory hydration and hardening [1]. Conventional curing methods such as ponding, spraying, or covering with wet hessian are effective in principle but often impractical in large scale or resource constrained projects. They are labor-intensive, water-intensive and frequently neglected on site leading to compromised concrete quality [2–4].

1.1 Limitations of Conventional Curing Methods

Traditional curing practices such as ponding, spraying or covering with wet burlap are widely used for structural elements including slabs, beams, columns and foundations. However, these methods require large volumes of water and are often impractical in regions facing potable water shortages or in remote project locations. Their efficiency is particularly limited in high performance concretes (HPCs) with low water/cement ratios. In practice, external curing in India is further constrained by labor dependence, inconsistent application and lack of awareness. While inadequate curing duration leads to insufficient hydration, over-curing wastes water through evaporation and runoff.

The effectiveness of external curing largely depends on the permeability of concrete in the early hydration stages. Within 2–3 days, hydration products begin to block the capillary pore network, restricting water penetration and limiting continued hydration. Consequently, external curing often fails to protect the surface zone beyond 30–50 mm under normal exposure, reducing strength and durability [5]. Thick members remain vulnerable to thermal cracking, while concretes with water/cement ratios < 0.35 are prone to chemical shrinkage, self-desiccation and autogenous shrinkage that external curing cannot mitigate [6]. Surface applied curing compounds can slow evaporation but provide no additional water to sustain hydration, making them ineffective for shrinkage control in low water/cement systems. Furthermore, their membrane forming action interferes with surface finishing and bonding treatments, further limiting performance [7].

These limitations underline a critical research gap: conventional external curing methods cannot simultaneously address water scarcity, durability and microstructural challenges of modern concretes. This necessitates alternative strategy such as Self-Curing (Internal Curing), which provides a more sustainable and technically reliable approach.

1.2 Water Shortage v/s Huge Water Consumption for Concrete Curing

For the production of 1 m^3 of hardened concrete, nearly 3 m^3 of water is typically required, with curing constituting the major share of this demand [8]. Such intensive consumption, combined with competing human needs, has contributed to ecological imbalance and increasing stress on water resources. Recognizing this, the National Water Mission under the National Action Plan on Climate Change (NAPCC) has set a target of enhancing water-use efficiency by 20% across the sectors [9].

In conventional practices, water demand for curing varies with the technique and environmental exposure. Ponding generally consumes about 5 L/m^2/day, while wet hessian covering requires approximately 3 L/m^2/day [10]. Considering an average value of 4 L/m^2/day and a typical curing duration of 3–5 days, the total water requirement for curing amounts to 12–20 L/m^2 of concrete surface [10]. At the national scale, construction growth projections indicate nearly 30 billion m^2 of urban built-up area by 2040, with an estimated annual addition of 1.5 billion m^2 as per India Energy Outlook-2021 [11]. Assuming concrete as the primary construction material, this translates to an annual curing water demand of approximately 18–30 billion litres up to 2040.

These estimates highlight the unsustainable scale of water consumption associated with conventional curing, underscoring the urgent need for alternative strategies to reduce water usage while ensuring durability and performance of concrete structures. Water scarcity in rapidly urbanizing regions has forced several communities to rely on alternative sources of supply. Frequent disruptions in municipal distribution have led to reliance on tanker based delivery [12], as illustrated in Fig. 1.

Fig. 1. Tanker water supply in Kharghar, Navi Mumbai amid municipal shortage [12]

News report further underscores the severity of the situation; for example, the Hindustan Times (April 02, 2025) highlighted demands by Kharghar housing societies to halt new projects due to acute shortages in municipal water supply [12]. Paradoxically, while residents struggle for essential water, enormous quantities continue to be consumed in construction, particularly for concrete curing. The magnitude of this utilization is depicted in Fig. 2, emphasizing the urgent need to adopt water-efficient curing strategies.

Fig. 2. Image depicting enormous water requirement associated with conventional concrete curing

1.3 Self-Curing Concrete or Internally-Cured Concrete

Cement hydration strongly depends on internal moisture. When pore relative humidity (RH) falls below 80%, hydration slows and below 30%, it almost stops [13], resulting in insufficient calcium silicate hydrate (C–S–H) formation [14]. Self-Curing offers an effective solution, particularly in low water/cement ratio concretes where chemical shrinkage and low permeability limit external curing. SAP, cross-linked hydrogel that absorbs and gradually releases water, is widely used to sustain internal humidity [13]. Shrinkage Reducing Admixtures (SRAs) such as acrylic acid, paraffin wax, polyvinyl alcohol, polyethylene glycol and propylene glycol are also employed. Added as a proportion of cement mass, SRAs lower the surface tension of pore water, reducing its chemical potential and vapor pressure, which in turn decreases evaporation and promotes continuous hydration [15, 16].

Alternatively, prewetted lightweight aggregates (LWAs) such as expanded clay, sintered fly ash, perlite, pumice, and expanded shale can serve as internal reservoirs. Incorporated as partial volumetric replacements of fine or coarse aggregates, they desorb water gradually, sustaining the hydration process [15]. Self-Curing through these mechanisms effectively mitigates self-desiccation, autogenous shrinkage, shrinkage induced cracking, plastic shrinkage cracking and excessive water absorption [17]. The benefits are especially pronounced in arid regions, where elevated temperatures and low RH would otherwise demand large volumes of curing water and extended curing durations due to accelerated evaporation [18]. Self-Curing saves considerable water quantity, leading to a sustainable development. Water penetration depth is influenced by concrete quality and age in case of external curing. On the contrary, Self-Curing facilitates in uniform water distribution throughout the concrete mass (see Fig. 3) [19].

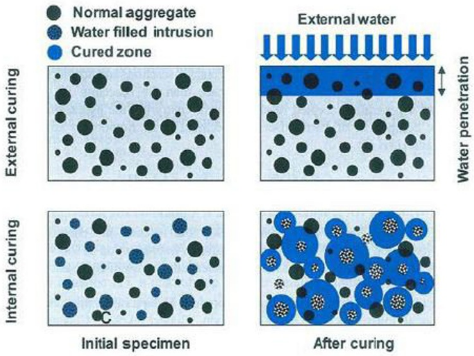

Fig. 3. Difference between external curing and Self-Curing

On MMR construction sites, early age external water curing is a problematic issue owing to the lack of awareness among labors or other inevitable conditions [20]. Climatic and geomorphological factors significantly influence concrete strength, as high temperatures accelerate moisture loss and hinder proper hydration, while cold conditions can slow the setting mechanism and cause early age cracking. Local soil chemistry such as sulphate rich or saline environments may chemically attack concrete and weaken its long term performance [3]. Additionally, using hard water for external curing with excessive chlorides, sulphates, or magnesium can interfere with cement hydration and reduce strength development [21].

1.4 Role of Self-Curing Concrete for Sustainable Infrastructure Development

Rapid urbanization, compounded by climate change, population density and resource depletion is exerting unprecedented pressure on modern infrastructure. To meet the demands of sustainable urban development, construction practices must advance toward efficiency, durability and environmental sustainability. Self-Curing concrete emerges as a viable and sustainable alternative to conventional curing, offering significant benefits for future projects within the MMR, including high rise buildings, precast elements, smart pavements, urban mobility corridors, data centers, hospitals, tunnels and deep foundations. Its adoption directly contributes to sustainability in the following ways:

Water Conservation

Challenge. Conventional curing consumes large quantities of potable water, particularly in large scale projects.

Solution. Self-Curing concrete reduces or eliminates the need for external curing.

Impact. Conservation of water resources, a critical concern in water-stressed urban contexts.

Durability and Service Life

Improved Hydration. Self-Curing ensures continuous cement hydration, especially in HPCs.

Reduced Cracking. It minimizes shrinkage and thermal cracking, leading to fewer repairs and extended service life.

Impact. Long lasting structures, lower maintenance demands and reduced resource consumption over time.

Construction Efficiency

No External Curing. Self-Curing eliminates labor-intensive curing practices.

Adaptability. It is highly effective for vertical and inaccessible construction sites.

Impact. Streamlined project execution, cost efficiency and improved construction timelines.

Carbon Footprint Reduction

Extended Lifespan: Reduced maintenance lowers embodied carbon throughout the structure's life cycle.

Material Optimization: Enhanced performance enables optimized mix designs with reduced cement content, lowering CO_2 emissions.

Impact: Tangible contribution toward climate change mitigation.

Enhanced Performance in Smart Infrastructure

Structural Integrity: Self-Curing promotes uniform strength development.

IoT Integration: It *s*upports the reliability of sensor-based, data-driven monitoring systems.

Impact: This enables robust infrastructure compatible with smart city initiatives.

Green Building Compliance

Certification Support: It contributes credits under IGBC, LEED and BREEAM categories, including water efficiency, material optimization and innovation.

Impact: It facilitates certified green buildings, aligning with sustainable and smart infrastructure mandates.

2 Methodology

A structured online survey was conducted using Google Forms to capture the perceptions and practices of civil engineers regarding concrete curing methods in the MMR. The survey targeted professionals from contracting firms, consulting organizations, client organizations, RMC plants, government establishments, builders and other stakeholders such as BIM consultants and project management professionals. Respondents' work experience ranged from 1 to over 10 years, ensuring representation across experience levels.

The survey comprised 15 questions addressing conventional curing practices, duration and quality of curing, feasibility challenges, awareness and adoption of Self-Curing concrete, perceived benefits, barriers and its potential role in sustainable urban development and smart city initiatives. Responses were collected and analyzed quantitatively, with results presented through figures and tables to identify trends, preferences and key barriers to adoption of Self-Curing concrete in MMR infrastructure projects.

Concrete mix design for M30 grade concrete was carried out as per Indian Standard codes [21, 22]. The target strength, considering risk factor and standard deviation [22], after 28 days' curing was fixed at 38.25 N/mm^2. Mix proportions per m^3 were: Ordinary Portland Cement 53 Grade- 345 kg, fine aggregates – 820 kg, coarse aggregates: 20 mm- 600 kg, 10 mm- 600 kg, mixing water-155 liters. The SAP dosages were 0.3%, 0.4% and 0.5% by mass of cement. The 28 days' density and compressive strength values of a set of 3 water-cured cube specimens and three sets of air-cured Self-Curing cube smaples were determined, after the experimental work.

2.1 Distribution of Survey Respondents by Sector and Experience

The responses received from the engineers in contracting firms were 33 (31.42%); that from consulting firm were 26 (24.76%); that from client organization were 13 (12.38%); that from RMC plant were 8 (7.62%); that from Government establishments were 5 (4.76%); that from builder firms were 12(11.43%) and 7 (6.67%) responded from "others" category like BIM consultant, EPC contractor, precast manufacturer, project management consultant, trust and engineering college faculty practicing in the field (see Fig. 4).

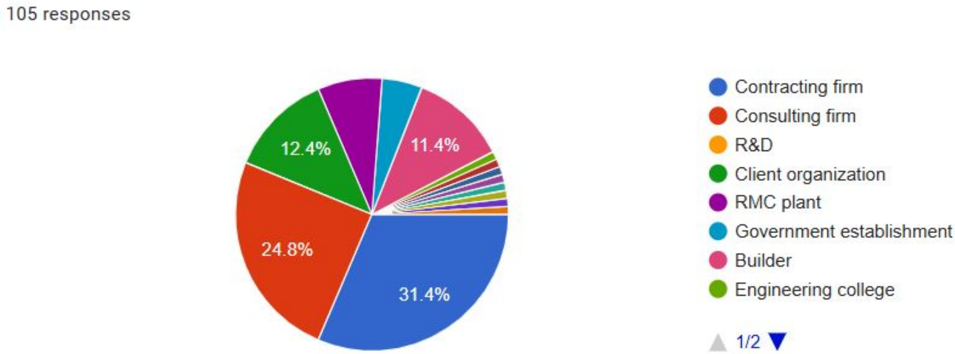

Fig. 4. Type of organization

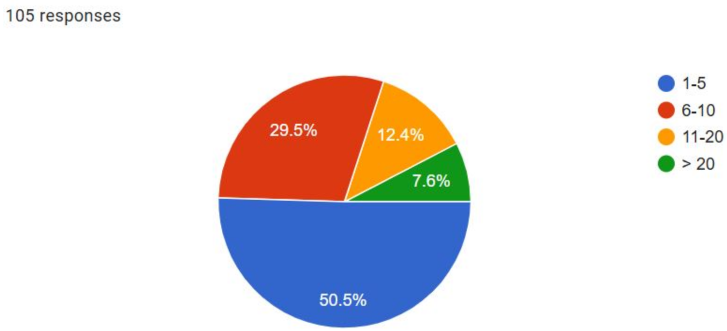

Fig. 5. Work experience (years)

It can be seen from fig. 5 that more than half of the respondents had an experience ranging between 1 and 5 years.

3 Results and Discussion

The following analysis presents the insights obtained from engineers regarding their current curing practices, perceptions of feasibility in urban environments and awareness of emerging sustainable techniques. It also highlights the perceived benefits, barriers to adoption and the potential role of Self-Curing concrete in achieving long term sustainability goals and smart city infrastructure development.

3.1 Google Form Survey Analysis

The following section presents the survey questions along with the corresponding analysis of respondents' answers.

Q. (1) What is the most commonly used method of curing on your construction sites?

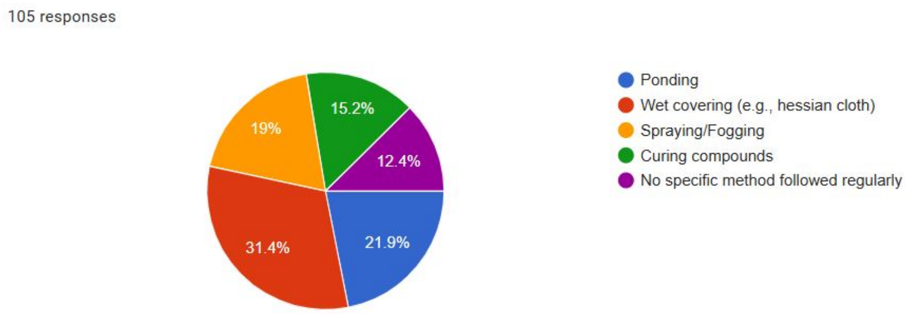

Fig. 6. Method of curing

Fig. 6 shows the preferred methods of curing on the constructions sites. Except the application of curing compounds, all the methods consume huge amount of water.

Q. (2) How long is concrete typically cured at your sites?

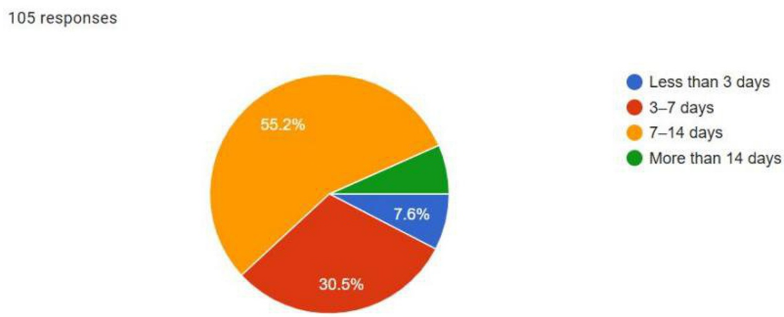

Fig. 7. Curing period

More than half the engineers conveyed 7 to 14 days of curing (see Fig 7). This curing period is quite acceptable. Curing less than a week is highly undesirable. Though curing for more time period enhances the concrete properties, huge water consumption is a significant factor leading to unsustainable practice in terms of water conservation.

Q. (3) Which factors make traditional curing methods less feasible in densely populated urban areas like MMR? (Choose all that apply).

60% engineers admitted that time constraint on fast paced projects make conventional curing techniques less feasible. Table 1 gives the self-explanatory details.

Table 1. Factors Affecting Feasibility of Traditional Curing Methods in MMR.

Sr. No.	Factors	Respondents (%)
1	Water scarcity	54.3
2	Space constraint for curing set up	44.8
3	Environmental regulations on water use	24.8
4	Time constraint on fast-paced projects	60
5	Difficulty in supervision/quality control	43.8
6	Delays due to curing time	41
7	Higher labor cost	19

Q. (4) How often is curing quality compromised (got affected badly) due to site limitations?

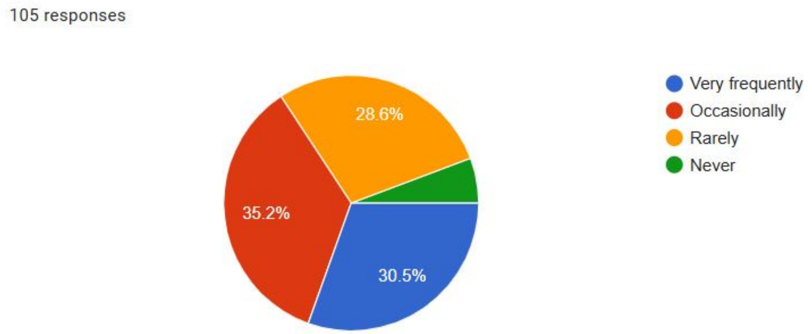

Fig. 8. Compromised curing quality due to site limitations

30.5% and 35.2% respondents, respectively, had an opinion that curing quality was compromised very frequently and occasionally.

Q. (5) Does the construction industry need better alternatives to conventional curing methods for high rise and urban infrastructure projects?

46.7% engineers felt an urgent need of better alternatives to traditional curing methods. However, 50.5% respondents thought that there is a need, but current curing methods are still adequate. One professional thought that conventional curing is sufficient; whereas, not sure was the response by two engineers (see Fig. 9).

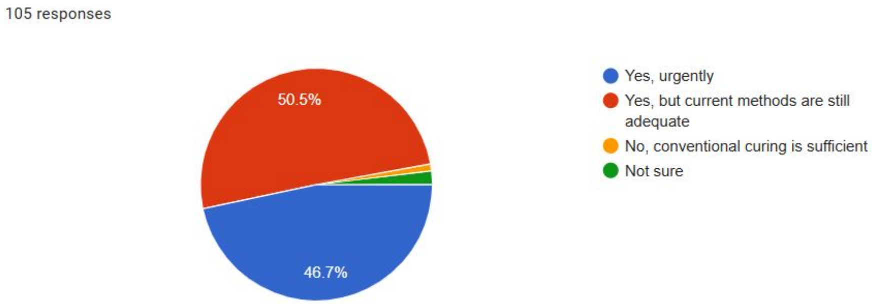

Fig. 9. Need of alternative curing methods

Q. (6) Are you familiar with the concept of Self-Curing (Internally-Cured) concrete?

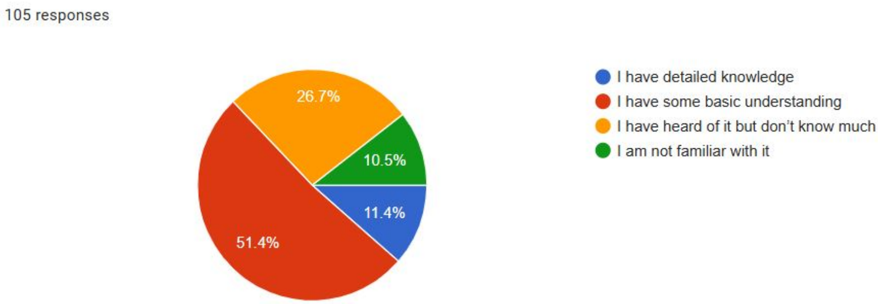

Fig. 10. Familiarity with Self-Curing Concrete

More than half of the engineers had some basic understanding about the concept of Self-Curing (see Fig. 10)

Q. (7) In your opinion, what are the main benefits of Self-Curing concrete? (Choose all that apply).

Table 2. Main Benefits of Self-Curing Concrete.

Sr. No.	Factors	Respondents (%)
1	Water conservation	69.5
2	Reduced labor and time	71.4%
3	Improved durability	55.2
4	Improved hydration in inaccessible areas	61.9
5	Lower maintenance requirements	41
6	No idea	3.8%

71.4% respondents felt that reduced labor and time is the main benefit of Self-Curing concrete; followed by 69.5% engineers admitting that water conservation is a major benefit (see Table 2).

Q. (8) Have you ever used or specified Self-Curing concrete in any of your projects?

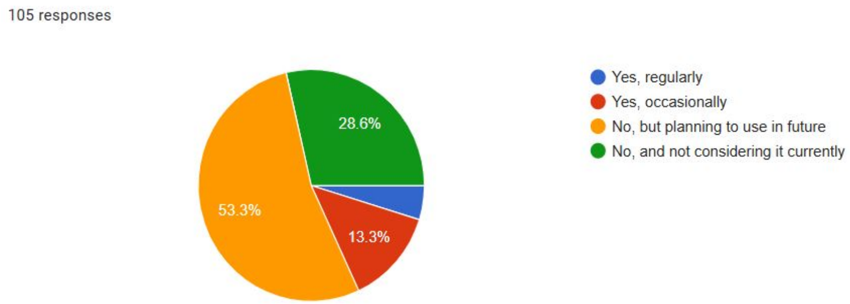

Fig. 11. Use of Self-Curing concrete

53.3% engineers have never used Self-Curing concrete, but they are planning to use it in future. 5 engineers (4.8%) are using it regularly (see Fig. 11). It's a small number. It needs to be practiced on a considerably large scale.

Q. (9) What are the main barriers for adopting Self-Curing concrete in MMR projects? (Choose all that apply).

Table 3. Main Barriers for Adopting Self-Curing Concrete in MMR Projects

Sr. No.	Factors	Respondents (%)
1	Lack of awareness	69.5
2	Higher initial cost	42.9
3	Limited availability of Self-Curing additives	35.2
4	Lack of skilled labor or technical know-how	46.7
5	Resistance to change	35.2
6	Not approved in standard code	30.5
7	No perceived advantage over conventional methods	12.4

Lack of awareness is the main barrier to adopt Self-Curing concrete as per 69.5% engineers (Table 3).

Q. (10) Which sustainability goal Self-Curing concrete supports the most?

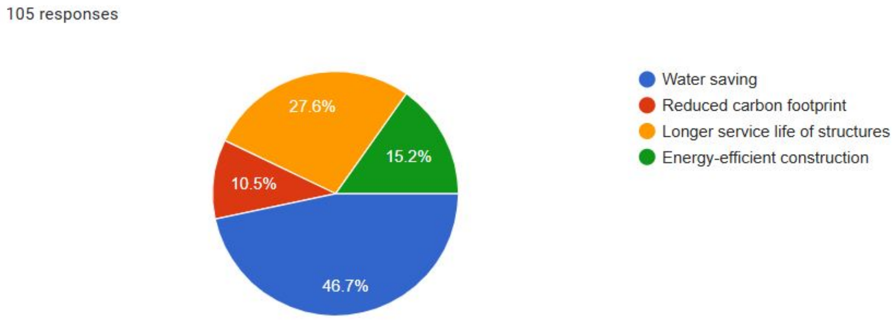

Fig. 12. Sustainability goal supported by Self-Curing concrete

Nearly half of the engineers felt that adopting the Self-Curing concrete results mainly in water saving. This shows that the respondents are aware of the major contribution of Self-Curing concrete (see Fig 12).

Q. (11) If given regulatory or financial incentives, would you consider adopting Self-Curing concrete in your projects?

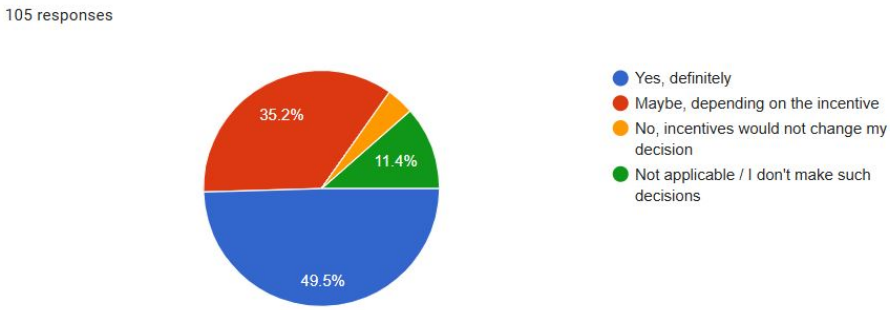

Fig. 13. Adoption of Self-Curing concrete

Half of the civil engineers would be definitely adopting Self-Curing concrete for their projects. This is a desirable mind set towards adopting a sustainable building technique for future urban infrastructure.

Q. (12) Are clients or project owners conscious about sustainable concrete practices (e.g., water saving, green materials, etc.)?

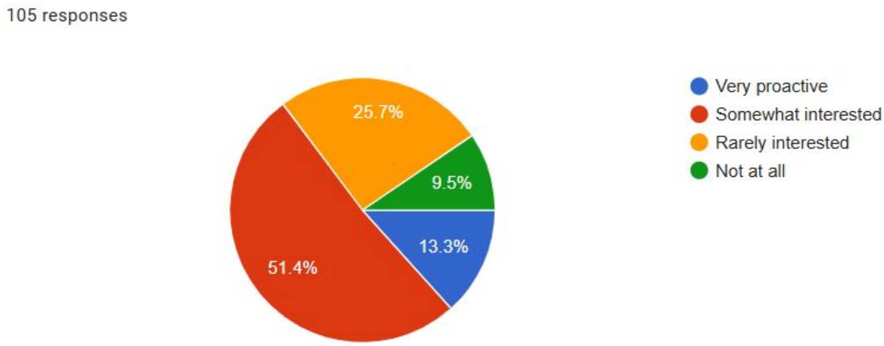

Fig. 14. Consciousness about sustainable concrete practices

Only 13.3% respondents admitted clients or project owners being very pro-actively conscious about sustainable concrete practices. It is expected that all the owners and clients should be aware about these practices (see Fig. 14).

Q. (13) Do you feel that Self-Curing concrete should be included in municipal or national codes (e.g., Indian Standard Codes)?

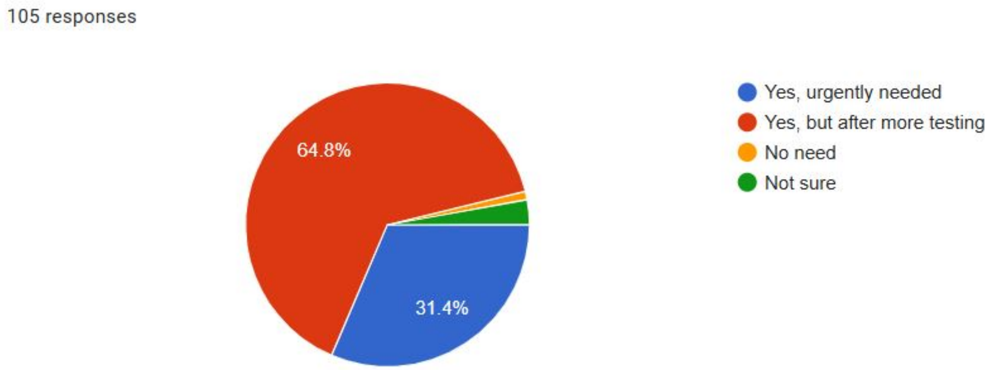

Fig. 15. Need of Inclusion of Self-Curing Concrete in Standard Codes

31.4% people felt that there is an urgent need of including Self-Curing concrete in codes. However, 64.8% thought that there is a need of inclusion, but after more testing. Negligibly few responded with “No need” and “Not sure” (see Fig. 15).

Q. (14) Do you believe that integrating Self-Curing concrete can help achieve smart city infrastructure goals?

56.2% engineers believed that integrating Self-Curing concrete would definitely help to achieve smart infrastructure goals; whereas, 36.2% thought that it would help to some extent. Overall, it shows a positive perception of civil engineering fraternity about adopting Self-Curing concrete in MMR (see Fig. 16).

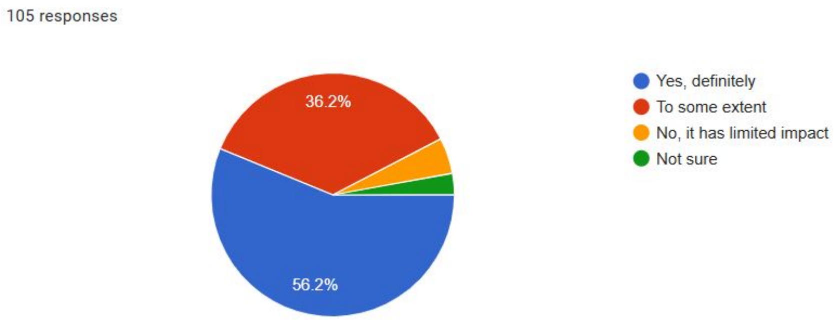

Fig. 16. Usefulness of Self-Curing concrete to achieve smart city infrastructure goals

Q. (15) How important is it for MMR to adopt advanced technique like Self-Curing concrete for sustainable urban development? (1- not important and 5- extremely important).

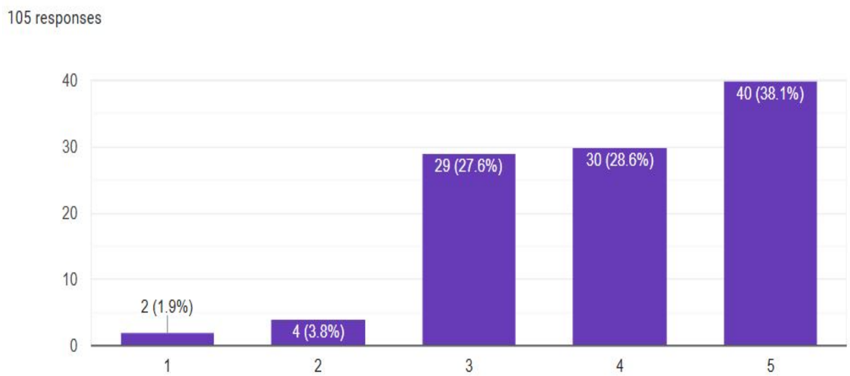

Fig. 17. Importance of Self-Curing concrete for sustainable urban development of MMR

99 engineers (94.3%) thought that it is important to adopt Self-Curing concrete for sustainable urban development in MMR. Out of this, 38.1% felt it to be extremely important. This is a positive sign towards achieving sustainability goal (see Fig. 17).

The 28 days' average denisty value of 3 cube specimens of a water-cured sample was 2480 kg/m^3; while that of Self-Cured samples were 2483 kg/m^3, 2488 kg/m^3 and 2493 kg/m^3, respectively for 0.3%, 0.4% and 0.5% SAP dosages, indicating that the Self-Cured samples could develop denisty on par with the water-cured sample, without any external curing. 28 days' average compressive strength value for water-cured sample was 40.56 N/mm^2 and that for the Self-Cured samples were 40.97 N/mm^2, 41.83 N/mm^2 and 42.82 N/mm^2, respectively, for 0.3%, 0.4% and 0.5% SAP dosages.

Strength values of SAP-incorporated samples were more than that of water-cured sample. This underlined the advantage of Self-Curing over the conventional curing in gaining the adequate strength, apart from huge saving of curing water.

4 Conclusion

Civil engineering professionals are well aware about the various factors which make conventional curing techniques non-feasible in MMR. They are also aware about the site limitations affecting the curing quality badly. They agree upon the fact that the construction sector needs better curing alternatives. They realize the significant benefits of adopting Self-Curing concrete. Many of them are planning to use Self-Curing concrete in future. Majority of them think that lack of awareness is a main barrier for adopting Self-Curing concrete in MMR projects. For majority of them, water saving is a main sustainability goal attained through practicing Self-Curing. They showed strong desire to adopt Self-Curing techniques in their projects. The clients and project owners are not very much aware about the sustainable concreting approaches. More than 95% engineers expressed a need of including Self-Curing concrete in municipal or national codes. Most of the professionals perceive Internally-Cured concrete as a step towards attaining smart city infrastructure goals; moreover, they feel it is vital and essential to adopt Self-Curing concrete for sustainable urban development in MMR.

Self-Curing concrete aligns perfectly with sustainable and resilient smart city goals. Through conserving water, improving density and strength, suppressing emissions and encouraging efficient construction, it provides a future solution for urban infrastructure. As cities evolve to become smarter and more sustainable, Self-Curing concrete plays a key role in building durable, resource-efficient foundations of future urban ecosystems. Its integration into sustainable construction practices would align with global endeavors to tackle climate change and promote a circular economy. Civil engineering professionals of MMR perceive Self-Curing concrete as a sustainable building technique and they exhibit a potential to adopt it for the future urban infrastructure.

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References

1. Bureau of Indian Standards: Indian Standard, IS 6461 (Part VII) -1973 (Reaffirmed 2002), Glossary of Terms Relating to Cement Concrete, Part VII, Mixing, Laying, Compaction, Curing and other Construction Aspects. BIS, New Delhi, India (2002)
2. Mindess, S., Young, J. F., Darwin, D.: Concrete. 2nd edn. Prentice-Hall, New Jersey (2003)
3. Neville, A. M.: Properties of Concrete. 4th Impression, Pearson Education, London (2009)

4. Mehta, P. K., Monteiro, P. J. M.: Concrete – Microstructure, Properties and Materials. 3rd Edition, Tata McGraw Hill, New Delhi (2009)
5. Taylor, P. C.: Curing Concrete. CRC Press, Boca Raton, FL (2013)
6. Aïtcin, P. C.: The durability characteristics of high-performance concrete: A review. Cement and Concrete Composites 23(2012), 409–420 (2012)
7. Sarbapalli, D., Dhabalia, Y., Sarkar, K., Bhattacharjee, B.: Application of SAP and PEG as curing agents for ordinary cement-based systems: impact on the early age properties of paste and mortar with water-cement ratio of 0.4 and above. Eur. J. Environ. Civ. Eng. (2016), 1–16 (2016)
8. Castro, L., Keiser, M., Golias, J., Weiss, J.: Absorption and desorption properties of lightweight aggregate for application to internally cured concrete mixtures. Cem. Concr. Compos. 33, 1001–1008 (2011)
9. Lokeshwari, M., Bandakli, B. R. P., Tarun, S. R., Sachin, P., Kumar, V.: A review on Self-Curing concrete. Mater. Today Proc. 43(2), 2259–2264 (2021)
10. Kulkarni, V.: Rough estimation of water requirements for concrete production and measures for conservation. Low Carbon Construction Forum, (July-Sept. 2022)
11. International Energy Agency: India Energy Outlook-2021, World Energy Outlook Special Report. http://www.iea.org (last accessed 2025/10/01)
12. Mohiuddin Jeddy, G.: Hindustan Times, April 02, 2025
13. Vedhsakthi, K., Saravanan, M.: Development of normal and high strength self-curing concrete using SAP and comparison of strength characteristics. Int. J. Eng. Res. Technol. (IJERT) 3 (2014)
14. Hamzah, N., Mohd Saman, H., Hajmohammadian Baghban, M., Mohd Sam, A. R., Faridmehr, I., Muhd Sidek, N. N., Benjeddou, O., Huseien, G. F.: A review on the use of self-curing agents & its mechanism in high-performance cementitious materials. Buildings 12, 152, 1–27 (2022)
15. Patil, D. S., Anadinni, S. B., Shivapur, A. V.: Sustainable development through use of Self-Curing concrete. NBM & CW, The Concrete Construction (2022)
16. Patil, D. S., Anadinni, S. B., Shivapur, A. V.: Evaporation, degree of hydration, porosity and gel/space ratio of self-curing polymer PEG 400 modified ordinary Portland cement paste. J. Appl. Sci. Eng. 26(3), 303–311 (2022)
17. Henkensiefken, R., Bentz, D., Nantung, T., Weiss, J.: Volume change and cracking in internally cured mixtures made with saturated lightweight aggregate under sealed and unsealed conditions. Cem. Concr. Compos. 31(7), 427–437 (2009)
18. Patil, D., Parkar, F, Nadaf, F.: Assessment of feasibility of sintered fly ash lightweight aggregate as an effective self-curing additive for sustainable concreting practice. International conference on civil, materials and environment for sustainability (ICCMES 2024), 596 (01017), 1-8 (2024).
19. De la Varga, I., Castro, J., Bentz, D., Weiss, J.: Application of internal curing for mixtures containing high volumes of fly ash. Cem. Concr. Compos. 34(9), 1001–1008 (2012)
20. Patil, D., Parkar, F.: A need of awareness about self-curing (internally-cured) concrete in the Indian construction industry. NBM & CW, Journal of International Concrete Construction (2023)
21. Bureau of Indian Standards: Indian Standard, IS 456: 2000, (Reaffirmed 2005), Plain and reinforced concrete – Code of practice (Fourth Revision). BIS, New Delhi, India (2005)
22. Bureau of Indian Standards, Indian Standard, IS 10262: 2019, Concrete mix proportioning – Guidelines (Second Revision). BIS, New Delhi, India