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Research Article

# EXPLORING THE IMPACT OF CURING TECHNIQUES ON THE COMPRESSIVE STRENGTH OF CONCRETE STRUCTURES: A COMPREHENSIVE INVESTIGATION

***Y. Bhattarai[1*], P. Chapagain [2], S. Panthi [3], S. P. Shrestha [1]***

[1] Lumbini Engineering Management and Science College, Nepal
[2] Eco Innovative Engineering Pvt. Ltd, Butwal, Rupandehi, Nepal
[3] Department of Road, Engineering, Butwal, Rupandehi, Nepal
*Corresponding Email: ybbhattrai7@gmail.com

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Abstract

This research investigates the influence of various curing methods on the compressive strength of plain concrete, exploring techniques such as water ponding, jute curing, plastic bag curing, dry curing, and geo-textile curing. Emphasizing both early and long-term concrete strength enhancement, the study identifies water ponding and geo-textile curing as the most promising for high early strength, while jute curing and plastic bag curing exhibit moderate performance, with dry curing ranking as the least effective. Incorporating insights from industry professionals through a structured questionnaire, the research underscores the collective awareness of the pivotal role of proper curing practices in concrete strength and durability. The study recommends further exploration into the influence of varying slump values and alternative curing methods, considering diverse environmental conditions, with the potential to optimize curing practices for robust and durable concrete structures. In conclusion, this research highlights the critical importance of correct curing practices for ensuring concrete structures' strength and longevity, offering practical implications for the construction industry and civil engineering.

***Keywords***—concrete strength, curing, compressive strength, water, structure, influence

## I. INTRODUCTION

### 1.1 Background

Concrete, a widely utilized construction material, is integral to the structural integrity of buildings. Compressive strength plays a pivotal role in ensuring the longevity and safety of concrete structures, particularly in developing countries like Nepal, where concrete is extensively employed for its affordability and adaptability. While the Nepal Standard (NS) and Indian Standard (IS) code books provide guidelines for concrete construction practices, challenges such as limited resources and technical expertise impact the practical implementation of curing methods, influencing concrete strength.

This research aims to bridge the gap between theoretical guidelines and practical implementation by conducting a comprehensive review of code book recommendations and existing literature on concrete curing practices in developing countries. Focusing on Nepal, the study will identify challenges during construction and assess their impact on the curing process and concrete strength. The outcomes aim to improve construction practices and contribute to the development of reliable and durable concrete structures in Nepal.

Existing literature emphasizes the importance of optimizing curing methods. For instance, [1] found water and steam curing effective in enhancing compressive strength. [2] explored jute bag curing, demonstrating improved compressive strength and reduced drying shrinkage. Additionally, studies by [3] and [4] underscore the role of proper curing in achieving a dense and strong concrete matrix. Alternative curing techniques, such as geotextile curing and polythene sheet curing, have shown promise in maintaining favorable moisture and temperature conditions, enhancing compressive strength and reducing permeability.

Identified gaps in the literature emphasize the need for further investigation into the influence of curing methods on the strength and durability of reinforced concrete structures. Through a systematic study, this research aims to provide valuable findings and recommendations, contributing to the development of optimized curing techniques and improvements in concrete construction practices.

### 1.2 Objective

The overarching goal of this study is to optimize curing conditions and durations to enhance the compressive strength of plain concrete, employing various techniques. To achieve this, specific objectives have been identified. First, an examination of the prevailing curing techniques and durations utilized in the construction practices of Nepal will be conducted. Subsequently, the study aims to comprehensively evaluate the influence of different curing methods, such as water curing, air curing, jute bag curing, polythene sheet curing, and geo-textile curing, on the compressive strength of plain concrete. Additionally, the research will assess the impact of curing duration on the strength development and durability properties of plain concrete. Through these specific objectives, the study endeavors to provide insights into optimizing curing practices, thereby contributing to the advancement of concrete construction techniques and ensuring the robustness of structures in the context of Nepalese construction practices.

## II. Methodology and test setup

The research employs an experimental research design to systematically explore the influences of diverse curing conditions and durations on the compressive strength of plain concrete. The materials utilized, including Ordinary Portland

Cement (OPC) grade 53 and specific aggregates, adhere to stringent standards. Concrete mix design, in alignment with IS: 10262-1982, is meticulously formulated to achieve a targeted 28-day compressive strength of 20 MPa. The casting of specimens, involving concrete cubes, is conducted under controlled room temperature conditions. Subsequent to the casting process, various curing techniques[5-8] such as immersion/ponding, sprinkling/fogging, plastic sheet, jute sack/saturated wet covering, and geotextile covering are employed until the assessment points at 3,7,14 and 28 days. Concurrently, a structured questionnaire is administered to industry professionals, capturing qualitative insights on their perspectives regarding curing methods and their perceived impacts on concrete strength and durability [ 9-12]. The research design incorporates ethical considerations, ensuring participant consent, data privacy, and voluntary engagement. Additionally, potential limitations are proactively addressed through meticulous sampling and analytical approaches. The overarching objective is to contribute nuanced insights that can inform the optimization of curing practices and advance the understanding of concrete construction techniques, particularly in the context of plain concrete strength development.


**Figure 1.** Curing concrete by covering with, [a] Geotextile; [b] Plastic bag; [c] Jute sack; [d] Water ponding.

## III. Test Results

The results of the study reveal significant insights into the compressive strength development of plain concrete under various curing conditions.

**Table 1.** Strength performance with respect to days of curing

| Type of Curing | Strength | | | |
|---|---|---|---|---|
| | 3 days | 7 days | 14 days | 28 days |
| | Average | Average | Average | Average |
| Dry Curing | 9.62 | 13.26 | 17.57 | 19.74 |
| Jute Bag | 11.24 | 13.47 | 18.82 | 20.3 |
| Geo-textile | 13.49 | 16.45 | 19.12 | 22.58 |
| Plastic Bag | 12.51 | 13.52 | 18.74 | 20.72 |
| Water Ponding | 13.9 | 17.95 | 19.60 | 22.83 |

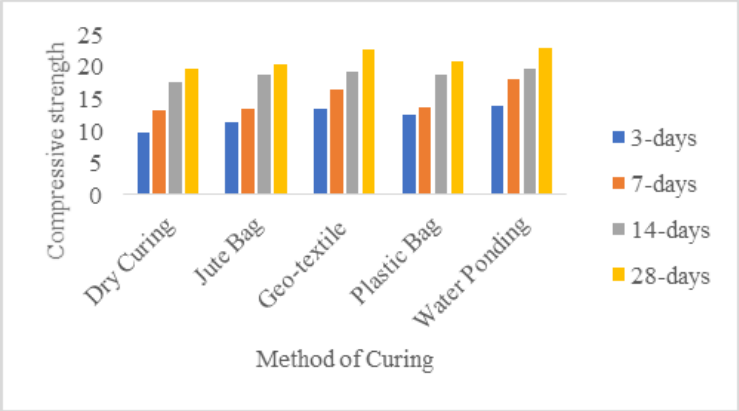


**Figure 2.** Strength performance at 3,7,14 and 28 days of curing

The 3-day compressive strength values demonstrate that "Water Ponding" is the most effective method for early strength development, followed by "Geotextile Curing." Conversely, "Dry Curing" exhibits the lowest 3-day average compressive strength. As the curing period extends to 7 days, "Water Ponding" maintains its superiority, achieving the highest average compressive strength, while "Geo-textile Curing" remains competitive. "Dry Curing" continues to exhibit the lowest strength development. The trend persists at 14 days, with "Water Ponding" consistently outperforming other methods. By the 28th day, "Water Ponding" still leads in average compressive strength, indicating its sustained effectiveness. "Geo-textile Curing" and "Plastic Bag Curing" also demonstrate respectable strength performances, while "Dry Curing" consistently lags behind. The questionnaire results provide valuable insights into industry professionals' demographics, familiarity with curing methods, and their beliefs and experiences. Respondents express a consensus on the critical role of awareness, knowledge, and responsible site work in ensuring effective curing practices. The study contributes nuanced understanding to the selection and implementation of curing techniques, emphasizing adaptability and customization based on project-specific requirements and environmental conditions [13-14]. The research findings hold implications for improving concrete construction practices, enhancing durability, and meeting the challenges posed by diverse geographical settings and resource constraints. The comprehensive analysis of both experimental and questionnaire data enriches the discourse on optimizing curing methods for enhanced concrete strength and durability.

## IV. Discussion and Conclusion

The study's findings offer crucial insights into optimizing concrete strength through different curing methods, with notable conclusions drawn from both experimental and survey data. "Geo-textile curing" and "Water Ponding" emerge as highly effective methods for achieving early strength in concrete mixes, while "Jute curing"

and "Plastic Bag curing" exhibit moderate performance, presenting viable options based on project-specific requirements and resource availability. In contrast, "Dry curing" proves to be the least effective for rapid strength development. Survey participants, primarily from engineering and construction backgrounds, exhibit a high level of awareness and knowledge about curing methods, emphasizing their importance in the industry. There is a unanimous consensus among respondents regarding the significant influence of proper curing on concrete strength and durability, underscoring its critical role in maintaining structural integrity. Water curing, particularly with jute bags, is widely known and used among respondents, highlighting its effectiveness. Instances of reduced strength and cracking due to improper curing emphasize the need for consistent adherence to proper curing methods. In recommendations, water ponding stands out as a promising technique, especially for slabs and rigid pavements, with considerations for sand boundaries to prevent water leakage. The study suggests exploring the influence of varying slump values on compressive strength and investigating alternative curing methods, such as steam curing, lime curing, water curing, and chemical curing, in different site-specific contexts. These avenues of research promise valuable insights into their respective impacts on compressive strength and the long-term durability of concrete structures. Overall, the study contributes significantly to advancing concrete construction practices and enhancing the industry's understanding of curing **methods.**

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