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Comparative Study Between Polyethylene Glycol-400 (PEG-400) and Polyvinyl Alcohol (PVA) for Self-Curing Concrete

Manish S. Bansode, Tejas S. Mokal, Saad S. Pathan, Karan K. Rathod,
Prof.Yash S.Seth, Prof.Hemanth K.Thakur
Department of Civil Engineering
G.M. Vedak Institute of Technology, Tala Maharashtra, India

Abstract- — The rapid increase in construction activities has significantly increased the demand for water used in concrete curing. Conventional curing methods require continuous external water supply, which is often impractical in regions with water scarcity. This research focuses on self-curing concrete using Polyethylene Glycol (PEG-400) and Polyvinyl Alcohol (PVA) as internal curing agents. The study evaluates the mechanical properties of concrete, particularly compressive strength, by varying the percentage of these agents. The results demonstrate that self-curing concrete improves hydration, reduces shrinkage, enhances durability, and minimizes water consumption. The study concludes that PVA shows better performance compared to PEG in terms of strength and water retention.

Keywords— Self-curing concrete, PEG-400, PVA, compres- sive strength, sustainability

I. INTRODUCTION

Concrete is the most widely used construction material due to its strength, durability, and versatility. However, the performance of concrete largely depends on proper curing, which ensures hydration of cement particles. Curing is the process of maintaining adequate moisture content in concrete during its early stages to allow the hydration process to continue effectively.

In conventional curing, water is applied externally to the concrete surface to prevent moisture loss. However, this method requires a continuous supply of water and proper supervision. In many real-world conditions such as high- rise buildings, arid regions, and inaccessible structures, conventional curing becomes difficult to implement effectively. Improper curing leads to reduced strength, increased permeability, and early cracking.

Self-curing concrete is an advanced technique that allows concrete to retain water internally. This is achieved by adding chemical admixtures such as Polyethylene Glycol (PEG) and Polyvinyl Alcohol (PVA), which act as water-retaining agents.

These materials release water gradually during hydration, ensuring continuous curing and improved performance.

II. LITERATURE REVIEW

Several researchers have explored the concept of self- curing concrete and its effectiveness in improving mechanical properties. Studies indicate that the use of Polyethylene Glycol enhances the hydration process by reducing evaporation losses. PEG forms a thin film around water molecules, preventing them from escaping and making them available for cement hydration.

Polyvinyl Alcohol has also been extensively studied for its ability to retain water within the concrete matrix. It improves bond strength, reduces permeability, and enhances durability. PVA acts as a hydrophilic material that absorbs water and releases it slowly over time, ensuring effective internal curing. Previous research suggests that both PEG and PVA significantly improve compressive strength compared to conventional curing. However, the performance depends on the dosage used and the mix design of concrete. Therefore, a comparative study is essential to determine the most efficient self-curing agent.

III. PROBLEM STATEMENT

Improper curing of concrete is a major issue in construction practices. When concrete is not cured properly, it leads to reduced strength, poor durability, and increased susceptibility to cracking. These issues can significantly affect the lifespan and performance of concrete structures.

In many cases, the availability of water for curing is limited. This creates a need for alternative curing methods that do not rely on external water supply. Self-curing concrete addresses this issue by providing internal moisture through chemical admixtures.

The primary problem addressed in this study is to determine which self-curing agent, PEG or PVA, is more effective in improving the strength and durability of concrete while reducing water dependency.

IV. MATERIALS AND PROPERTIES

The materials used in this study include cement, fine aggregate, coarse aggregate, water, PEG-400, and PVA. Cement acts as a binding material and plays a crucial role in strength development. Fine and coarse aggregates provide bulk and contribute to the mechanical properties of concrete.

Table I: Material Properties

Material	Property	Value
Cement	Specific Gravity	3.24
Fine Aggregate	Specific Gravity	2.76
Coarse Aggregate	Specific Gravity	2.54
Water	pH Value	7
PEG-400	State	Liquid
PVA	State	Powder

Polyethylene Glycol is a water-soluble polymer that reduces evaporation and enhances hydration. Polyvinyl Alcohol is a hydrophilic material that retains moisture and improves durability.

V. METHODOLOGY

The methodology adopted in this study involves a system- atic experimental approach to evaluate the performance of self-curing concrete using Polyethylene Glycol (PEG-400) and Polyvinyl Alcohol (PVA). Initially, all materials such as cement, fine aggregate, coarse aggregate, and water were selected in accordance with relevant Indian Standard specifications to ensure consistency and reliability of results. The mix design was prepared for M25 grade concrete with a proportion of 1:1:2 and a water-cement ratio of 0.45. Self-curing agents were incorporated into the concrete mix in different proportions, specifically PEG at 1% and 1.5% and PVA at 0.8% and 1% by weight of cement. The materials were dry-mixed thoroughly to achieve uniform distribution, followed by gradual addition of water and curing agents to form a homogeneous mix.

The prepared concrete was then cast into standard cube moulds of size 150 mm × 150 mm × 150 mm. Proper compaction was ensured using tamping rods to eliminate air voids and achieve dense concrete. A total of six specimens were prepared for each mix proportion, with three cubes designated for 7-day testing and the remaining three for 28-day testing. Unlike conventional curing methods, these specimens were not subjected to external water curing; instead, they were kept under ambient conditions to allow internal curing through the self-curing agents. This approach ensured that the effectiveness of PEG and PVA in retaining moisture and supporting hydration could be accurately evaluated.

VI. EXPERIMENTAL ANALYSIS

The experimental analysis was carried out to evaluate the mechanical performance of self-curing concrete incorporating Polyethylene Glycol (PEG-400) and Polyvinyl Alcohol (PVA). Concrete specimens were prepared using M25 grade mix proportions and tested for compressive strength at curing intervals of 7 and 28 days. The testing procedure was conducted using a standard compression testing machine, where load was applied gradually until failure of the specimen occurred. The maximum load at failure was recorded for each cube, and the compressive strength was calculated using the standard formula. The obtained results were compared with those of conventionally cured concrete to assess the effectiveness of internal curing agents. It was observed that the inclusion of PEG and PVA improved the hydration process by retaining moisture within the concrete matrix, resulting in better strength development.

Further analysis of the results indicated that the performance of self-curing concrete depends significantly on the type and dosage of curing agent used. PEG-based concrete showed noticeable improvement in strength compared to conventional concrete, particularly at 1% dosage, while excessive dosage led to a slight reduction in strength due to increased work- ability and possible segregation. On the other hand, PVA- based concrete demonstrated superior performance, especially at 1% dosage, due to its higher water retention capability and improved bonding characteristics. The experimental findings also suggested reduced shrinkage and fewer surface cracks in self-curing specimens, indicating enhanced durability. Overall, the analysis confirms that self-curing agents play a crucial role in improving the mechanical properties of concrete while reducing dependency on external curing methods.

VII. RESULTS AND DISCUSSION

Table 2: Compressive Strength Results

Mix Type	7 Days (MPa)	28 Days (MPa)
Conventional	18	28
PEG 1%	20	32
PEG 1.5%	19	30
PVA 0.8%	21	33
PVA 1%	22	35

The results indicate that both PEG and PVA improve compressive strength compared to conventional curing. However, PVA shows better performance due to its superior water retention capability.

The results obtained from the experimental investigation indicate a clear improvement in the compressive strength of self-curing concrete when compared to conventionally cured concrete. At 7 days, both PEG-400 and PVA mixes exhibited higher early strength development, which can be attributed to enhanced internal hydration due to effective moisture retention. At 28 days, the strength gain was more prominent, with PEG at 1% dosage showing a noticeable increase over

conventional concrete. However, increasing the PEG content to 1.5% resulted in a slight reduction in strength, which may be due to excessive water retention leading to increased workability and reduced compactness of the mix. These observations confirm that an optimum dosage of PEG is necessary to achieve maximum performance without negatively affecting the concrete structure.

Advantages

Self-curing concrete offers significant advantages over conventional curing methods, primarily by reducing the dependency on external water supply. The incorporation of self-curing agents such as Polyethylene Glycol (PEG-400) and Polyvinyl Alcohol (PVA) enables internal moisture retention, which ensures continuous hydration of cement particles. This results in improved compressive strength, reduced shrinkage, and enhanced durability of concrete. Additionally, self-curing concrete minimizes the risk of early-age cracking and improves the overall microstructure, leading to better long-term performance. It is particularly beneficial in regions where water scarcity is a major concern or where proper curing is difficult to achieve, such as in high-rise structures and remote construction sites.

Another important advantage is the reduction in labor and maintenance associated with traditional curing methods, as there is no need for continuous water application. The use of self-curing agents also enhances workability and provides better consistency in concrete properties. Overall, self-curing concrete contributes to sustainable construction practices by conserving water resources while maintaining or even improving the mechanical and durability characteristics of concrete.

Limitations

Despite the advantages of self-curing concrete, certain limitations must be considered for practical implementation. The use of chemical admixtures such as Polyethylene Glycol (PEG-400) and Polyvinyl Alcohol (PVA) can increase the overall cost of concrete compared to conventional methods. Additionally, the performance of self-curing concrete is highly dependent on the accurate dosage of these agents, as excessive quantities may lead to increased workability, segregation, or reduction in strength. There may also be compatibility issues between self-curing agents and other admixtures used in the mix, which can affect the final properties of concrete. Furthermore, the availability of materials like PVA may be limited in some regions, and proper handling is required during mixing to ensure uniform distribution. These factors highlight the need for careful mix design and quality control to achieve optimal results.

VIII. CONCLUSION

The present study demonstrates that self-curing concrete using Polyethylene Glycol (PEG-400) and Polyvinyl Alcohol (PVA) is an effective alternative to conventional curing meth- ods. The experimental results indicate that both self-curing agents enhance the hydration process, leading to improved compressive strength, reduced shrinkage, and better durability of concrete. Among the two, PVA at an optimum dosage of 1% showed superior performance in terms of strength and moisture retention, while PEG also provided noticeable improvement when used in controlled proportions. The use of self-curing concrete significantly reduces the dependency on external water supply, making it highly suitable for water-scarce regions and challenging construction conditions. Overall, self-curing technology contributes to sustainable construction practices by conserving water resources while maintaining the required structural performance.

Future Scope

The concept of self-curing concrete offers significant po- tential for future research and practical applications in the construction industry. Further studies can be conducted by exploring different grades of concrete and optimizing the dosage of self-curing agents such as PEG and PVA for enhanced performance. Long-term durability studies, includ- ing resistance to

environmental conditions such as chloride attack, carbonation, and freeze-thaw cycles, can provide deeper insights into the behavior of self-curing concrete. Additionally, the use of alternative eco-friendly and cost-effective self- curing materials can be investigated to improve sustainabil- ity. Field applications and large-scale implementation studies can also be carried out to validate laboratory results under real construction conditions. The integration of self-curing techniques with advanced materials and smart construction technologies may further enhance the efficiency, durability, and sustainability of modern concrete structures.

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