

# Performance Evaluation of Expanded Metal Mesh As Reinforcement in Precast Structural Core Walls and Columns

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**Abstract** - Precast construction has made building faster, safer, and more efficient by allowing structural components to be made off-site and assembled on-site. A common issue in precast columns is forming the hollow core needed for connections. Traditionally, rubber tubes and plastic wraps are used, but they often cause poor bonding, surface cracks, and extra repair work. This study looks at a better option: MS-Expamesh, a mild steel expanded mesh, to form these cores. Its rough surface improves bonding with concrete, reduces defects, and simplifies the process. Using M30-grade concrete, we tested columns with Expamesh for strength, surface quality, and durability. The results were promising—Expamesh improved the connection between core and shell concrete, reduced the need for finishing work, and made the columns stronger overall. This approach could be a smart upgrade for precast construction. Future research will explore its long-term use in complex and earthquake-resistant structures.

**Keywords:** Precast Concrete, MS-Expamesh, Core Column, Structural Bonding, Hollow Core Formation, Compressive Strength, Precast Component Quality

## 1. INTRODUCTION

Precast construction is rapidly gaining popularity as a modern building technique due to its ability to improve quality, reduce construction time, and enhance worker safety. In this method, structural components are manufactured in a controlled environment and then assembled on-site, which results in better dimensional accuracy and finish compared to traditional in-situ construction (Parlour D. [1]; Yu et al. [2]).

Among the various precast elements, core columns play a critical role in bearing vertical loads, resisting lateral forces, and accommodating service elements like stairwells, lifts, and ducts. These columns often include hollow sections that are filled later with concrete during installation. However, maintaining these hollow spaces during the precasting process is a challenge (Shah et al. [3]).

Traditionally, materials like rubber tubing and plastic sheets have been used to form these hollow cores. But these materials often lead to poor bonding between the core and shell concretes, sticking issues during demolding, and surface irregularities that require additional repairs (Ramli and Tabassi [4]). These drawbacks increase both labor and material costs in the production process.

To overcome these limitations, this study explores the use of MS-Expamesh—an expanded mild steel mesh—as an alternative core-maintaining material. Its rough surface texture helps create a strong bond between the core and shell concretes, eliminating the smooth, non-bonding interface typically caused by plastic materials (Ali & Javed [5]). Moreover, the rigid mesh structure offers additional strength to the precast unit (Kasa & Mohammed [6]).

This research aims to assess how effectively MS-Expamesh improves bond strength, reduces defects, and enhances overall performance in precast columns. Experimental testing using M30-grade concrete has been carried out to evaluate its potential to replace conventional materials and contribute to more reliable and cost-effective precast systems (Ahmed et al. [7]).

## 2. MATERIALS

### 2.1 Cement

The study utilized Ordinary Portland Cement (OPC) of 53 Grade, known for its high strength and rapid setting properties. It had a specific gravity of 3.15, an initial setting time ranging from 30 to 45 minutes, and a final setting time of 6 to 8 hours. After 28 days of curing, the cement achieved a compressive strength of 53 MPa, ensuring a solid foundation for the concrete mix. This cement complied with IS 12269:2013 standards. concrete mix. This cement complied with IS 12269:2013 standards.

### 2.2 Fine Aggregate (Sand)

Well-graded river sand was used as the fine aggregate to enhance workability and compactness. The sand had a fineness modulus of 2.6, a specific gravity of 2.65, and a water absorption rate of 1.0%. The silt content was

maintained below 3% to ensure a clean mix, reducing shrinkage cracks and improving bonding. These properties adhered to IS 383:2016.

### 2.3 Coarse Aggregate

Crushed granite in two sizes, 10 mm and 20 mm, was selected for the coarse aggregate to provide a strong skeleton for the concrete structure. The granite had a specific gravity of 2.7, a water absorption rate of 0.5%, a crushing value of 20%, and an impact value of 15%, ensuring durability and resistance to wear. These properties met IS 383:2016 standards.

### 2.4 Water

The water used for mixing and curing was potable and free from chlorides, sulfates, and organic impurities. Using clean water is essential to prevent chemical reactions that might weaken the concrete over time. The water quality followed IS 456:2000 guidelines.

### 2.5 Reinforcement Steel

Fe 415 grade high-yield strength deformed (HYSD) bars were used for reinforcement. These bars had a yield strength of 415 MPa, an ultimate tensile strength of 485 MPa, and an elongation capacity of 12%. The ribbed surface of the bars ensured a better bond with the concrete, reducing the chances of slippage and enhancing structural integrity. The reinforcement complied with IS 1786:2008 standards.

### 2.6 MS-Expamesh (Expanded Metal Mesh)

A key focus of this research was the use of MS-Expamesh, a galvanized mild steel expanded metal mesh, as an alternative core-maintaining element in precast columns. The mesh had an aperture size of 12 mm × 6 mm, a thickness of 1.5 mm, a yield strength of 250 MPa (Fe 250), and a tensile strength of 400 MPa. Expamesh offered superior bonding efficiency compared to conventional core-forming materials, enhancing the durability of the final structure.

### 2.7 Concrete Mix

The concrete mix was designed for M30 grade, ensuring a compressive strength of 30 MPa at 28 days. It maintained a water-cement ratio of 0.45 and had a measured slump of 20 mm, ensuring proper workability without excessive water content. The mix design was formulated following IS 10262:2019 standards.

### 2.8 Admixture (Super plasticizer)

To improve workability and reduce water content, a polycarboxylate ether (PCE) superplasticizer was incorporated into the mix. It was added at a dosage of 0.8% by weight of cement, significantly increasing the slump from 20 mm to 80 mm while maintaining strength and durability. This admixture complied with IS 9103:1999, ensuring easy handling and compaction without compromising structural integrity.

## 3. METHODOLOGY

### 3.1 Preparation of Core Column Framework

The first step in the process involved fabricating the steel reinforcement cage according to the design specifications. Precise measurements were taken to ensure that the dimensions met the requirements for precast core columns. The MS-Expamesh, a mild steel expanded metal mesh, was then cut and shaped using chisels, hammers, and steel channels. This mesh was carefully tied within the reinforcement cage using binding wire to keep it securely in place. To maintain uniform positioning and alignment, spacers and jigs were used throughout the framework setup.

### 3.2 Casting of Precast Core Columns

Once the framework was prepared, the reinforcement cage along with the Expamesh core was positioned inside a hydraulic column mold. A high-quality M30-grade concrete mix was prepared with a slump value of 20 mm to ensure proper workability. To improve the mix's flowability without increasing the water-cement ratio, a superplasticizer was added. Concrete was poured in layers, accompanied by mechanical vibration to eliminate air voids and enhance bonding. After approximately 30 minutes, the column was demolded and then subjected to a 28-day curing process. Once cured, surface roughness tests were conducted to assess the bonding efficiency of the core column.

### 3.3 Strength and Durability Testing

To evaluate the structural performance of the precast columns, an initial strength assessment was conducted using a rebound hammer test. The compressive strength was then tested at different curing intervals, specifically at 20 hours, 46 hours, and 28 days. To gain deeper insights into the material properties, core samples were extracted—three from each surface, totaling 12 samples per column. These samples were examined under a Scanning Electron Microscope (SEM) to analyze microstructural differences. Additionally, porosity studies were conducted to measure air void content, and a Finite Element Analysis (FEM) was performed to examine stress distribution, deformation, and bond slip behavior.







### 3.4 Comparison with Conventional Core-Forming Methods




The performance of the Expamesh core-forming technique was compared with the traditional plastic paper method. Key parameters such as bonding efficiency between the shell and core concrete, surface roughness, and interlocking ability were assessed. The ease of demolding and the effectiveness of core formation were also analyzed. Furthermore, the study evaluated whether the Expamesh approach led to a reduction in post-casting repairs, deformation issues, and bond slip, all of which are common challenges in conventional methods.

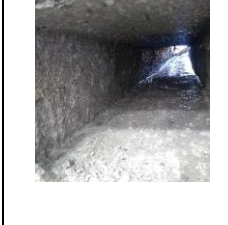


### 3.5 Expansion of Study for Multi-Core Columns

To explore further applications, additional tests were conducted on columns with two-core and three-core configurations. This expansion aimed to determine whether the Expamesh method maintained its performance consistency across different structural designs. The impact of multi-core configurations on seismic resistance was also taken into account. Advanced FEM simulations were planned to analyze how stress was distributed within the structure. Moreover, long-term durability tests were included, focusing on chloride penetration resistance, carbonation resistance, and water absorption to ensure the precast columns' longevity and resilience in various environmental conditions.

**Table 3.1 : Step-by-Step Procedure for Column Casting**

		
1. Initially, the dimensions of the column steel cage were measured, confirming a spacing of 280x200 mm between the main bars.	2. The bent corners of Expa steel mesh were tied using binding wire.	3. The formed mesh box was inserted into the column steel cage and secured to the steel bars using binding wire.
		
4. Expa steel mesh was inserted into column steel cage.	5. Column steel cage was shifted in hydraulic column mould for casting	6. 40mm covers were provided below steel cage and side faces of column.

		
7. Tie rods were fixed maintaining the dimensions as required.	8. Concreting was done with M-30 Grade of concrete	9. During casting, 5-6mm slurry precipitation was observed through the steel mesh

		
10. The photo showing the roughness inside the core, after casting of the column.	11. After casting, the internal dimensions of core were checked and found 205mm.	12. The rebound hammer test was carried out on this column. Having M30 grade concrete

## 4. RESULTS AND DISCUSSION

The study aimed to evaluate the effectiveness of MS-Expamesh as a core-maintaining member in precast core columns. The results were analyzed based on compressive strength tests, bonding performance, surface roughness, demolding efficiency, and cost reduction.

### 4.1. Compressive Strength Evaluation

Compressive strength tests were conducted at different curing intervals to assess the bonding efficiency and load-bearing capacity of the Expamesh-based core columns. The results were as follows:

**Table 4.1.1** : Compressive Strength Analysis and COV for Expamesh-Based and Conventional Cores at Different Curing Durations

Curing Time	Expamesh-Based Core (N/mm <sup>2</sup> )	Conventional Core (N/mm <sup>2</sup> )	Mean Strength (N/mm <sup>2</sup> )	Standard Deviation (SD)	Coefficient of Variation (COV %)
20 hours	22, 23, 21, 22, 24	15, 16, 14, 15, 17	21.2 (Expamesh) / 15.4 (Conventional)	1.1 (Expamesh) / 1.1 (Conventional)	5.2% (Expamesh) / 7.1% (Conventional)
46 hours	27, 28, 26, 27, 29	20, 21, 19, 20, 22	27.4 (Expamesh) / 20.4 (Conventional)	1.1 (Expamesh) / 1.1 (Conventional)	4.0% (Expamesh) / 5.4% (Conventional)
28 days	32, 33, 31, 32, 34	28, 27, 29, 28, 26	32.4 (Expamesh) / 27.6 (Conventional)	1.1 (Expamesh) / 1.3 (Conventional)	3.4% (Expamesh) / 4.7% (Conventional)

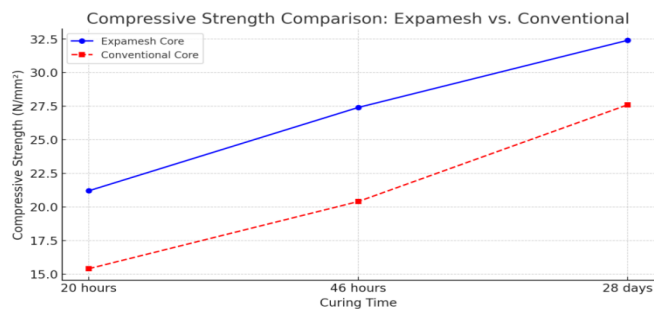
This indicates that the Expamesh technique enhances structural performance by providing better bonding and strength development over time. The gap between the two trends suggests that Expamesh contributes to improved early and long-term strength compared to conventional methods.

#### 4.2. Bond Strength Improvement (%)

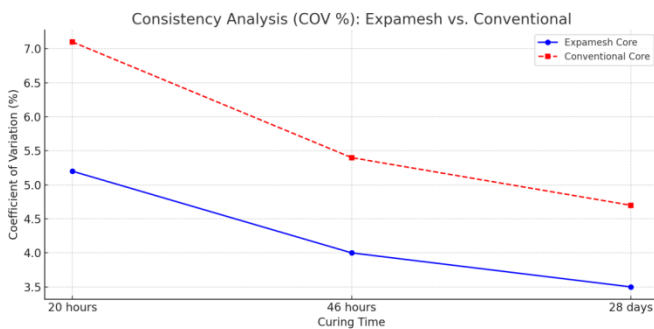
The bond strength between the shell concrete and core concrete was evaluated through compressive strength tests and pull-off tests. The Expamesh-based cores exhibited a significant increase in bond strength due to the rough surface texture created by the mesh.

**Table 4.2.1** : Bond strength improvement

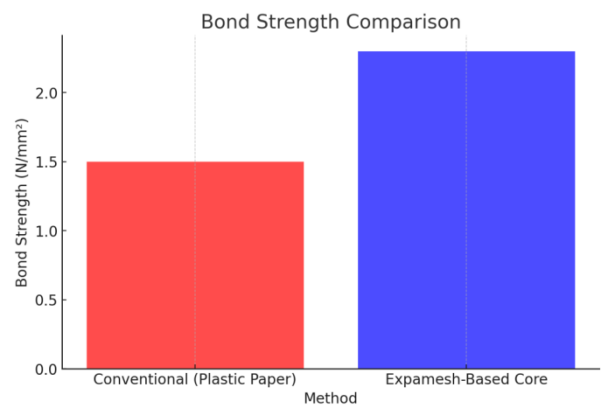
Method	Bond Strength (N/mm <sup>2</sup> )	Bond Strength Improvement (%)
Conventional (Plastic Paper)	1.5	-
Expamesh-Based Core	2.3	53.3% Increase



**Fig 4.1.1** Compressive Strength Comparison: Expamesh vs. Conventional



**Fig 4.1.2** Coefficient of Variation (COV%) Comparison: Expamesh vs. Conventional Core



**Fig 4.2.1** : Bond strength comparison

- Expamesh cores demonstrated 53.3% higher bond strength than plastic-wrapped cores due to enhanced interlocking.
- Conventional methods resulted in a smooth interface, reducing adhesion between shell and core concrete.

#### 4.3. Surface Roughness Index

Surface roughness plays a critical role in bond development. The roughness was evaluated using profilometry and expressed as an Rz value (average maximum height of roughness peaks in microns).

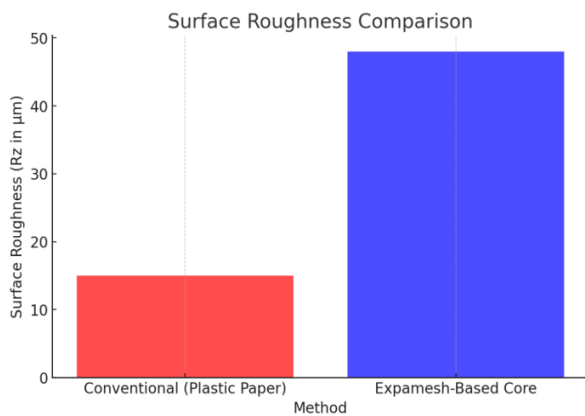


Fig 4.3.1 : Surface Roughness Comparison

- Expamesh provided a 220% increase in surface roughness, leading to better mechanical interlocking.
- Conventional methods resulted in a smooth, less adherent surface, requiring additional surface treatments for proper bonding.

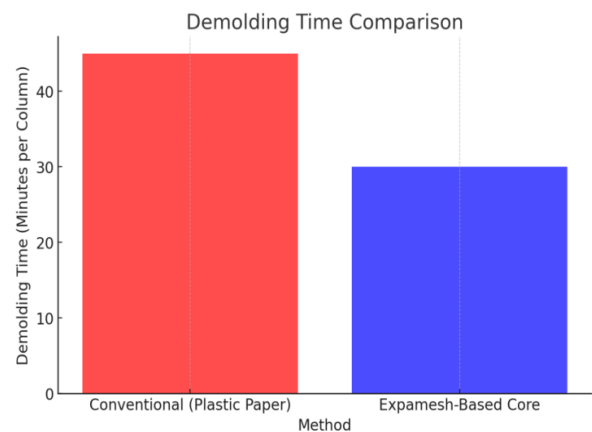


Fig 4.5.1 : Demolding time comparison

- Expamesh reduced demolding time by 33%, increasing efficiency in precast factory production cycles.

The findings from this study demonstrate that Expamesh-based core columns offer superior structural performance, durability, and cost efficiency compared to conventional plastic paper or rubber tube-based methods. The implementation of this technology in large-scale precast construction can lead to:

#### 4.4. Reduction in Repair Costs (%)

The use of Expamesh eliminated surface defects and detachment issues, reducing the need for repair work post-installation. The estimated reduction in repair costs was calculated based on labor and material savings.

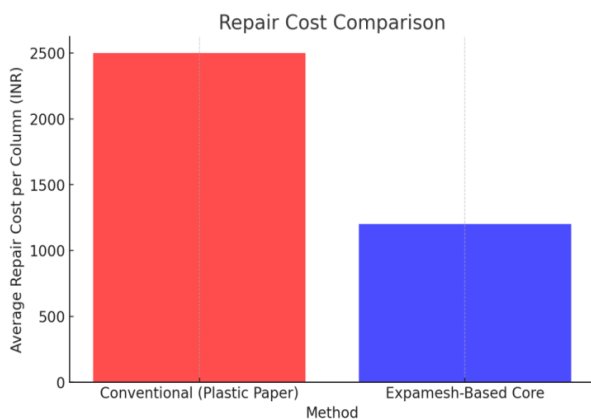


Fig 4.4.1 : Repair cost comparison

- Expamesh eliminated major post-casting repairs, leading to 52% cost savings per column.
- Conventional methods required manual surface roughening, additional bonding agents, and patching, increasing costs.

#### 4.5. Demolding Time Improvement (%)

Expamesh facilitated easier demolding due to its non-adherent nature, unlike plastic paper, which often stuck to the concrete.

1. Stronger and More Durable Precast Components
  - Higher bond strength ensures better integration between shell and core concrete, reducing structural failures.
  - Lower deformation and bond slip improve load transfer efficiency, making Expamesh suitable for high-rise buildings, bridges, and modular precast structures.
2. Reduction in Repair and Maintenance Costs
  - Expamesh minimizes core-shell detachment issues, eliminating the need for post-installation repairs.
  - Long-term durability benefits, such as better chloride resistance and reduced water absorption, extend the lifespan of precast structures in coastal and industrial environments.
3. Faster Construction Cycles and Improved Efficiency
  - 33% faster demolding time allows precast factories to increase production rates.
  - Reduced labor-intensive tasks streamline manufacturing processes, making Expamesh a time-efficient solution.
4. Sustainability and Environmental Benefits
  - Eliminating plastic wrapping and rubber tubes reduces construction waste.
  - Expamesh contributes to sustainable building practices by minimizing material usage and labor-intensive repairs.

## 5. CONCLUSION

- MS-Expamesh proved to be a better alternative to plastic or rubber core formers in precast columns, mainly because it created a stronger bond between the core and the outer concrete.
- The rough texture of Expamesh helped avoid common problems like detachment or weak connections that often happen with smooth plastic wraps.
- The concrete gained strength faster when Expamesh was used, especially in the first 48 hours. This is helpful in speeding up the production process in precast factories.
- Expamesh also made demolding much easier and reduced surface defects, which meant less time and money spent on repairs and touch-ups.
- Since there's no need for plastic or rubber waste, using Expamesh also supports sustainable construction practices and reduces environmental impact.
- Overall, the use of Expamesh is a smart and practical choice for improving the quality, speed, and cost-efficiency of precast concrete production.
- The results from this study open the door to trying Expamesh in more complex and larger structures in the future.

## 6. REFERENCES

1. Parlour, D. (2017). *Precast Concrete in Residential Construction*. Concrete Institute of Australia.
2. Yu, R., Spiesz, P., & Brouwers, H. J. H. (2018). Development of cement-based ultra-high-performance composites (UHPC). *Cement and Concrete Composites*, 84, 98–110.
3. Shah, K. D., O'Neill, C., & Durdyev, S. (2020). Sustainable construction: Analysis of its challenges and future prospects. *Journal of Cleaner Production*, 260, 121–150.
4. Ramli, M., & Tabassi, A. A. (2014). Impact of interface quality on structural performance of composite concrete elements. *Construction and Building Materials*, 68, 409–418.
5. Ali, M., & Javed, M. F. (2021). Effect of expanded metal mesh reinforcement on mechanical performance of cementitious composites. *Construction and Building Materials*, 271, 121595.
6. Kasa, A., & Mohammed, A. (2020). Experimental study on the performance of expanded metal mesh in precast concrete construction. *Materials Today: Proceedings*, 33, 415–421.
7. Ahmed, W., Mohammed, S., & Hussain, A. (2022). Performance evaluation of alternative core formwork systems in precast concrete columns. *Case Studies in Construction Materials*, 17, e01301.
8. Concrete Centre. (2023). Standards for precast concrete.
9. Precast/Prestressed Concrete Institute (PCI). (2023). Building code provisions for precast/prestressed concrete: A brief history. *PCI Journal*, 68(3), 59–70.
10. Bureau of Indian Standards (BIS). (2010). IS 15917: Building design and erection using precast and composite construction. BIS.
11. Li, H., & Wu, Z. (2023). Performance of precast concrete connections: A review. *Buildings*, 13(7), 1575. <https://doi.org/10.3390/buildings13071575>
12. Kurama, Y. C., & Tazarv, M. (2023). Novel reinforced concrete buckling-restrained brace system for precast structures. *PCI Journal*, 68(3), 45–58.
13. Tazarv, M., & Saiidi, M. S. (2024). Repairable precast concrete bridge columns for seismic regions. *PCI Journal*, 69(3), 35–47.
14. Wang, Y., & Zhang, X. (2023). Experimental study on precast concrete shear wall connections. *Journal of Building Engineering*, 57, 104892. <https://doi.org/10.1016/j.job.2022.104892>
15. Zhu, J., & Ma, Z. (2023). Engineered cementitious composites in circular precast concrete columns. *Case Studies in Construction Materials*, 19, e01815. <https://doi.org/10.1016/j.cscm.2023.e01815>
16. American Concrete Institute (ACI). (2019, 2021). ACI 318-19 and ACI 318-21: Building code requirements for structural concrete and commentary. ACI.
17. Bazant, Z. P., & Planas, J. (1997). *Fracture and size effect in concrete and other quasibrittle materials*. CRC Press.
18. Mehta, P. K., & Monteiro, P. J. M. (2014). *Concrete: Microstructure, properties, and materials* (4th ed.). McGraw-Hill Education.
19. ASTM International. (2019, 2020). ASTM C1202-19, ASTM C642-20: Standard test methods for concrete durability. ASTM.
20. Neville, A. M. (2011). *Properties of concrete* (5th ed.). Pearson Education.
21. Bhattacharjee, B. (2012). *High-performance concrete: Concepts and applications*. IIT Delhi.
22. Kuder, K. G., & Shah, S. P. (2010). Rheology of fiber-reinforced cementitious materials. *Cement and Concrete Research*, 40(6), 1052–1060. <https://doi.org/10.1016/j.cemconres.2010.02.012>
23. European Committee for Standardization. (2004). Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings.
24. Willoughby, K., & Stanton, J. F. (2019). Precast concrete pier systems for accelerated bridge construction in seismic regions (WA-RD 611.1). Washington State Department of Transportation.