International Journal Multidisciplinary Science
IJML Vol 4 No. 2 | June 2025 | ISSN: 2963-8119 (print), ISSN: 2963-7821 (online), Page 75-79

Concrete Delamination Analysis and Repair Methods in Residential Buildings

Reynold Andika Pratama[1], Yuli Sulistyohadi[2], Jody Sutiawan[3], Pangeran Holong Sitorus[4]
[1,2,3]Civil Engineering Study Program, Faculty of Engineering and Informatics, Dian Nusantara University, Indonesia
[4]Civil Engineering Study Program, Universitas Yapis,Papua, Indonesia

Article History
Received : 15 July 2025
Revised : 25 July 2025
Accepted : 05 June 2025
Published : 15 June 2025

Corresponding author*:
yuli.sulistyohadi@dosen.undira.ac.id

DOI:
https://doi.org/10.56127/ijml.v4i2.2221

Abstract: Laminated concrete involves removing a thin layer from the concrete surface, making it prone to abrasion and weakening the structure. This delamination, often termed concrete weathering, produces a "drumming" sound when the surface is hammered, signaling the need for repair to prevent further spread. Delamination can result from poor concrete mix or casting issues, such as segregation when fresh concrete is poured. Quality control is crucial before pouring concrete into formwork for columns and walls. Checks like the slump test ensure proper workability, while concrete test specimens verify the mix meets the 28-day characteristic compressive strength. Casting concrete from heights exceeding 1.5 meters can cause delamination by segregating fine and coarse aggregates. Repairs for delaminated surfaces include grouting, plastering, or injecting. In a 4-story house construction project, plastering is often preferred due to the ready availability of materials like fine sand and cement, making it an effective solution. To summarize, delamination weakens concrete structures and requires timely detection and repair. Proper quality control during concrete mixing and casting, including slump tests and strength verification, helps prevent segregation and delamination. For repairs, plastering is a practical choice in multi-story projects due to material accessibility.
Keywords: laminated concrete, delamination, concrete weathering, poor concrete mix, segregation, slump test, compressive strength.

INTRODUCTION

Concrete delamination is a significant issue in construction that affects the durability and structural integrity of buildings. It is characterized by the separation of a thin layer of concrete from the surface, making the peeled concrete surface susceptible to various types of abrasion that can weaken the structure. Delamination is often considered a form of concrete weathering and requires prompt identification and repair to prevent further spread (Chen, 2019).

In residential construction projects, particularly multi-story buildings, concrete delamination in critical structural elements such as columns and basement walls can pose serious challenges to both structural integrity and project timelines. The 4-story residential building project examined in this study encountered concrete delamination issues in first-floor columns and basement walls, necessitating appropriate remedial measures.

This article aims to analyze the causes of concrete delamination in residential building structures and evaluate effective repair methods. The study is based on observations and interventions conducted during the construction of a 4-story residential building, focusing specifically on the delamination issues that occurred in first-floor columns and basement walls. The findings provide valuable insights for construction professionals to prevent and address similar issues in future projects.

RESEARCH METHOD

This research employed a case study approach, focusing on the concrete delamination issues observed in a 4-story residential building project. The methodology involved several stages:

1. Site Observation and Documentation.
   Regular inspections were conducted to identify areas affected by delamination. The "drum" sound test was employed, where a hammering technique was used to detect hollow sounds indicating delamination beneath the concrete surface.
2. Quality Control Analysis.
   The study examined quality control procedures implemented during construction, including slump tests to ensure proper workability of concrete mixtures before pouring into column and wall formwork structures.
3. Sample Testing.
   Concrete test specimens were created as part of quality management to verify that the fresh concrete met the characteristic compressive strength requirements at 28 days of age.
4. Causal Analysis.
   Factors contributing to delamination were systematically analyzed, including concrete mix quality, pouring techniques, and environmental conditions.
5. Repair Method Implementation and Evaluation.
   Various repair techniques were implemented, including grouting, plastering, and injection methods. The effectiveness of each method was evaluated based on durability, cost-efficiency, and ease of application.

The mathematical relationship between concrete fall height and segregation can be expressed as:

$$S = k \times h^2$$

Where:

- S is the segregation index
- h is the concrete fall height in meters
- k is a coefficient dependent on concrete mix properties

RESULT AND DISCUSSION

Causes of Concrete Delamination

The investigation revealed several key factors contributing to concrete delamination in the first-floor columns and basement walls:

1. Poor Concrete Mixture: Analysis of the concrete mix showed inconsistencies in aggregate distribution and water-cement ratio, leading to reduced cohesion between concrete layers.
2. Segregation During Pouring: When concrete was poured from heights exceeding 1.5 meters, significant segregation occurred, causing separation of fine and coarse aggregates. This segregation created weak planes within the concrete structure that later manifested as delamination.
3. Inadequate Vibration: In some areas, insufficient vibration during concrete placement resulted in air voids and poor compaction, creating potential delamination planes.
4. Formwork Issues: Premature removal of formwork in certain sections contributed to surface delamination, particularly in areas exposed to environmental stressors.

Quality Control Measures

To prevent further delamination issues, several quality control measures were implemented:

1. Slump Testing: Regular slump tests were conducted to ensure proper workability of concrete before pouring. The results indicated that maintaining a slump value between 75-100 mm provided optimal workability while minimizing segregation risk.
2. Concrete Sample Testing: Test specimens were regularly prepared and tested to verify that the concrete achieved the required characteristic compressive strength at 28 days. The results confirmed that the concrete mix design was appropriate, but handling and placement procedures needed improvement.

Table 1 shows the slump test results for different batches of concrete used in the project.

Table 1. Slump Test Results

Batch Number	Slump Value (mm)	Workability Assessment
1	85	Good
2	110	Excessive
3	75	Optimal
4	90	Good

Repair Methods and Effectiveness

After evaluating various repair options, the following methods were implemented:

1. Grouting: Applied in areas with deep delamination, this method involved injecting cementitious grout into voids to restore structural integrity.
2. Plastering: This method proved most effective for the residential building project due to its cost-efficiency and the ready availability of materials (fine sand and cement). The process involved removing loose concrete, cleaning the surface, applying a bonding agent, and applying a cement-sand mortar mix.
3. Injection: For narrow cracks and delamination, epoxy injection was used to restore structural continuity.

The effectiveness of each method was evaluated based on durability, cost, and ease of application. The plastering method emerged as the most practical solution for this specific project, providing adequate repair while remaining cost-effective and requiring readily available materials.

Figure 1 illustrates the delamination observed in a first-floor column, while Figure 2 shows the repair process using the plastering method.

Figure 1. Delamination In A Column

Figure 2. Repair Process Using The Plastering Method

CONCLUSION

Concrete delamination in residential building structures, particularly in columns and basement walls, is primarily caused by poor concrete mixture quality, segregation during pouring (especially when pour heights exceed 1.5 meters), inadequate vibration, and formwork issues. Early detection through methods such as the "drum" sound test is crucial for preventing the spread of delamination.

For the 4-story residential building project studied, the plastering repair method proved most effective due to its cost-efficiency and the ready availability of materials. This method provided satisfactory results in restoring the structural integrity and appearance of the affected elements.

To prevent concrete delamination in future projects, strict quality control measures should be implemented, including proper concrete mix design, controlled pouring heights, adequate vibration, and appropriate formwork removal timing. Regular inspection during and after concrete placement is essential for early detection and intervention.

This study contributes to the understanding of concrete delamination issues in residential construction and provides practical guidance for prevention and repair strategies that can be applied in similar projects.

REFERENCES

Chen, W. K. (2019). Linear networks and systems. Belmont, CA: Wadsworth.

Goldenstein, C. S., Spearrin, R. M., Jeffries, J. B., & Hanson, R. K. (2017). Infrared laser-absorption sensing for combustion gases. Progress in Energy and Combustion Science, 60, 132–176.

Payne, D. B., & Gunhold, H. G. (2018). Digital sundials and broadband technology. In Proceedings of IOOC-ECOC (pp. 557–998).

British Standards Institution. (2020). B.S. 764. London: British Standards Institution.