A Mixed Methods Study on Tile Installation Techniques to Prevent Hollow Sounds

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***Abstract*: This study investigated the effectiveness of tile installation techniques in preventing hollow-sounding tiles among tile setters in Pampanga. The study aimed for the identification of the common causes of hollow-sounding tiles, determination of the different installation techniques used by tile setters, and evaluation of which method was most effective in reducing hollowness. Six tile setters were selected in the study through purposive sampling. Data were gathered using semi-structured interviews, on-site observations, survey questionnaires, and kapak testing procedures. Weighted mean and percentage analysis were utilized for the quantitative aspect of the study, whereas thematic analysis was applied for the qualitative data. The findings showed that insufficient mortar coverage, rushed workmanship, improper installation procedures, and poor material application were the factors in the occurrence of hollow-sounds. Among the techniques, double-layer mortar application produced the lowest kapak occurrence rate which indicates better performance compared to other techniques. The study concluded that proper mortar coverage, disciplined workmanship, and standard compliance procedures improves tile installation quality and minimize the occurrence of hollow-sounding tiles.**

***Keywords*: Tile Installation; Hollow Sounds; Tiles; Tile setter; Industry Standards**

1. Introduction

Floors are fundamental elements in all types of structures. It needs to be flat to help people perform tasks more efficiently and effortlessly. Most individuals prefer the floors to be made of concrete due to its durability and affordability. The concrete floors are excellent but they are not quite appealing. That is why it is essential to apply a floor finish to enhance the overall look of the room. This is an additional layer that makes the concrete floor aesthetic.

Tile installation is important in structures for overall beautification and cleanliness. The common materials used to fabricate tiles were mostly ceramic, porcelain, glass, cement, and natural stone. Even though tiles provide durability, aesthetics, and ease of maintenance, proper installation techniques are still the basis of good tile performance. The most common problem of contractors and clients is the hollow sound, or 'kapak,' in Filipino. This sound indicates poor adhesion or voids under the tiles. Since tile setters use different techniques during installation, improper application may lead to cracking, loosening, and water intrusion.

According to the Tile Council of North America (TCNA, 2019), these voids or “kapak”, are detected by tapping the tiles where they produce hollow sounds. This sound is an indication in which there is a lack of mortar coverage and a weak bond between the tile and the substrate. These gaps become critical points that can cause the tile to crack, chip, or fail and lessen the total profit of the contractor. This reoccurrence can result in wastage of materials, repairs, project delays, and poor professional reputation. Voids not only cause waste but also negatively affect the integrity and functionality of the structure by influencing its comfort, and moisture retention. Salustio et al. (2022)

The tile installation process is regulated by standards provided by international organizations, including the International Organization for Standardization and the Tile Council of North America. These organizations instructed on applying at least 80% mortar coverage. But, even with structured standards, there are still issues towards hollow sounding tiles which reflect a difference between theoretical and practical application. The methods and processes used by tile setters, which are usually the outcome of training and practice, are central to this factor

In the Philippines, the construction industry contributes a large share in the economy. International standards from the ISO have been adapted by the national government through the Bureau of Philippine Standards (BPS) under the Department of Trade and Industry (DTI) for quality assurance and control. The Technical Education and Skills Development Authority (TESDA) offers NC-II certification for tile setters to guarantee that they possess the required competency and skills. But since it's a tropical country, the weather creates a difficulty for the curing time and strength of some adhesives. Project pressures, usually part of a "pakyawan" system, can also result in hasty procedures which compromise the outcome Manuel et al. (2024). The factors point to learning how tile setters work their way around these difficulties to avoid the creation of voids.

While existing studies also established their results based on experimental and laboratory tests, creating a baseline in the

effectiveness of a method in tile installation and ensuring its quality. Current Studies, such as Gomes et al. (2022) shows low contact area, which also pertains to mortar or adhesive coverage, creates stress concentration that shifts critical stress zones towards the center of the tile, increasing the possibility of failure. In addition, according to the study of Pontillas (2024), the use of wrong troweling tools contributes to the hollowness of tiles. With this, the majority of the existing study is only limited to the adequate technique and use of the right tools. While the theoretical criteria for tile installation are clearly defined, the actual step-by-step procedures and workmanship quality found on construction sites are often overlooked. Existing studies focus mainly on laboratory testing and theoretical installation standards, while limited in empirical evidence regarding the actual field practices of tile setters in construction sites. There is also insufficient observational data comparing installation techniques and their measurable relationship to hollow tile occurrence.

There are different methods being used by tile setters in order to perform quality assured tile installation. And each method and technique consists of different effectiveness when it comes to preventing hollow-sounding tiles that are caused by the hollowness underneath the tile surface. In this study, the researchers aim to determine the most effective and practical tile installation technique to prevent hollow sound. Therefore, the study aims to address the following objectives:

1. To identify the common factors in having hollow-sounding tiles that the participants experience.
2. To identify different installation techniques used to prevent hollow sounds during tile setting.
3. To choose from the varied techniques the most effective way of setting the tiles with zero to few hollow sounds

2. Literature Review

A. Industry Standards

In the construction terminology, a “hollow sound” in a tiled surface is an indication of a void, or air pocket, under the tile. This effect is a common problem in construction and is primarily due to lack of mortar coverage (Salustio et al., 2022). When tiles are not fully supported, the hollow area experiences loads that can increase the risk of cracking and failure. The Tile Council of North America (TCNA) indicates that inadequate mortar coverage is the most common factor for tile failure due to the lack of support for load stress at contact points (TCNA, 2019). The minimum adhesive coverage is 80% in the case of dry surfaces and 95% in the case of wet surfaces, by most international and local institutions (ISO, 2019). In the Philippines, international standards have guided the government for regulating tile quality and professional qualifications. The Department of Trade and Industry (DTI) inlined its standards with the International Organization for Standardization (ISO), while the Technical Education and Skills Development Authority (TESDA) offers a certification for tile setters for providing a competency base of skills and knowledge (TESDA, n.d.). However, research on construction practices discovered that even with these measures taken, the self-reported practices of tile setters tend to be divergent from these standards. According to Manuel et al. (2024), knowledge based on experience, typical ways, and not in a formal training, is still a major issue and can still lead to inconsistent workmanship and will soon result in installation failures. According to South Aukland Tilers (2023), Lili Tile, and Flooring Clarity (2025), thin-set mortar has its appropriate setting time in order to handle light foot loads. This is already enough to properly conduct the knock test or “kapak test” in local Filipino term. In addition, the duration of the curing time based on Flooring Clarity ranges from 24 to 72 hours depending on the adhesive type that is used in the tile installation. Based on the Floor Modeling Services (2025), the quality of the materials used in tile installation such as the tile itself and the adhesive can contribute to many issues. They claimed that the quality tile can resist much better than the cheaper ones and that the right adhesive will ensure quality bonding that may allow it to last longer. Meanwhile, according to Patel (2025), old cement loses its strength and binding property. Cement is a fine powder. If it gets hydrated with moisture, it will form lumps. For best quality, it is recommended for cement to be utilized within three months of its date of manufacture. If stored for a long period, it may lose about 20-30% of its total strength.

B. Construction Practices in Tile Installation

The strength and durability of tiles being installed mostly depend on the bonding of the tile itself to the base surface, typically concrete flooring, regardless of whether it is suspended or a grade slab. In the study of Lee et al. (2021), they concluded based on scientific research that the performance of tiles installed under loading is based on the area that is covered by the adhesive. In mathematical terms on laboratory tests, bond strength and effective contact area of the adhesive show a linear relationship. The study resulted in 100% increase in adhesion strength because of the contact area ratios due to the properties of each material, the tiles, and the mortar.

C. Effects of Hollowness in Tile Installation

The engineering field identifies "hollow sounds" as dangerous because they reveal the presence of voids. A tile that consists of voids results in unsafe areas due to lack of adhesive and mortar support that directly affects the load-bearing capacity of the tile itself, decreasing the capacity of the tile to support common dead loads and live loads such as house furniture and residents casually roaming around the house or infrastructure. Based on the studies of Salustio et al. (2022) and Lee et al. (2021), lower areas covered by adhesive and mortar resulted in air pockets or voids. These unsupported areas are compared to small beams because of the lack of support for the tile. Due to the voids, there is a resulting concentration of loadings that in the long run becomes the starting point of micro-cracks. These voids lessen the capability of the mortar

and adhesive to withstand shear forces, which results in debonding and cracking or total tile failures.

D. Tile Setters' Competencies

In the Philippine construction industry, many tile setters acquire their skills through on-the-job observation rather than having a National Certificate Level II (NCII) from the Technical Educational and Skills Development Authority (TESDA). While this helps people build skills, it can also contribute to ongoing systemic human error. According to Pontillas (2024), "manpower" is the primary root cause of tiling defects. The study recommends that the industry should focus more on the technical skills of the installers. They must also be equipped with standard knowledge of substrate and mortar application rather than solely relying on their personal experience. According to the Ceramic Tile Education Foundation (CTEF, 2026), many tile installers use "spot bonding" to save time and adhesive. While this shortcut may have worked for small tiles, it creates massive voids in larger tile formats. Defects are seldom due to poor material, but more often to human procedural mistakes. A recent analysis by Kuchinka (2026) revealed that 67% of tile cladding failures originated from the installation phase. This suggests that human error, particularly in mortar application and substrate preparation, is a contributing factor.

E. Methods of Tile Installation

There are certain and proper installation techniques that are essential to minimize the void formation and to prevent the presence of voids under the tiles. According to Lee (2021), the most efficient way to eliminate voids is by using the sound technique, where the tile setter uses a rubber hammer or vibration to equally distribute the adhesive and mortar in between the tiles and base surface. In addition to this, back-buttering is also an efficient technique. Tile setters apply a thin layer of mortar at the back of the tiles before being laid to the mortar. It is usually used in large tiles since it improves the transfer and coverage of the mortar in the entire area. The findings of the study of Pontillas (2024) show that using the wrong troweling instrument and orientation is one of the main causes of why a hollow sound is occurring. Similarly, Carothers (2022) explains that proper usage of a notched trowel is also important. Directional troweling is the recommended approach, wherein the mortar should be applied in one direction. This will enable the escape of trapped air during setting of the tile and reduce void formation to a minimum. Whereas swirling motion can create air spaces or voids. In the Philippines, Niro Granite Philippines (2025) recommends thin-set mortar for better bond strength and application in most projects. In the Philippines, guides usually distinguish thin-set from other types of adhesives such as mastic, noting its resistance to moisture and versatility across different substrates.

In the study of Dal Ross and Dos Santos (2023), there are specific types of ways to install ceramic tiles, using either a single-layer method or double-layer method of adhesive application using compaction tools such as a vibrating machine or a traditional rubber hammer. In order to prove the effectiveness of these two techniques, the researchers conducted an experimental study to compare porcelain tiles that are installed using a single layer of mortar with a rubber hammer, a single layer of mortar with a vibrating machine, a double layer of mortar with a rubber hammer, and a double layer of mortar with a vibrating machine. Their study's result was checked through the kneading chords of the mortar. Whichever type of layer the researchers used, both resulted in a better kneading of chords in terms of using a vibrating machine compared to the sample where a rubber hammer was used. It only indicates that a double layer of mortar or adhesive is much preferable to hold the tiles in place and reduce the voids in floor tiles.

F. Scheduling and Timeframe of Tile Installation

Based on Siman (2023), finishing works in the Philippines where tile installation is included, often happens in the sixth or seventh month prior to the starting date of the construction. It ensures that the priority works are already done such as the structural and utilities of the building before starting the architectural finishing works. According to Wiyanti et al. al (2019), tile installation working time is influenced by the work methods used by bricklayers. The study about different methods applied by workers, showing that each method results in variations in activity duration. The results indicate that differences in the sequence and execution of tasks affect overall performance. Efficient work methods help to improve productivity, rather than simply increasing the speed of work. This implies that improving the method is more effective than rushing the installation process. In addition, Holcim Pinoy Builders (2024) stated that starting a phase of a construction under the period of the rainy season can result in the different challenges a construction project might face. Included in these challenges are delayed timelines, structural integrity, safety hazards, and soil stability issues. The tile-laying works fall under the finishing phase of the project, and if the project starts in the dry season, tile-laying works will typically start within the months of May onwards. According to PAGASA, Pampanga is classified as type 1 based on the Philippine climate map where it is stated that the dry season starts from November to April and the wet season for the rest of the year. Within the timeline of the dry season from November to April, tile-laying works should be done before the end of April to ensure 100% project completion in the month of April.

In summary, review of related literature focuses on the industry standards in tile-laying works, the actual construction practices in tile installations, the effects of hollowness or voids that are present in tiles, the tile setters' competency in work practices, the different methods applicable for tile installation, and the scheduling and time frame of tile-laying works. Several studies are focused on the standards to ensure quality control. While most of the study focuses on the methods of tile installation and effects of hollowness or voids in tiles

3. Methodology

A. Research Design

In this study, the researchers used a mixed-method research design, integrating both qualitative and quantitative approaches to obtain a comprehensive understanding of tile installation techniques and their relationship to the occurrence of hollow-sounding tiles. The researchers selected mixed-method design because a single method alone is insufficient to fully explain the relationship between workmanship practices and tile installation quality. According to Sharma et al., (2023), Mix method research is used when one type of data alone is insufficient, allowing the researcher to view the problem from multiple perspectives and strengthen the findings through data integration. The qualitative approach involves non-numerical data, and it was used to explore the experiences, opinions, techniques, and practices of the tile setter. The researchers used thematic analysis wherein the interview responses and field observations were transcribed, organized and carefully reviewed to identify recurring patterns. On the other hand, the quantitative approach was used to measure the occurrence of hollow-sounding tiles through the conduct of kapak tests. The researchers recorded the number of hollow-sounding tiles and computed the percentages based on total tiled area. Comparative analysis was also used to evaluate the effectiveness of different tile installation techniques. The integration of qualitative and quantitative findings enabled the researchers to validate observations using measurable field data

B. Instrument of the Study

The study utilizes multiple instruments to gather data for qualitative and quantitative research. For the qualitative method, the researchers came up with a semi-structured interview type, prepared open-ended questions, and added follow-up questions depending on the interviewee's answer. The researchers observed the participants during the actual tile installation process. On the other hand, the quantitative method was used through a survey questionnaire and "kapak" test recording sheet. The participants are asked to rate each statement in the survey questionnaire. Using a Likert scale, the level of agreement regarding factors contributing to hollow-sounding tiles will be determined. Weighted mean was used to analyze and interpret the gathered process. The "kapak" test recording sheet is used to assess the presence of hollow sounds in installed tiles through the coin-tapping method.The researchers conducted the test after a minimum curing period of 24 hours. During the test, the researchers recorded the number of hollow-sounding tiles detected. Since the tiles used vary in size, the researchers multiplied the number of hollow-sounding tiles to the corresponding tile size to determine the total affected area. Doing this will help the researchers in comparing the 'kapak' occurrence on different tile dimensions as well as identify the technique that experienced the most and least amount of 'kapak' problems. To ensure the validity of the instruments, the interview guide and survey questionnaire were reviewed by the research adviser to confirm that the questions were relevant and aligned with the objectives of the study. Reliability was maintained by applying consistent interview formats, observation procedures, and "kapak" testing methods across all participants.

C. Target Respondents of the study (Research Locale)

The study was conducted in the province of Pampanga, specifically in the municipalities of Mexico, Bacolor and the City of San Fernando. These locations were selected due to the continuous growth of infrastructure projects in residential and commercial areas.

The Participants were tile setters currently practicing in the construction industry, with or without NC II tile-setting certification from Technical Education and Skills Development Authority (TESDA). The researchers used a purposive sampling technique because the study specifically requires tile setters. These participants were selected because of their background knowledge, skills, and direct experience in tile installation. To ensure precise data, the study focused on a selected six (6) tile setter accessible practitioners within the specific timeframe of the data collection. This allowed the researchers to gather direct information and actual data from skilled workers who were currently active in the field.

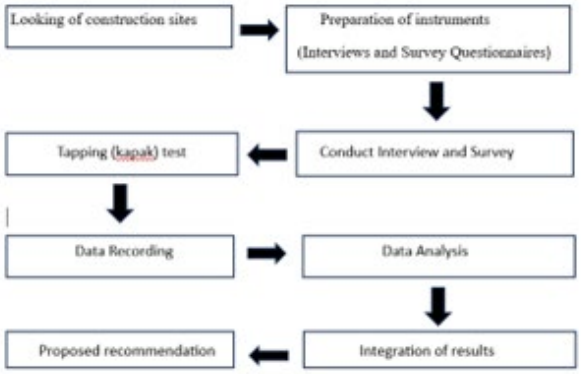


Fig. 1. Process flowchart

D. Description of the Method Used

The study process began with the finding of several construction sites around Pampanga where there is an actual tile installation activity being executed. After site selection, the researchers asked permission from the site supervisor if they can be allowed to conduct a survey on site. Once the supervisor granted permission, the researchers proceeded to the preparation of instruments that will be used such as interview guide and questionnaires, pen, and mobile phone for documentation and recordings.

Upon completion of the necessary preparation, the researchers carried out the interview proper to collect information regarding their profiles, installations practices, materials used and common factors that they have encountered. After the interview, the researchers asked the participants to demonstrate their technique on tile setting. To conclude the

interview and demonstration, the tile setter was given a small token of appreciation.

The next thing to be done is the "kapak" test. After the tiles cured for a certain time frame, the researchers returned to the site and conducted a tapping test using a coin which will detect and verify if there are hollow sounding tiles.

As all interviews and tests are done, the researchers organized the collected data which underwent analysis. This analysis provided themes and patterns to help identify the main factors that contributed to tile failure.

Integration of results is the next step after analysis. This enabled the results from the survey, responses and kapak test to be combined to form a detailed interpretation of the study

Finally, the researchers developed recommendations based on the analyzed results. It aims to improve tile installation practices to minimize the occurrence of the hollow sounding tiles.

4. Results and Discussion

A. Common factors in having hollow-sounding tiles

1) Theme: The Impact of Productivity Pressures and Workmanship Standards

Figure 2 illustrates the participants' insights regarding mortar coverage as a cause of hollow sounds. Tile setter 1 gave a rating of 5, tile setters 2, 4, and 5 gave ratings of 4, while the remaining tile setters gave ratings of 2, resulting in a mean of 3.5. This indicates that insufficient mortar coverage is a significant factor in the occurrence of hollow-sounding tiles.

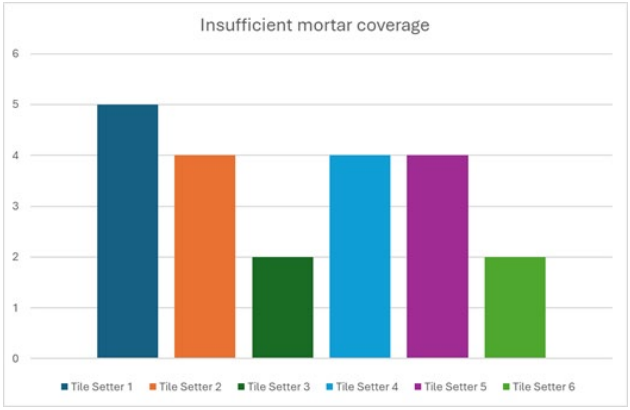


Fig. 2. Insufficient mortar coverage

2) Comparison to the actual execution

1. Tile setter 1

The tile setter strongly agreed with this factor and applied mortar on the entire back of the tile during installation. The kapak test resulted in only 4.70%, showing that full mortar coverage reduced hollow sounds.

2. Tile setter 2

Although he gave a high rating, his actual execution contradicted his response. He used adhesive slurry on the dry pack instead of applying mortar directly on the tile, resulting in a high kapak percentage of 52.5%.

3. Tile setter 3

This tile setter provided a low rating but achieved only 4% kapak. Proper tapping using a rubber mallet allowed the mortar to spread evenly and fill the gaps.

4. Tile setter 4

The tile setter strongly agreed with the factor and applied mortar on both the substrate and the tile. Through proper tapping and full coverage, he achieved a low kapak percentage of 2.3%.

5. Tile setter 5

This participant also provided a high rating and achieved only 2.9% kapak by evenly spreading mortar and using a rubber mallet to eliminate gaps.

6. Tile setter 6

The tile setter provided a low rating and produced the highest kapak percentage of 78.33%. During installation, some tile areas, especially corners, lacked mortar coverage, resulting in more hollow sounds.

The thematic analysis revealed that insufficient mortar coverage is commonly caused by rushed work, shortcuts, and poor workmanship. Participants explained that workers sometimes prioritize speed over proper installation procedures, leading to installation defects. P1 emphasized proper work to avoid back jobs, while P2 and P4 highlighted the importance of patience and proper pacing during installation. According to TCNA (2019) and ISO (2019), inadequate mortar coverage is one of the leading causes of tile failure. Studies by Pontillas (2024) and Kuchinka (2026) also identified human error and poor workmanship as major contributors to tile installation defects.

B. Theme: Substrate Management

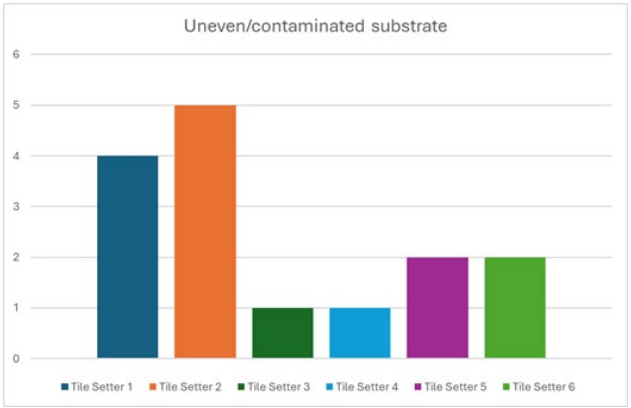


Fig. 3. Uneven/contaminated substrate

Figure 3 shows that substrate condition is a lesser factor in hollow-sounding tiles, with a mean rating of 2.5. Most participants believed that uneven surfaces can still be corrected using dry pack.

1) Comparison to the actual execution

During the observations, all tile setters cleaned the substrate before installation by removing dust, debris, and concrete lumps to maintain a clean and even surface. Some participants,

particularly P3 and P5, also moistened the floor before installation to prevent the concrete from absorbing moisture from the mortar too quickly.

The thematic analysis showed that proper substrate preparation is still important in preventing hollow sounds and ensuring successful tile installation.

C. Theme: Trowel technique and the mastery of installation

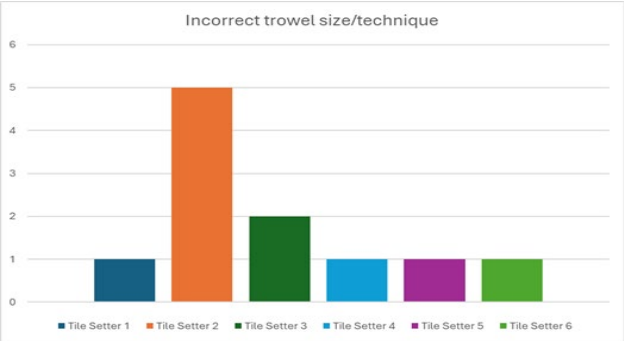


Fig. 4. Incorrect trowel size/technique

Figure 4 shows that trowel type and size were considered a low factor, with a mean rating of 1.83. Tile setters 1, 4, 5, and 6 rated this factor as 1, while tile setter 2 gave a rating of 5. Despite the different ratings, all tile setters used only a spatula during installation and still produced varying results.

Comparison to the actual execution

During the observations, all participants used spatulas instead of different trowel types and sizes, showing that installer skill and proper technique are more important than the tool itself.

The thematic analysis revealed that mastery of mortar consistency and application technique helps prevent defects. Participants explained that most of their skills were learned through experience rather than formal training, which may lead to procedural errors such as swirling mortar application. According to Carothers (2022), directional troweling is recommended because it allows trapped air to escape and minimizes void formation.

D. Theme: Conflict Between Hasty Work and Good Quality

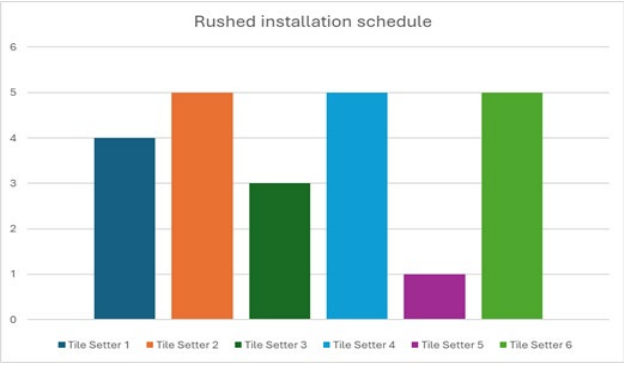


Fig. 5. Rushed installation schedule

Figure 5 shows that rushed installation is a major factor affecting tile quality, with a mean rating of 3.83. Tile setters 2, 4, and 6 gave ratings of 5, indicating that rushing often leads to shortcuts, skipped procedures, and poor workmanship.

1) Comparison to the actual execution

During the observations, tile setters who worked patiently achieved better installation quality. Rushed work was observed to cause missed steps, uneven tiles, and damaged tiles.

The thematic analysis revealed that pressure to meet quotas often leads workers to sacrifice proper procedures. P2 explained that workers sometimes “rush to impress” supervisors, while P4 stated that rushing eventually results in back jobs and repairs. Manuel et al. (2024) also found that workers tend to ignore TESDA and DTI standards when schedules are too tight. P1 emphasized that doing the work properly helps avoid future repairs and saves both time and money

Figure 6 shows that curing time is an important factor in preventing hollow-sounding tiles, with a mean rating of 3.67. Tile setters 2, 4, and 6 gave ratings of 5, indicating that sufficient curing time helps the mortar achieve proper bonding strength before loads are applied.

2) Comparison to the actual execution

During the observations, all tile setters allowed adequate curing time before applying loads on the installed tiles. The researchers also conducted the kapak test after 24 hours of curing.

The thematic analysis revealed that curing is essential for achieving proper bond strength. Participants explained that disturbances such as vibrations or people walking on freshly installed tiles may weaken the bond and cause hollow sounds. P6 stated that even with proper installation, interruptions during curing can still result in hollowness. Lee et al. (2021) also explained that interrupted curing reduces the effective contact area and weakens tile adhesion.

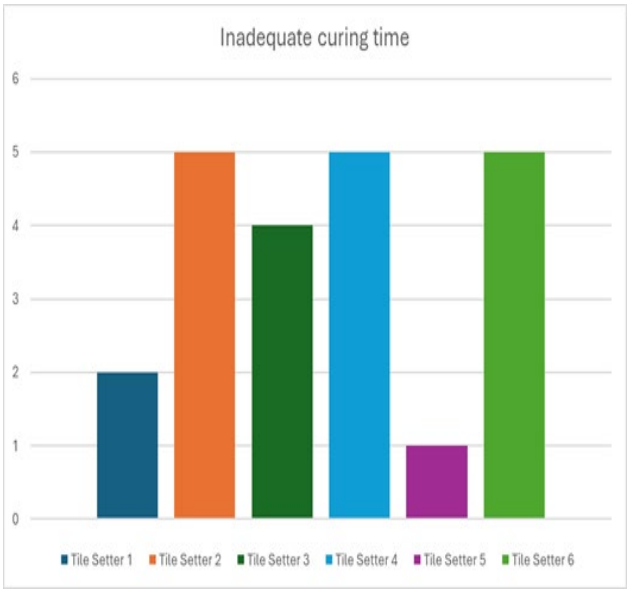


Fig. 6. Inadequate curing time

E. Theme: Material Integrity and Adhesive Performance

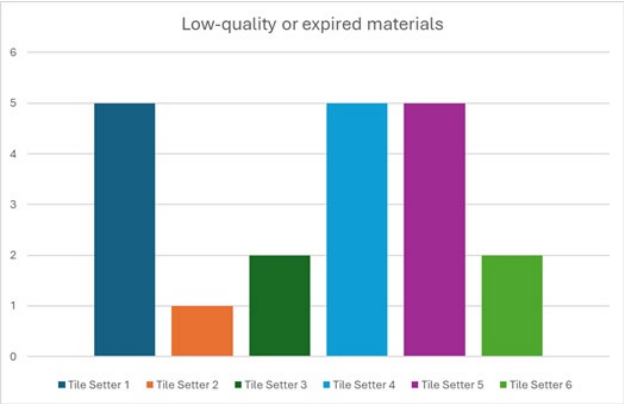


Fig. 7. Low-quality or expired materials

Figure 7 shows that material quality is an important factor in preventing hollow-sounding tiles, with a mean rating of 3.33. Tile setters 1, 4, and 5 strongly agreed that poor-quality or expired materials weaken bonding performance, while tile setters 2, 3, and 6 gave lower ratings.

1) Comparison to the actual execution

During the observations, all tile setters used good-quality materials such as tiles, cement, and adhesives. The researchers also checked the labels, expiration dates, and certifications to ensure the materials were suitable for use.

The thematic analysis revealed that fresh and high-quality materials contribute to successful tile installation. Participants explained that using cheap or expired materials may save money initially but can lead to weak bonding and future repairs. According to Lee et al. (2021), bond strength depends on the contact area between the mortar and tile surface. P2 also emphasized that using proper materials helps avoid voids and reduces back jobs.

2) Identifying Different Installation Techniques.

Table 1
Summary of tile installation data and results for tile setter 1

Tile setter	**1**
Technique	Single Layer Mortar Application with dry pack
Tile size	1000mm x 200mm
Adhesive Ratio	1 cement: 1 adhesive
Dry pack Ratio	1 cement: 5 sand
Thickness	50mm
Slurry	1 cement: 1 water (16 liters)
Tiled area	12.8 m^2
Total tiles	64 pcs
Number of kapak	3pcs
Locations	2 center, 1 side
Number of non-kapak	61 pcs
Area of 'kapak'	0.6 m^2
Percentage	4.70%
Productivity rate	95.3%
Ratio	1:20

Step by Step Procedure

Phase 1: Area preparation

1. Prepared the materials, tools, and equipment
2. Cleaned the area of installation
3. Setting a guide wire

Phase 2: Tile Installation

1. Made a mix for dry pack and mortar
2. Wetted the floor
3. Applied a dry pack to the flooring and even it out
4. Using the tile, press it initially to compact and shape the dry pack then remove
5. Applied a mortar to the tiles and pressed it to the dry pack
6. Used a rubber mallet to help even out the mortar and for better adhesion
7. Used a tile spacer to provide gaps for thermal expansion and chipping the adjacent tiles.

Table 2
Summary of tile installation data and results for tile setter 2

Tile setter	**2**
Technique	Dry pack + Adhesive slurry
Tile size	600mm x 600mm
Adhesive Ratio	N/A
Dry pack Ratio	1 cement: 7 sand
Thickness	20mm
Slurry	0.5 ABC Redifix adhesive: 1 water (16 liters)
Tiled area	14.4 m^2
Total tiles	40 pcs
Number of kapak	21pcs
Locations	10 center, 2 side + center. 9 sides
Number of non-kapak	19 pcs
Area of kapak	7.56 m^2
Percentage	52.5 %
Productivity rate	47.5%
Ratio	1:2

Step by Step Procedures

Phase 1: Area preparation

1. Prepared the materials, tools, and equipment
2. Cleaned the area of installation
3. Setting a guide wire

Phase 2: Tile Installation

1. Made a mix for dry pack and slurry
2. Wetted the floor with the slurry
3. Applied a dry pack to the flooring
4. Using the tile, press it initially to compact and shape the dry pack then remove
5. Applied the slurry to the dry pack and place the tile
6. Used a rubber mallet to tap the tile for adhesion
7. Used a tile spacer to provide gaps for thermal expansion and chipping the adjacent tiles.

Table 3
Summary of tile installation data and results for tile setter 3

Tile setter	**3**
Technique	Single Layer Mortar Application
Tile size	300mm x 300mm
Adhesive Ratio	1 cement: 1 adhesive
Dry pack Ratio	N/A
Thickness	N/A
Slurry	N/A
Tiled area	2.25 m^2
Total tiles	25 pcs
Number of kapak	1pcs
Locations	1 center

Number of non-kapak	24 pcs
Area of kapak	0.09 m^2
Percentage	4%
Productivity rate	96%
Ratio	1:25

Phase 1: Area preparation
1. Prepared the materials, tools, and equipment
2. Cleaned the area of installation
3. Setting a guide wire

Phase 2: Tile Installation
1. Made a mix for mortar
2. Wet the floor
3. Applied a mortar to the flooring and even it out
4. Wetted the back side of the tile
5. Press the tile to the flooring
6. Used a rubber mallet to help even out the mortar and for better adhesion
7. Used a tile spacer to provide gaps for thermal expansion and chipping the adjacent tiles.
8. Clean the excess mortar that came out of the edges

Table 4
Summary of tile installation data and results for tile setter 4

Tile setter	**4**
Technique	Double Layer Mortar Application
Tile size	150 mm x 600mm
Adhesive Ratio	1 cement: 1 adhesive
Dry pack Ratio	N/A
Thickness	N/A
Slurry	N/A
Tiled area	15.75m^2
Total tiles	175 pcs
Number of kapak	4 pcs
Locations	1 center, 1 side + center. 2 sides
Number of non-kapak	171 pcs
Area of kapak	0.36 m^2
Percentage	2.3%
Productivity rate	97.7%
Ratio	1:44

Step by Step Procedures
Phase 1: Area preparation
1. Prepared the materials, tools, and equipment
2. Cleaned the area of installation
3. Setting a guide wire

Phase 2: Tile Installation
1. Made a mix for mortar
2. Wetted the floor
3. Applied a mortar to the flooring and even it out
4. Applied the mortar to the tiles
5. Press the tile to the flooring
6. Used a rubber mallet to help even out the mortar and for better adhesion
7. Used a tile spacer to provide gaps for thermal expansion and chipping the adjacent tiles.
8. Clean the excess mortar that came out of the edges

Table 5
Summary of tile installation data and results for tile setter 5

Tile setter	**5**
Technique	Single Layer Mortar Application
Tile size	150 mm x 600mm
Adhesive Ratio	1 Adhesive: 0.5 water (8 liters)
Dry pack Ratio	N/A
Thickness	N/A
Slurry	N/A
Tiled area	15.75 m^2
Total tiles	175 pcs
Number of kapak	5 pcs
Locations	2 center, 1 side + center, 2 sides
Number of non-kapak	170 pcs
Area of kapak	0.45 m^2
Percentage	2.9 %
Productivity rate	97.1%
Ratio	1:35

Step by Step Procedures
Phase 1: Area preparation
1. Prepared the materials, tools, and equipment
2. Cleaned the area of installation
3. Setting a guide wire

Phase 2: Tile Installation
1. Made a mix for mortar
2. Wetted the floor
3. Applied a mortar to the flooring and even it out
4. Press the tile to the flooring
5. Used a rubber mallet to help even out the mortar and for better adhesion
6. Used a tile spacer to provide gaps for thermal expansion and chipping the adjacent tiles.
7. Clean the excess mortar that came out of the edges

Step by Step Procedure
Phase 1: Area preparation
1. Prepared the materials, tools, and equipment
2. Cleaned the area of installation
3. Setting a guide wire

Phase 2: Tile Installation
1. Made a mix for dry pack and mortar
2. Wetted the floor
3. Applied a dry pack to the flooring and even it out
4. Using the tile, press it initially to compact and shape the dry pack then remove
5. Applied a loose thin layer of dry pack above the compacted dry pack
6. Applied a mortar to the tiles and pressed it to the dry pack
7. Used a rubber mallet to help even out the mortar and for better adhesion
8. Used a tile spacer to provide gaps for thermal expansion and chipping the adjacent tiles.

Table 6
Summary of tile installation data and results for tile setter 6

Tile setter	6
Technique	Single Layer Mortar Application with dry pack
Tile size	600mm x 600mm
Adhesive Ratio	1 cement: 3 adhesive
Dry pack Ratio	1 cement: 4 sand
Thickness	50mm
Slurry ratio	Water only
Tiled area	21.6 m^2
Total tiles	60 pcs
Number of kapak	47 pcs
Locations	2 center, 6 side + center, 39 sides
Number of non-kapak	13pcs
Area of kapak	16.92 m^2
Percentage	78.33%
Productivity rate	21.67%
Ratio	1:2

F. Theme: Bond Reliability

The analysis of the six tile installations showed that kapak is caused by differences in installation techniques and workmanship. Although all participants followed standard preparation procedures, the kapak results varied greatly: Tile Setter 4 (2.3%), Tile Setter 5 (2.9%), Tile Setter 3 (4.0%), Tile Setter 1 (4.70%), Tile Setter 2 (52.5%), and Tile Setter 6 (78.33%).

Tile Setter 4 achieved the best result by using double-layer mortar application and proper back-buttering, which improved bonding strength. Tile Setter 3 also produced low kapak by evenly spreading mortar and wetting the tile before installation. In contrast, Tile Setter 2 used a self-made slurry instead of proper adhesive application, resulting in a high kapak percentage of 52.5%. Tile Setter 6 produced the highest failure rate of 78.33% due to improper dry pack and adhesive application. These findings show that disciplined procedures, proper mortar application, and correct installation techniques are important in preventing hollow-sounding tiles.

1) Concluded Method for Tile Setting with reduced Hollow

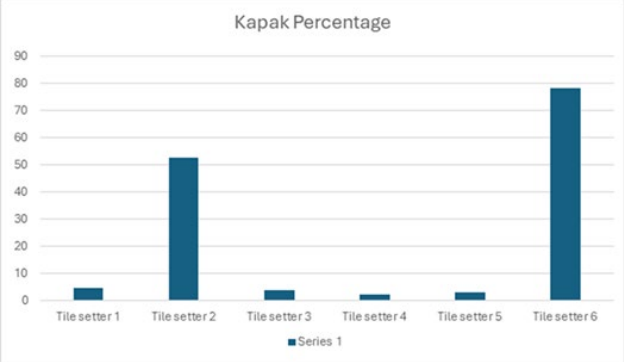


Fig. 8. Kapak percentage

Figure 8 shows the percentage of hollow sounds which were based on the performance of the installation techniques by the participants. For the back buttering techniques of 1, 3, 4, and 5, they demonstrated a high technical proficiency. Their percentages were acceptable due to the allowable threshold of 2% to 10% of waste/defects. As for the tile setter 6, the technique is similar to tile setter 1 but its mortar coverage is insufficient and applies a thin layer of loose dry pack over the compacted material which can be a cause for hollow sounds. This results in the highest kapak percentage. And for the tile setter 2, the technique used resulted in a high kapak percentage.

G. Theme: Technical Standardization for Optimized Bond Integrity

The Concluded Procedures:

Phase 1: Materials, tools, equipment and area preparation

1. Prepare the materials, tools and equipment.
2. Ensure the area is free of debris and dust.
3. Proper layout, orientation and elevation of tiles

Phase 2: Double Layer Mortar Installation

1. Make a mortar mix, ideally maintaining a 1:1 cement-to-adhesive ratio.
2. Wet the floor thoroughly.
3. Apply the mortar to the flooring and even it out using a spatula.
4. Apply a layer mortar directly to the back of the tile.
5. Using a rubber mallet, firmly strike the tiles to collapse air pockets and merge the mortar layers.

The wide gap in failure rates proves that kapak is also a result of how the tiles are installed. This concluded method focuses on Double-Layering mortar application. By applying mortar, the setter removes the air pockets that cause hollow sounds. This may improve bond reliability, allowing the tiles to attach to the substrate without developing hollow sounds. Furthermore, adopting this procedural discipline may avoid the need for back-jobs. P2 also stated the importance of applying the procedural discipline early on. Doing so increases the efficiency of work and also help save total project time as well as reduce unnecessary costs due to ‘kapak’ occurrences.

H. Conclusion and Recommendations

This study focused on identifying the most effective tile installation techniques to prevent hollow-sounding tiles through interviews, field observations, and kapak testing conducted among selected tile setters in Pampanga. The findings revealed that insufficient mortar coverage, rushed work practices, and improper installation procedures were the primary causes of hollow tiles. These poor practices often resulted in air voids beneath the tiles, which may eventually lead to cracking, loosening, and tile failure. The study also showed that low-quality or expired materials negatively affected bonding performance and increased the possibility of hollow sounds. On the other hand, the type and size of the trowel had minimal effect on the installation outcome, proving that workmanship and proper execution are more important than the selection of tools alone. Furthermore, techniques involving full mortar application on both the substrate and tile surface produced stronger bonding and better installation results.

Based on the gathered data, the study concluded that the occurrence of hollow-sounding tiles is influenced by a combination of factors, particularly the tile setter’s skills,

installation techniques, workmanship, and the quality of materials used. Proper curing time and adherence to standard procedures were also identified as important elements in achieving durable and high-quality tile installations. The study therefore supports the alternative hypothesis that tile setter experience and installation practices significantly affect the occurrence of hollow-sounding tiles.

The researchers recommend that tile setters consistently follow proper installation techniques and ensure full mortar coverage during installation. The use of tools such as rubber mallets and tile vibrators is also encouraged to eliminate air pockets and improve bonding efficiency. Tile setters are further advised to undergo skills training and certifications, such as TESDA programs, to improve their knowledge and align their practices with industry standards. For contractors and developers, strict quality control procedures, including regular inspections and kapak testing, should be implemented to detect issues early. While project deadlines are important, quality should never be sacrificed to avoid costly future repairs. The use of modern tools like laser levels, notched trowels, and tile vibrators is also recommended to improve installation quality. Clients and homeowners should also be more aware of the installation methods and materials being used in their projects. They are advised to inspect the quality of work carefully and withhold full payment until the project is properly completed to minimize future repair expenses.

For future studies, researchers are encouraged to include a wider range of respondents, examine wall tile installations, compare adhesive brands and tile types, and explore different dry pack and mortar mix ratios. The recommended installation procedure for elevations less than 1.5 inches involves double-layer mortar application with a 1:1 cement-to-adhesive ratio and the use of a tile vibrator for better adhesion. For elevations more than 1.5 inches, the study recommends the use of dry pack with a 1:3 cement-to-sand ratio combined with mortar application and tile spacers to improve stability and prevent hollow sounds.

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