OPEN ACCESS
Saudi Journal of Civil Engineering
Abbreviated Key Title: Saudi J Civ Eng
ISSN 2523-2657 (Print) |ISSN 2523-2231 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com/journal/sjce/home

Original Research Article

Common Defects, Causes, and Impacts in High-Altitude Stone Masonry Construction: A Case Study of Jumla, Nepal

Subash Kumar Bhattarai[1,2,3]*, Birendra Bahadur Bud Thapa [3,4], Sushma Arayal[2,5], Gangesh Kumar Joshi[6]

[1]Visiting Faculty for MSc Construction Engineering and Management, Institute of Engineering, Pulchowk Campus, Lalitpur
[2]Visiting Faculty for MSC Construction Management, Universal Engineering and Science College, Lalitpur
[3]Visiting Faculty for MSC Construction Management Mid-West University, Surkhet, Nepal
[3]Graduate Scholar, Mid-West University, Surkhet, Nepal
[4]Engineer at CTEVT Nepal
[5]Assistant Professor, ACME Engineering College, Basundhara
[6]Managing Director, Endeavour Engineering Services Private Limited, Kathmandu, Nepal

DOI: https://doi.org/10.36348/sjce.2026.v10i09.003 | **Received:** 27.07.2026 | **Accepted:** 21.09.2026 | **Published:** 28.09.2026

***Corresponding author:** Subash Kumar Bhattarai
Visiting Faculty for MSc Construction Engineering and Management, Institute of Engineering, Pulchowk Campus, Lalitpur

Abstract

Stone masonry is the predominant construction method in Nepal's high-altitude regions, yet buildings frequently suffer from defects that compromise structural integrity and occupant safety. This study investigates the common defects, underlying causes, and impacts in stone masonry residential buildings through a case study of Jumla District, Nepal. Using a qualitative methodology incorporating Focus Group Discussions (FGDs) with 15 stakeholders and field observations of 5 buildings, the research identifies recurrent defects including cracking, uneven settlement, mud plaster fall-down, weathering and deterioration, discoloration/erosion, and poor drainage. Thematic analysis reveals that these defects primarily originate from poor-quality materials, improper construction practices, inadequate foundation work, and harsh environmental conditions. The impacts range from structural instability and aesthetic degradation to increased maintenance costs. A notable finding is the divergence in perspectives between technical stakeholders (engineers) who emphasize systemic design and material issues, and non-technical stakeholders (owners, workers) who focus on observable symptoms and workmanship problems. The study contributes empirical evidence on construction quality challenges in high-altitude, resource-constrained environments and provides practical insights for improving stone masonry construction practices. Recommendations include enhancing workforce skills, improving foundation construction, strengthening material quality control, and implementing regular maintenance programs.

Keywords: Stone Masonry, Construction Defects, High-Altitude Construction, Nepal, Focus Group Discussion, Building Quality.

1. INTRODUCTION

Masonry stands as one of humanity's oldest building technologies, with stone construction methods that have persisted for millennia due to their simplicity, durability, and reliance on locally available materials (Lourenço, 2014). In Nepal, particularly in remote mountainous regions, stone masonry remains the dominant construction technique for residential buildings. The Jumla District, located in the western Himalayan region at high altitude, exemplifies this trend, with approximately 98.27% of buildings constructed using mud-bonded stone masonry (Acharya & Shrestha, n.d.). These structures typically comprise two-story buildings with either traditional mud roofs or corrugated galvanized iron (CGI) sheet roofing.

Despite its prevalence and cultural significance, stone masonry construction in such regions faces substantial challenges. Non-engineered, unreinforced masonry buildings constitute the majority of the housing stock, often constructed without adherence to modern building codes or seismic design principles (Annuar *et al.,*2021; Bhattarai & Mishra, 2017). The harsh climatic conditions of high-altitude areas, including extreme temperature fluctuations, heavy monsoon rainfall, and seismic activity, exacerbate the vulnerability of these structures. Furthermore, the remoteness of districts like Jumla limits access to quality construction materials, skilled labor, and technical supervision, creating conditions conducive to construction defects (Rokaya & Bhattarai, 2025).

Construction defects in buildings represent a significant global concern, affecting structural safety, aesthetic quality, and economic value (Sravani & Shashikant Chandgude, 2020). Common defects such as cracking, dampness, joint failure, and material deterioration can progress from minor nuisances to major structural failures if unaddressed. In the context of developing countries and rural areas, the consequences of such defects are particularly severe due to limited resources for repair and maintenance, and the critical role of housing for family safety and livelihood (Maharjan *et al.,*2025; Rijal *et al.,*2025).

While substantial research exists on the seismic performance of Nepalese stone masonry buildings (Ali *et al.,*2013; Mishra & Kumar Bhattarai, 2017; Varum *et al.,*2018), there is a notable gap in understanding the day-to-day construction defects, their causes, and their impacts from the perspective of local stakeholders. Recent studies on building code compliance in various municipalities have highlighted systemic deficiencies in construction quality (K.C. *et al.,*2023; Maharjan *et al.,*2025; Rijal *et al.,*2025; Shrestha *et al.,*2015), but few have focused specifically on stone masonry in high-altitude regions. This research addresses this gap by investigating the following research questions:

1. What are the common construction defects in stone masonry residential buildings in Jumla?
2. What causes these defects?
3. What are the impacts of these defects on building performance and occupants?
4. How do different stakeholder groups perceive these defects and their solutions?

The study aims to provide empirical evidence that can inform practical strategies for improving stone masonry construction quality in Nepal's high-altitude regions and similar contexts worldwide.

2. LITERATURE REVIEW

2.1 Stone Masonry as a Building System

Stone masonry represents a construction system where natural stones are laid in courses and bonded with mortar, either mud-based or cement-based. The technique is valued for its simplicity, requiring minimal specialized equipment, and its adaptability to local conditions. However, the structural behavior of stone masonry is complex, depending on factors including stone type, mortar properties, wall geometry, construction quality, and the interaction between these elements (Bosiljkov *et al.,*2010).

The seismic performance of unreinforced stone masonry buildings has been extensively studied, particularly in the Himalayan region where earthquake risk is high. Ali *et al.,* (2013) conducted shake table tests on rubble-stone masonry models and identified damage patterns, capacity curves, and response modification factors. Their findings highlighted the vulnerability of such structures to seismic forces and the importance of construction quality in determining performance. Varum *et al.,* (2018) further documented the seismic performance of buildings in Nepal after the Gorkha Earthquake, emphasizing that non-engineered structures suffered significant damage due to substandard materials and poor workmanship.

2.2 Common Building Defects and Their Causes

Construction defects are defined as flaws or deficiencies in a building that reduce its performance, safety, or aesthetic value. Sravani and Shashikant Chandgude (2020) identified common building defects including poor workmanship, cracks, dampness, erosion of mortar joints, fungal attacks, and defective plaster rendering. These defects typically arise from poor design, inadequate materials, improper construction practices, or a combination of these factors.

In masonry structures specifically, defects commonly manifest as:

- **Cracking:** Often resulting from foundation settlement, thermal movement, or structural overloading
- **Efflorescence:** Salt deposits indicating moisture problems
- **Joint Failure:** Deterioration of mortar bonds due to poor materials or water ingress
- **Weathering:** Surface degradation from environmental exposure
- **Plaster Failure:** Detachment or cracking of surface finishes

2.3 Construction in Nepal's Himalayan Context

The building stock of Nepal's mountainous regions is characterized by traditional construction techniques using locally available materials (Annuar *et al.,*2021). These structures, while culturally significant and economically accessible, often lack engineering design and seismic detailing. Acharya and Shrestha (n.d.) documented the prevalence of stone masonry in Jumla, noting the predominance of two-story mud-roof buildings and step-back configurations on sloping ground.

Mishra and Bhattarai (2017) highlighted the challenges of building code implementation in Nepal, noting that monitoring, evaluating, and supervising construction are critical for ensuring seismic resistance. However, the enforcement of building codes in remote areas remains limited, with many structures built using traditional knowledge rather than engineered design. Bhattarai and Mishra (2017) emphasized that "earthquakes do not kill people; poorly built structures do," underscoring the critical importance of construction quality.

Recent studies have documented widespread non-compliance with building codes across Nepal. K.C. *et al.,* (2023) found that out of 27 completed buildings in Sisne Rural Municipality, only one fully complied with compliance checklists. Similarly, Rijal *et al.,* (2025) reported that among 22 completed buildings in Birendranagar Municipality, only 5 fully complied with approved designs. Maharjan *et al.,* (2025) found that only 27 of 78 completed buildings in Godawari Municipality fully complied with approved designs. These studies highlight the systemic nature of compliance challenges in Nepalese construction.

The challenges in high-altitude regions are further compounded by infrastructure limitations, lack of skilled labor, and harsh environmental conditions (Rokaya & Bhattarai, 2025). Sustainable construction practices face significant barriers in such contexts, including transportation difficulties, extreme weather, and limited access to quality materials.

2.4 Stakeholder Perspectives on Construction Quality

Understanding construction quality requires examining the perspectives of diverse stakeholders including owners, workers, contractors, and technical professionals. Each group brings different knowledge, priorities, and constraints to the construction process. Owners prioritize cost and timely completion; workers focus on practical execution; contractors balance quality with profitability; and engineers emphasize technical standards. These divergent perspectives can create tensions and contribute to quality issues if not effectively managed (Rijal *et al.,*2025; Maharjan *et al.,*2025).

The role of masons and contractors is particularly critical in the Nepalese context, where most construction is owner-built or owner-supervised. Studies have shown that masons often lack formal training and awareness of building codes. Rijal *et al.,* (2025) found that only 30% of masons in Birendranagar were familiar with earthquake-resistant design principles. Maharjan *et al.,* (2025) reported that only 25% of masons in Godawari had knowledge of building code provisions, despite 93.75% having awareness of earthquake phenomena. K.C. *et al.,* (2023) found that 100% of masons in Sisne were untrained professionals.

3. RESEARCH METHODOLOGY

3.1 Study Area

The study was conducted in Jumla District, located in the Karnali Province of western Nepal. Jumla covers an area of 2,531 square kilometers and lies at a high altitude in the Himalayan foothills. The district is characterized by mountainous terrain, cold winters with snowfall, and a monsoon season with heavy rainfall. These environmental conditions present unique challenges for building construction and maintenance.

The housing stock in Jumla is predominantly stone masonry, with approximately 98.27% of buildings using mud-bonded stone masonry. Two-story buildings with mud roofs and two-story structures with CGI sheet roofing are the most common types. Buildings are constructed on both level and sloping ground, with step-back configurations on hillsides (Acharya & Shrestha, n.d.).

3.2 Research Design

This study employed a qualitative research design to explore the common defects, causes, and impacts in stone masonry construction. The qualitative approach was chosen to capture the rich, contextualized perspectives of local stakeholders and to understand the practical realities of construction in the study area. The research involved Focus Group Discussions (FGDs) and field observations, following the methodology recommended by Dasanayaka and Matsuda (2019) for understanding local knowledge in construction contexts.

3.3 Data Collection Methods

3.3.1 Focus Group Discussions

Fifteen stakeholders were purposively selected to participate in FGDs conducted at Patarashi Rural Municipality, Ward No. 7, Rini, Jumla. Participants included:

- Rural/Municipal engineers (technical professionals)
- Sub-engineers (technical professionals)
- Construction contractors
- Skilled workers (masons)
- Building owners

The FGDs followed a semi-structured format exploring: (1) common defects encountered; (2) causes of defects; (3) impacts of defects; and (4) potential solutions. The discussions were facilitated by the researcher with note-taking and recording of responses. Thematic analysis was conducted to identify patterns and categories in the qualitative data.

3.3.2 Field Observations

Five residential buildings were selected on a purposive basis for detailed field observation. The observations aimed to: (1) verify the defects identified in FGDs; (2) document visual evidence of defects through photographs; and (3) assess the severity and extent of defects in situ.

3.3.3 Thematic Analysis

Data from FGDs and field observations were analyzed using thematic analysis. The process followed Braun and Clarke's (2006) six-phase framework: familiarization with data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report. Codes were organized into categories representing defects, causes, impacts, and solutions.

3.4 Ethical Considerations

Informed consent was obtained from all participants before the FGDs. Participants were assured of confidentiality and anonymity in reporting. The study was conducted in accordance with ethical standards for research involving human participants.

4. RESULTS

4.1 Common Defects Identified

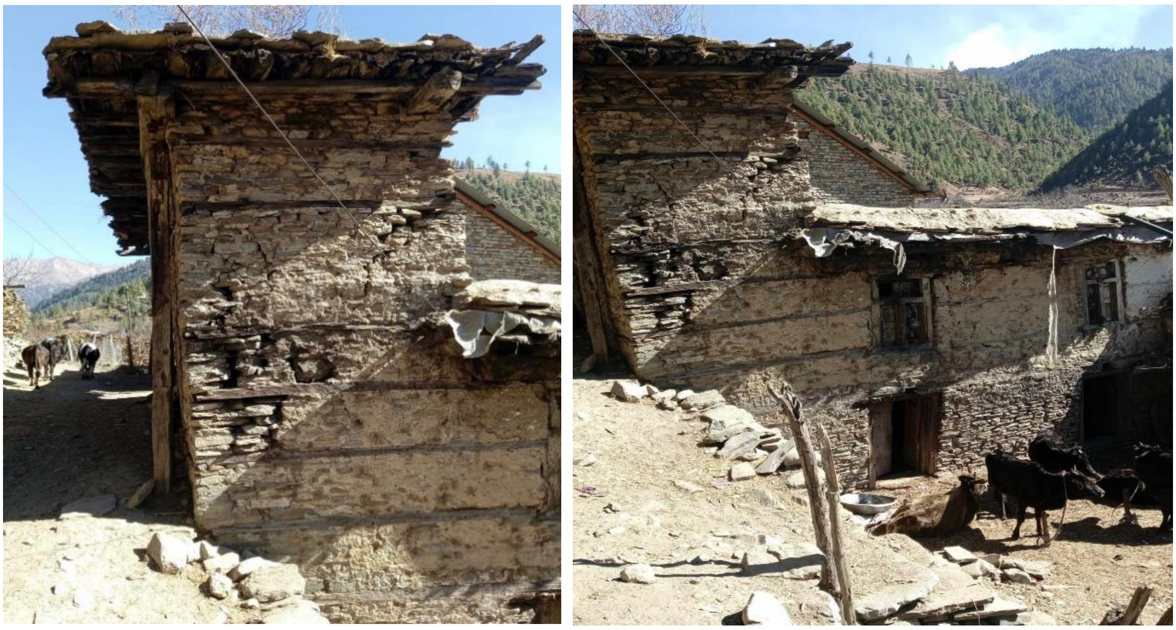
The FGDs and field observations revealed multiple recurrent defects in stone masonry residential buildings. Table 1 summarizes the defects identified by different stakeholder groups.

Table 1: Common Defects Identified by Stakeholder Groups

Defect Type	Technical Stakeholders	Non-Technical Stakeholders
Cracking	✓	✓
Uneven Settlement	✓	✓
Efflorescence	✓	
Joint Failure	✓	✓
Leaks & Poor Drainage		✓
Weathering & Deterioration	✓	✓
Discoloration/Erosion	✓	✓
Mud Plaster Fall-Down	✓	✓
Inconsistent Appearance	✓	
Zig-Zag Wall	✓	
Uneven Foundation	✓	
Wall Collapse		✓
Corrosion/Brittleness	✓	

4.1.1 Cracking

Cracking was the most frequently mentioned defect across all stakeholder groups. Cracks were observed on wall surfaces, at wall-foundation junctions, and around door and window openings. In some cases, cracks extended completely through the wall thickness, indicating significant structural distress.

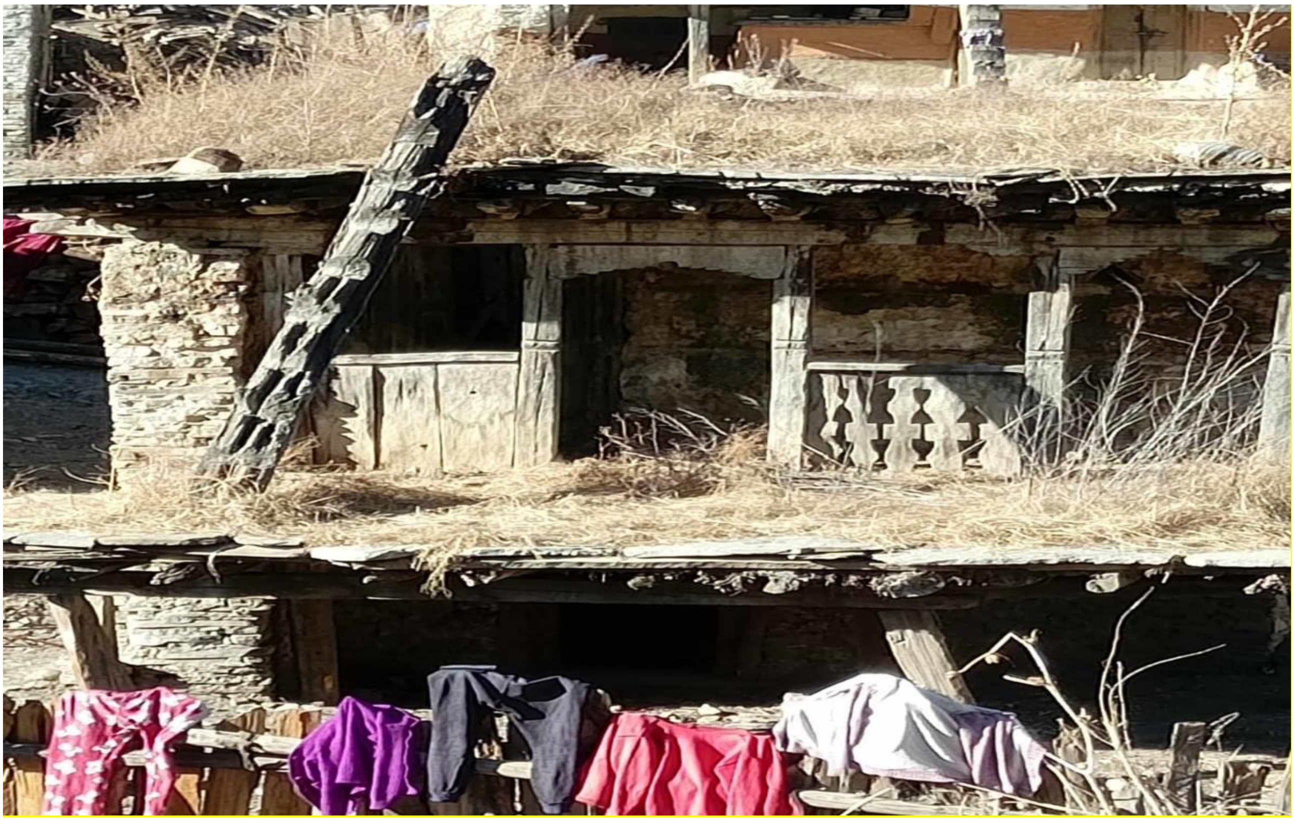


Picture 1: The common and repeated construction defects cracking on wall is seen. The wall may collapse due to uneven settlement form the foundation

Field Observation Evidence: Picture 1 shows wall cracking resulting from uneven foundation settlement. The crack pattern suggests differential movement, with widening at the top indicating ongoing settlement.

4.1.2 Uneven Settlement

Foundation settlement was identified as a critical issue, with technical stakeholders emphasizing its role in causing cracking, wall misalignment, and door/window frame distortion. Non-technical stakeholders also noted settlement problems but were less able to articulate the underlying causes.

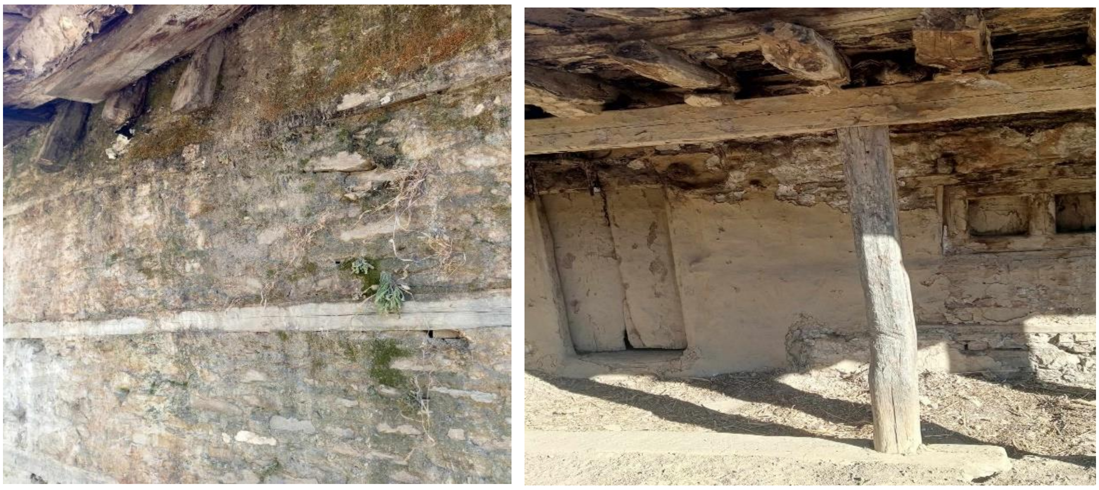


Picture 2: Due to settlement issues the level of window, door fall down from their original level

Field Observation Evidence: Picture 2 demonstrates how settlement caused door and window frames to fall below their original levels, rendering them inoperable.

4.1.3 Mud Plaster Fall-Down

Mud plaster deterioration was common on wall surfaces, particularly on exposed exterior walls. The plaster showed signs of weathering, with flaking, cracking, and partial detachment from the underlying masonry.

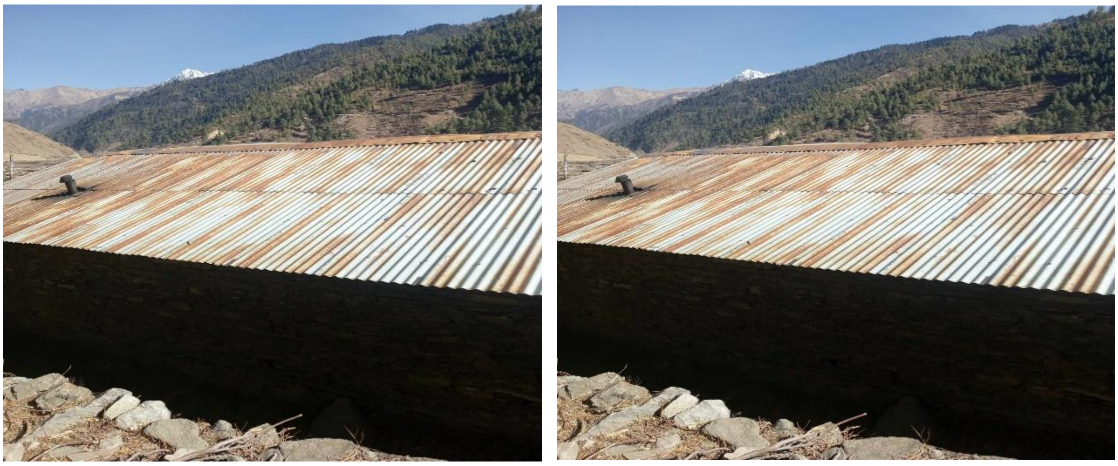


Picture 3: Mud plaster fall down & weathering effect is seen at wall surface

Field Observation Evidence: Picture 3 shows mud plaster fall-down and weathering effects on wall surfaces, revealing the underlying stone masonry.

4.1.4 Weathering and Deterioration

Weathering effects were visible on both wall surfaces and roofing materials. CGI roof sheets showed discoloration and signs of corrosion, while wooden elements experienced deterioration from moisture exposure.



Picture 4: Discoloration / erosion & weathering on the CGI roof sheet is seen.
Field Observation Evidence: Picture 4 illustrates discoloration, erosion, and weathering on CGI roof sheets.

4.1.5 Discoloration and Erosion

Discoloration was noted on roof sheets and wall surfaces, resulting from prolonged exposure to sun, rain, and temperature fluctuations. Erosion of mortar joints was also observed, compromising the bond between stones.

4.2 Causes of Defects

Thematic analysis of FGD data identified three main categories of causes for construction defects: material-related causes, construction practice-related causes, and environmental causes. Figure 1 presents the common causes in word cloud format.

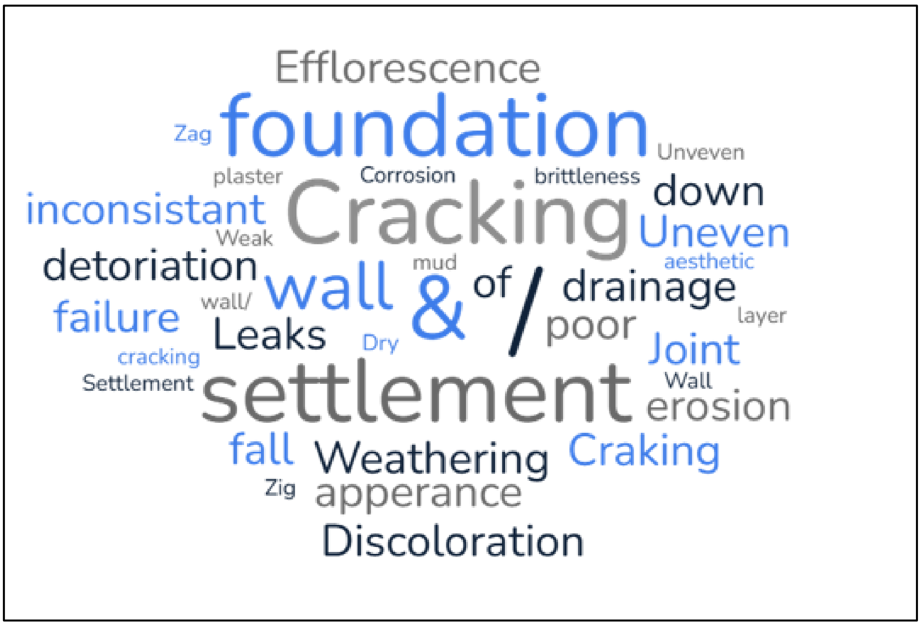


Figure 1: common causes of the defects according to FGD in word cloud format

4.2.1 Material-Related Causes

The following material issues were identified as contributing to defects:

Material	Defect	Stakeholder Observation
CGI Sheets	Corrosion, Discoloration, Leaks	Low-quality sheets are common; poor sloping causes water pooling
Wood	Deterioration, Discoloration	Use of unseasoned wood leads to warping and rot
Round-Shaped Stones	Wall Cracking	Poor interlocking; unsuitable shape for load-bearing walls
Weak Mortar	Joint Failure, Cracking	Mud mortar lacks strength and water resistance

4.2.2 Construction Practice-Related Causes

Construction practices identified as problematic included:

- **Shallow Foundations:** Insufficient foundation depth leads to uneven settlement, particularly in areas with weak or variable soil conditions.
- **Poor Foundation Leveling:** Uneven foundations cause differential settlement and wall cracking.
- **Inadequate Masonry Techniques:** Inconsistent stone placement, poor bonding, and improper wall alignment create structural weaknesses.
- **Lack of Skilled Labor:** The shortage of skilled masons results in poor workmanship and non-compliance with best practices.
- **Insufficient Supervision:** Limited technical supervision on-site allows defects to develop without correction.

A technical stakeholder (municipal engineer) noted: *"The foundation work is often done quickly without proper leveling or compaction. This is the root cause of many cracking and settlement issues we see."*

4.2.3 Environmental Factors

The harsh climatic conditions of Jumla were identified as a significant contributing factor:

- **Temperature Fluctuations:** Freeze-thaw cycles cause material expansion and contraction, leading to cracking.
- **Heavy Rainfall:** Water infiltration causes deterioration of mud mortar and wood elements.
- **Seismic Activity:** While not the primary cause of defects, earthquakes can exacerbate existing weaknesses.

Table 2: Summary of Causes by Defect Type

Defect	Material	Practice	Environmental
Cracking	✓	✓	✓
Uneven Settlement		✓	
Efflorescence	✓		
Joint Failure		✓	
Leaks	✓	✓	
Weathering	✓		✓
Mud Plaster Fall-Down		✓	✓
Discoloration/Erosion	✓	✓	✓

4.3 Impacts of Defects

4.3.1 Structural Integrity

The most serious impact of defects is the compromise of structural integrity. Cracking, uneven settlement, and joint failure can progress to the point of wall collapse, endangering occupants. Technical stakeholders expressed particular concern about:

- Progressive cracking leading to structural failure
- Wall collapse from foundation settlement
- Joint failure compromising wall stability

A sub-engineer noted: *"We have seen walls lean significantly before collapsing. The cracks start small but get wider over time if the foundation is not corrected."*

4.3.2 Aesthetic Degradation

Discoloration, erosion, mud plaster fall-down, and weathering significantly reduce the aesthetic quality of buildings. This has implications for property value and occupant satisfaction. Non-technical stakeholders were particularly concerned with aesthetic issues, noting that deteriorating buildings reflect poorly on owners and communities.

4.3.3 Maintenance and Repair Costs

Defects require ongoing maintenance and repair, imposing financial burdens on owners. Repairs often address symptoms rather than root causes, leading to repeated expenditure. Technical stakeholders noted that many defects, including cracking and joint failure, are typically addressed only when they become severe, rather than through preventive maintenance.

A building owner stated: *"Every year I have to repair the roof and plaster. It costs money and time, but there is no alternative."*

Table 3: Summary of Impacts

Impact Category	Specific Impacts
Structural	Wall collapse risk; Instability; Progressive deterioration
Aesthetic	Visual degradation; Reduced property value
Economic	Increased maintenance costs; Repair expenses; Potential for major remediation
Social	Safety concerns; Reduced occupant comfort; Community reputation

4.4 Stakeholder Perspective Comparison

A notable finding was the difference in perspective between technical and non-technical stakeholders. Table 4 summarizes these differences.

Table 4: Comparison of Technical and Non-Technical Stakeholder Perspectives

Aspect	Technical Stakeholders	Non-Technical Stakeholders
Defect Identification	Detailed, systematic (e.g., efflorescence, joint failure)	General, symptom-based (e.g., leaks, wall damage)
Causes Emphasized	Systemic issues (design, material, foundation)	Observable issues (poor masonry, weather)
Impacts Highlighted	Structural integrity, long-term performance	Visible damage, immediate concerns
Solutions Proposed	Technical interventions (design improvements, material selection)	Practical fixes (repairs, better workmanship)
Role in Process	Oversight, design, supervision	Execution, ownership

This divergence has practical implications:

- Technical stakeholders understand root causes but may struggle to communicate them effectively to non-technical audiences.
- Non-technical stakeholders control resources and make decisions but may lack understanding of systemic issues.
- Bridging this gap is essential for improving construction quality

5. DISCUSSION

5.1 Comparison with Existing Literature

The defects identified in this study align with those documented in international literature. Sravani and Shashikant Chandgude (2020) identified poor workmanship, cracking, dampness, and defective plaster as common building defects, all of which were observed in Jumla. The prevalence of cracking and settlement issues is consistent with findings on stone masonry buildings in seismic zones (Ali *et al.,* 2013; Varum *et al.,* 2018).

However, this study highlights the specific challenges of high-altitude construction in developing regions. The combination of material constraints, limited skilled labor, and harsh environmental conditions creates a unique set of challenges that require context-specific solutions (Rokaya & Bhattarai, 2025). The literature on Nepalese construction has primarily focused on seismic vulnerability (Mishra & Bhattarai, 2017; Annuar *et al.,*2021), with less attention to the day-to-day quality issues affecting building durability. This study addresses that gap by documenting the practical realities of construction quality management.

The findings regarding stakeholder perspectives align with previous studies. The limited awareness among non-technical stakeholders regarding systemic causes of defects is consistent with findings from Rijal *et al.,* (2025) and Maharjan *et al.,* (2025), who documented low levels of building code awareness among homeowners and masons. The gap between technical and non-technical stakeholders identified in this study mirrors the findings of K.C. *et al.,* (2023), who noted that 69% of masons altered designs due to owner instructions.

5.2 Causes of Defects: A Systems Perspective

The causes of defects identified in this study can be understood as symptoms of a broader system failure in construction quality management. Key system issues include:

Knowledge and Skills Gap:

The shortage of skilled masons trained in proper stone masonry techniques leads to poor workmanship. This is compounded by limited access to training and educational resources in remote areas. Studies have consistently shown that masons lack formal training, with Rijal *et al.,* (2025) reporting that 81.25% of masons had no formal training, and K.C. *et al.,* (2023) finding 100% untrained masons in their study area.

Quality Control Weakness:

Without effective quality control systems, material quality and construction practices cannot be verified or enforced. The absence of on-site supervision allows defects to develop and progress. Bhattarai and Mishra (2017) noted that municipal inspections are typically limited to the plinth stage, leaving critical aspects unchecked.

Economic Constraints:

Financial limitations lead to the use of lower-quality materials and shortcuts in construction. Owners prioritize immediate cost reduction over long-term quality. Rokaya and Bhattarai (2025) identified high material costs and transportation challenges as significant barriers to quality construction in high-altitude regions.

Institutional Challenges:

Limited enforcement of building codes, inadequate technical oversight, and lack of awareness about best practices contribute to persistent quality issues (Maharjan *et al.,*2025; Rijal *et al.,*2025).

Bosiljkov *et al.,* (2010) emphasized the importance of diagnostic approaches for assessing masonry structures, including on-site testing to understand material properties and structural conditions. Such approaches could be valuable in Jumla for identifying defects early and informing appropriate remedial measures.

5.3 Practical Implications

The findings of this study have several practical implications:

For Construction Stakeholders:

- Emphasize foundation construction as a critical quality determinant
- Invest in skilled labor development through training and knowledge sharing
- Implement simple quality control measures (stone sizing, mortar mixing, wall alignment)

For Local Governments:

- Strengthen building code enforcement and technical supervision
- Provide technical assistance and resources for quality construction
- Support worker training programs (as recommended by K.C. *et al.,*2023; Maharjan *et al.,*2025)

For Homeowners:

- Recognize the importance of quality materials and skilled labor
- Plan for ongoing maintenance and periodic inspections
- Seek technical advice before and during construction

For Sustainable Development:

- Address infrastructure and transportation limitations that increase costs
- Promote the use of locally available, climate-resilient materials
- Integrate sustainable construction principles into local building practices (Rokaya & Bhattarai, 2025)

6. CONCLUSION

This study investigated common defects, causes, and impacts in stone masonry residential buildings in Jumla, Nepal. The research found that cracking, uneven settlement, mud plaster fall-down, weathering, discoloration/erosion, and poor drainage are recurrent defects in the region. These defects arise from a combination of poor-quality materials, improper construction practices (particularly in foundations), and harsh environmental conditions. The impacts include compromised structural integrity, aesthetic degradation, and increased maintenance costs.

The study contributes to the limited literature on construction quality in high-altitude regions of Nepal by documenting stakeholder perspectives and practical realities. The findings highlight the need for a systems approach to quality improvement, addressing knowledge gaps, quality control weaknesses, economic constraints, and institutional challenges

6.1 Recommendations

Based on the findings and supported by existing literature, the following recommendations are made:

1. **Improve Foundation Construction:** Focus on proper foundation depth, leveling, and compaction to prevent settlement issues (Ali *et al.,*2013; Varum *et al.,*2018).
2. **Enhance Workforce Skills:** Implement training programs for masons and workers in proper stone masonry techniques. K.C. *et al.,* (2023), Rijal *et al.,* (2025), and Maharjan *et al.,* (2025) all emphasize the critical need for mason training to improve construction quality.
3. **Strengthen Material Quality Control:** Promote the use of quality materials and appropriate stone shapes for load-bearing walls (Rokaya & Bhattarai, 2025).
4. **Provide Technical Supervision:** Ensure adequate on-site supervision by qualified personnel, addressing the gap identified by Bhattarai and Mishra (2017).
5. **Conduct Regular Inspections:** Encourage periodic building inspections to identify and address defects early (Maharjan *et al.,* 2025).
6. **Bridge Stakeholder Communication:** Improve communication between technical and non-technical stakeholders to ensure shared understanding of quality requirements (Rijal *et al.,* 2025).
7. **Promote Sustainable Practices:** Address infrastructure and energy challenges through appropriate technology and material selection (Rokaya & Bhattarai, 2025).

REFERENCES

- Acharya, D., & Shrestha, H. (n.d.). Capacity Assessment of Stone Masonry Building of Jumla District. *Proceedings of 12th IOE Graduate Conference*.
- Ali, Q., Khan, A. N., Ashraf, M., Ahmed, A., Alam, B., Ahmad, N., Javed, M., Rahman, S., Fahim, M., & Umar, M. (2013). Seismic performance of stone masonry buildings used in the Himalayan belt. *Earthquake Spectra*, 29(4), 1159–1181.
- Annuar, A. S., Rahman, R. A., Munir, A., Murad, A., El-enshasy, H. A., & Illias, R. (2021). Financial assessment of incremental seismic retrofitting of Nepali stone-masonry buildings. *International Journal of Disaster Risk Reduction*.
- Bhattarai, S. K., & Mishra, A. K. (2017). Existing scenario of building code implementation in newly formed "Nagarjun Municipality." *Asian Journal of Science and Technology*, 8(11), 6751-6762.
- Bhattarai, S. K., Rokaya, M., Arayal, S., Karmacharya, N., & Joshi, G. K. (2025). Empowering sustainability: Unveiling green

building awareness and solutions in Kathmandu Valley. *Journal of Recent Activities in Infrastructure Science*, 10(1), 1-10.
- Bosiljkov, V., Uranjek, M., Žarnić, R., & Bokan-Bosiljkov, V. (2010). An integrated diagnostic approach for the assessment of historic masonry structures. *Journal of Cultural Heritage*, 11(3), 239–249.
- Dasanayaka, U., & Matsuda, Y. (2019). A study on local knowledge in adaptation to landslide disasters in Sri Lanka. *Engineering Journal*, 23(6), 501–509.
- K.C., K., Bhattarai, S. K., & Katuwal, K. (2023). Compliance of building code in construction of residential buildings in Sisne Rural Municipality, Rukum (East) District. *KEC Conference Proceedings*, 27 April 2023, Lalitpur, Nepal.
- Lourenço, P. B. (2014). Masonry Structures, Overview. In *Encyclopedia of Earthquake Engineering* (pp. 1–9). Springer.
- Maharjan, N. (2017). *Compliance of Concrete Strength Used in Low Rise Residential Buildings with NBC 205: A Case Study of Lalitpur Metropolitan City-28, 29*. Pulchwok Campus, Lalitpur.
- Maharjan, R., Bhattarai, S. K., & Arayal, S. (2025). Assessing compliance with Nepal's building code and bylaws: Insights from residential construction in Godawari Municipality. *Journal of Engineering Research and Reports*, 27(10), 1-21.
- Mishra, A. K., & Aithal, P. S. (2021). Socio-economic suitability of AAC block in Nepal. *Solid State Technology*, 64(2), 575-595.
- Niraula, B. K. (2018). *Status of implementation of building code on post-earthquake reconstruction work in Kakani Rural Municipality, Nuwakot*. Nepal Engineering College, Bhaktapur.
- Rijal, N., Bhattarai, S. K., Baduwal, P., & Khatri, G. (2025). Assessing code compliance and mason proficiency in residential construction in Birendranagar Municipality, Surkhet. *The OCEM Journal of Management, Technology & Social Sciences*, 4(1), 155-167.
- Rokaya, S. S., & Bhattarai, S. K. (2025). Challenges in implementing sustainable construction practices in high-altitude regions of Nepal. *Journal of Sustainable Development*, 12(1), 1-15.
- Shrestha, S. G., Pradhan, S., & Shrestha, S. N. (2015). Status of building code compliance: A case study in Karyavinayak Municipality. *International Symposium on New Technologies for Urban Safety of Mega Cities in Asia (USMCA)*.
- Shrestha, S. K., Bhattarai, S. K., & Shrestha, R. K. (2019). Building codes and quality control. In *A Textbook of Construction Management* (3rd ed., pp. 288-293). Heritage Publishers & Distributors Pvt. Ltd.
- Sravani, T., & Shashikant Chandgude, Y. (2020). Assessment on various construction defects and possible solutions of a building. *Journal of Critical Reviews*, 7(18).
- Thapa, P., & Shrestha, H. K. (2022). *Evaluation of implementation process of national building code for reconstruction of residential buildings after Gorkha Earthquake 2015 (A case study of Chandragiri Municipality, Kathmandu)*. Nepal Engineering College, Bhaktapur.
- Varum, H., Dumaru, R., Furtado, A. F., Barbosa, R., Gautam, D., & Rodrigues, H. (2018). Seismic performance of buildings in Nepal after the Gorkha earthquake. In *Impacts and Insights of Gorkha Earthquake* (pp. 47-63). Elsevier Inc.

