Journal of Infrastructure Planning and Engineering

Journal homepage: https://ejournal.warmadewa.ac.id/index.php/jipe

# Resilience of educational infrastructure in Nepal: a mixed methods approach to structural and functional assessment

**Kishor Badu[1], Khem Raj Joshi[1], Dipesh Dhami[1], Dipak Raj Bhatt[1], Shriya Bohara[1], Bhim Kunwar[1], Birendra Kumar Bohara[2*]**

[1]*School of Engineering, Far Western University, Mahendranagar, 10400, Nepal*
[2]*Assistant Professor, School of Engineering, Far Western University, Mahendranagar, 10400, Nepal*
[*]birendra.bohara@fwu.edu.np

Received on 1 September 2025, accepted on 15 October 2025, published on 31 October 2025

## ABSTRACT

Higher education institutions in developing nations are growing swiftly to address the increasing demand for quality education; however, their physical infrastructures frequently lack adequate evaluation regarding safety, functionality, and environmental performance. This study focuses on the Education and Humanities Building at Far Western University (FWU), Nepal, constructed in the early 2010s and in continuous use, with limited maintenance reported by users. A mixed-methods strategy was utilized, including visual assessments, non-destructive testing (NDT) using a rebound hammer, physical measurements, user surveys, and a review of secondary data. The results indicate moderate rebound-derived strength estimates (14.46 MPa for masonry walls, 17.0 MPa for masonry columns, and 17.4–26.63 MPa for slabs and beams), which are typical of older institutional buildings, but there are significant issues such as cracks, moisture infiltration, corrosion, and the lack of expansion joints. Assessments of indoor environmental quality revealed high thermal discomfort, as the temperatures of second-floor slabs exceeded 50 °C, and limited ventilation in several classrooms. User surveys (n=55) revealed ongoing issues concerning structural cracks, congested circulation areas, leaking roofs, and poor maintenance, all of which adversely impact safety and learning environments. The results emphasize the critical necessity for preventive maintenance, structural upgrades, and functional enhancements to comply with Nepal National Building Code (NBC) standards and international guidelines for healthy educational settings. By merging technical evaluations with user feedback, this research identifies priority areas for repair and further investigation of higher education infrastructure in regions of far western Nepal that are prone to seismic activity.

**Keywords:** structural assessment; rebound hammer test; environmental performance; infrastructure; Far Western University

## 1 Introduction

Higher education institutions in developing countries like Nepal are undergoing rapid infrastructure expansion to meet the growing demand for quality education. This expansion is particularly critical in regions historically deprived of educational access due to socioeconomic, geographic, and infrastructural challenges. Among these, FWU, located in Mahendranagar, Kanchanpur, Nepal, stands as a prominent example of a public institution with a mission to provide inclusive, accessible, and equitable higher education to underserved communities in the Far Western Region of Nepal. Established under the Far-Western University Act 2067 (2010 A.D.), FWU began operating as an autonomous institution with the vision of bridging educational disparities between Nepal's central and peripheral regions. Over the past decade, several factors have contributed to the gradual deterioration of its older buildings. Prolonged climatic exposure marked by intense sunlight, monsoon rains, and seasonal humidity has led to material weathering, seepage, and fungal growth in damp interiors [1]. Although the Far Western Region has not been the epicenter of recent major earthquakes, its location within the seismically active Himalayan belt leaves it susceptible to moderate to strong tremors, raising concerns about structural resilience [2], [3]. Continuous high utilization, combined with budgetary and technical constraints in maintenance, has further exacerbated structural and functional wear. Additionally, design limitations such as inadequate ventilation, insufficient daylight in

DOI: https://doi.org/10.22225/jipe.4.2.2025.92-103 E-ISSN: 2829-5153

certain spaces, congested staircases, and the absence of expansion joints in elongated structures compromise long-term serviceability and occupant comfort. Feedback from building users highlights recurring issues, including poor air circulation, leaky roofs, overcrowded lobbies and staircases, and ineffective lighting and acoustics. These deficiencies not only diminish the quality of the teaching-learning environment but also pose potential risks to occupant safety during emergencies [4]. In light of these concerns, a structured assessment is essential to verify the structural safety of load-bearing masonry and reinforced concrete elements, evaluate functional performance in terms of environmental comfort, space planning, and accessibility, and identify priority areas for maintenance, retrofitting, and compliance with the latest provisions of the NBC [4], [5], [6].

Historical evidence and geological studies confirm that the Himalayan region has endured several large-magnitude earthquakes over the centuries, each causing widespread destruction to infrastructure and significant loss of life [7], [8], [9]. The 2015 Gorkha Earthquake (magnitude 7.8) was a stark reminder of this vulnerability; although its epicenter was far from the Far Western Region, it raised nationwide concerns about the seismic resilience of public buildings, particularly schools and universities [10], [11]. The disaster revealed that many institutional structures built prior to or without compliance with updated provisions of the NBC suffered partial or complete failure, even in areas with only moderate shaking. Although the Far Western Region is less urbanized than central Nepal, it is not exempt from earthquake risk; geological studies indicate that the western segment of the Main Himalayan Thrust has not experienced a major rupture for over a century, suggesting a “seismic gap” and an elevated potential for a significant future event [12], [13], [14]. This context underscores the urgency for preventive structural health assessments in the region.

Assessment of building conditions is a critical part of maintaining safety, usability, and resilience, particularly in public and educational buildings [15]. In the context of Nepal, this has gained heightened importance following the devastating 2015 Gorkha Earthquake (2072 BS), which exposed vulnerabilities in many institutional structures. Ghimire and Chaulagain developed fragility curves for typical Nepali school building types, helping to quantify seismic risk and guide future resilience planning across the Himalayan region [16]. These fragility models offer valuable insights into the likelihood of damage under different intensity earthquakes and are vital tools for structural risk mapping [17]. In the broader South Asian and global context, NDT has emerged as an essential method for assessing reinforced concrete and masonry buildings [18]. On the policy front, Nepal has a codified framework through the NBC, which sets out minimum safety and structural requirements for different building types [19], [20], [21]. Although not always strictly enforced in institutional settings, the NBC provides a guideline for structural assessment, seismic design, and retrofitting interventions [14]. Periodic visual inspection and risk-based structural audits are recommended for public buildings, especially those that house students and teachers [22].

Several studies across different regions have demonstrated a direct relationship between the physical condition of educational buildings and both student/teacher comfort and academic performance [23], [24]. Indoor Environmental Quality parameters including thermal comfort, lighting, ventilation, humidity, and noise play a major role in student satisfaction and performance. Similarly, in the context of Nepal, Shrestha and Rijal [25] reported an average comfort temperature of 26.9 °C among surveyed students, highlighting the importance of designing learning environments that reflect local thermal preferences. NDT methods are widely employed for assessing the structural health of concrete in existing buildings due to their efficiency and minimal impact on the structure [26]. Among these, the rebound hammer test (also known as the Schmidt hammer test) is particularly popular.

Classroom temperature plays a crucial role in shaping the learning environment, directly influencing students' comfort, attention span, and overall academic performance. Research indicates that a thermally comfortable classroom environment supports cognitive functions such as memory, concentration, and problem-solving skills [27]. When classroom temperatures are too high, students often experience drowsiness, irritability, and reduced engagement, while excessively low temperatures can lead to discomfort, distraction, and slower reaction times [27]. A stable thermal environment not only promotes better on-task behavior but also reduces fatigue, creating a setting conducive to active participation and effective learning. Several studies highlight the negative impacts of thermal discomfort on academic outcomes. For example, Wargocki and Wyon [27] found that thermal and air-quality conditions outside recommended ranges can reduce children’s performance of schoolwork. The available literature on safety, maintenance, and emergency preparedness in Nepal's educational institutions after the 2015 Gorkha earthquake remains limited [9], [28]. Despite the growing body of literature on seismic vulnerabilities and post-2015 Gorkha earthquake reconstruction efforts in Nepal, there remains a significant research gap in comprehensive, mixed-methods evaluations of educational infrastructure, particularly in underserved peripheral regions like the Far Western Province, where studies integrating non-destructive testing (NDT), environmental monitoring, and user perceptions are scarce. This study addresses

this gap by assessing the Education and Humanities Building at Far Western University, offering insights into structural defects, thermal discomfort, and users' safety perceptions, and identifying priority areas for repair and further investigation. Overall, while detailed research on school-specific emergency readiness and maintenance is sparse, available programs and reports underscore the need for focused, institution-level studies in the aftermath of seismic events in Nepal

### 1.1 Objectives of the Study

The primary aim of this study is to assess the structural integrity and functional suitability of the Education and Humanities Building at FWU, with a view to identifying vulnerabilities and recommending improvements. Specific objectives include:

- Structural Assessment – Using NDT and visual inspection to determine the condition of masonry walls, columns, beams, and slabs.
- Functional Performance Review – Evaluating ventilation, lighting, thermal comfort, spatial adequacy, and accessibility in relation to academic needs.
- Safety and Preparedness Perception – Reviewing users' perceptions of the availability and effectiveness of emergency exits, fire safety equipment, and earthquake preparedness measures.

### 1.2 Scope and Significance

This research focuses on the academic building at FWU, the Education and Humanities Building. Its significance lies in an integrated methodology that combines technical evaluation through NDT and environmental monitoring for objective structural and environmental data, user-based feedback to capture the lived experiences and perceptions of building occupants, and code-based benchmarking to assess compliance with Nepal NBC safety and functional standards. By generating empirical evidence, the study aims to support university administrators, engineers, and policy-makers in making informed decisions on infrastructure investment, safety enhancement, and maintenance prioritization, while also contributing to the broader discourse on improving the resilience of higher education infrastructure in Nepal's seismically active context.

## 2 Data and Method

The study was conducted at FWU, located in Mahendranagar, Kanchanpur District, Sudurpashchim Province, Nepal. Established in 2010 (2067 B.S.), FWU serves as a major higher education institution for the Far-Western Region, offering programs in Humanities, Education, Science, Management, and Technology. The location of the studied building is shown in **Figure 1**. The assessment focused on the Education and Humanities Building within the central campus, constructed in the early 2010s and currently in continuous daily use. It is among the oldest buildings on campus and is essential to the university's teaching, learning, and administrative functions.




**Figure 1.** Location of Education and Humanities Building (source: Google Maps)

### 2.1 Research Design

A mixed-methods approach was employed, integrating technical building inspections with user perception surveys to obtain both quantitative and qualitative insights into the building's structural and functional performance. This approach ensured that the findings reflected both the measurable physical condition of the structure and the lived experiences of its occupants.

### 2.2 Data Collection Methods

A comprehensive visual assessment of the Education and Humanities Building at Far-Western University was conducted to analyze its physical and functional conditions. The walk-through evaluation revealed various signs of deterioration, such as surface cracks in both structural and non-structural components, corrosion of exposed reinforcements, water leakage at the bases and ceilings of walls, moisture in classrooms, peeling paint, and indications of general material decline due to insufficient maintenance. Functional elements of the building were also examined, with a specific focus on accessibility and circulation. Common issues identified included narrow lobbies, crowded staircases, and inadequate sanitary facilities, which collectively contribute to overcrowding and decreased convenience for users. Field notes and photographic evidence were meticulously gathered to document these issues and provide a solid foundation for further analysis. These findings emphasize the urgent requirement for both structural repairs and functional enhancements to guarantee safety, usability, and adherence to building standards.

The Rebound Hammer Test was performed on the masonry walls, masonry columns, beams, and slabs of the Education and Humanities Building to assess surface hardness and its corresponding compressive strength, without inflicting damage on

the structural elements. A grid-based testing methodology was employed, with measurements taken at various points and orientations (+90°, -90°, and 0°, as applicable) to ensure a thorough representation of the material conditions. For each test point, 10 rebound readings were recorded and averaged to minimize variability from surface irregularities. The average rebound values were then converted to estimated compressive strength using the calibration curves provided with the Rebound hammer. Because these curves are calibrated for concrete, values obtained on masonry are indicative rebound-derived estimates used for relative comparison only. Descriptive statistics, including mean, were calculated for each structural element to evaluate strength consistency and identify localized weaknesses. For interpretation, readings below 13 MPa were treated in this study as a screening threshold indicating possible material degradation or stress concentration, warranting further inspection. This non-destructive technique offered essential insights into material strength while maintaining the integrity of the components.

Physical measurements were conducted to evaluate the spatial and environmental performance of the Education and Humanities Building. The sizes of specific classrooms, office rooms, staircases, and lobbies were documented to analyze circulation space and spatial adequacy based on user needs. The opening-to-wall ratio was calculated to assess natural lighting and ventilation, then compared to the minimum standards set by the Nepal National Building Code (NBC). Furthermore, indoor and outdoor thermal conditions were recorded by measuring temperature and relative humidity at three different times during the day (10:00, 13:00, and 15:00) using a handheld infrared thermometer and digital hygrometer, yielding important data regarding indoor comfort levels.

User perception was evaluated through structured questionnaires distributed to building users, comprising students, teachers, administrative staff, and visitors, chosen through purposive sampling. A total of 55 responses were received. Not all respondents answered every question, so percentages are based on the number of valid responses to each question. Survey data were cleaned for completeness and analysed using Excel software and Google Sheets. Descriptive statistics (frequencies, percentages, and means) were calculated for closed-ended questions, providing insights into user perceptions such as the prevalence of structural issues and comfort levels. This analytical approach facilitated a comprehensive understanding of the building's condition from both quantitative and qualitative perspectives.

The purpose of the survey was to gather opinions on essential elements of the building environment, including classroom comfort, ventilation, lighting, accessibility, safety preparedness, and the frequency of maintenance tasks. Respondents were also requested to share their overall satisfaction with building conditions and to identify any structural problems they had noticed, such as cracks, dampness, or material degradation. Additional queries focused on issues like overcrowding in hallways and the sufficiency of emergency preparedness measures, providing important insights for enhancements.

Prior to questionnaire distribution, informed consent was obtained from all survey participants, comprising students, teachers, administrative staff, and visitors. Respondents were briefed on the assessment's objectives and assured of strict data confidentiality and anonymity. Participation was entirely voluntary, with the understanding that all responses would be processed in aggregate. All collected data were utilized exclusively for academic analysis to guide infrastructure maintenance and structural risk mitigation. The questionnaire was anonymous, collected no personal identifiers, and involved minimal risk to participants.

The review of secondary data included analyzing existing records concerning the construction history, maintenance efforts, and previous inspections of the Education and Humanities Building at Far-Western University. These documents delivered valuable background on the building's age, the materials used, and the types of repair or maintenance work undertaken over the years. Nevertheless, the records were not exhaustive for all timeframes, indicating gaps in systematic documentation. Despite these shortcomings, the data provided key context for understanding the present physical state of the building and reinforced the findings from the field assessment.

This study has several limitations. The authors are affiliated with Far Western University, which owns the assessed building. The assessment relied on instrument readings, photographs, and an anonymous questionnaire, but no independent external verification was carried out. The study also covers a single building, a purposive sample of 55 respondents, and one day of temperature monitoring. The findings should be interpreted with these limitations in mind.

## 3 Results and Discussion

### 3.1 Structural Condition

NDT using the Rebound Hammer method and visual inspections provided quantitative and qualitative insights. Rebound Hammer Test results showed average rebound-derived compressive strength estimates of 14.46 MPa for masonry walls (12–18 MPa), 17.0 MPa for masonry columns (12–24 MPa), and 17.4–26.63 MPa for reinforced concrete slabs and beams, as shown in **Figure 2** to **Figure 9**. These values indicate moderate strength. Adequacy for occupancy or seismic loads was not verified by structural analysis. Localized low readings (below 13

MPa) suggest material degradation or stress concentration. Visual inspections identified critical distress, including longitudinal cracks near beam supports and slab joints, indicating poor bonding between structural and non-structural elements, which compromises lateral stability. Diagonal shear cracks around window and door openings signal seismic vulnerability shown in **Figure 10**. Additional defects include moisture seepage, corroded window frames, rotting wooden doors (see **Figure 10**), peeling paint, and ceiling stains, reflecting environmental exposure and poor maintenance these types of similar study also suggested in [29], [30]. A notable concern is the absence of expansion joints despite the building's elongated footprint, which should be checked against the plan-proportion provisions of NBC 205:2024 [20]. The combination of moderate and variable material strength, environmental deterioration, irregular plan shape, and the absence of expansion joints necessitates immediate intervention [14], [31]. Also building's shape is L shape, which leads to the vulnerability of the structure, and careful design is required for such of structure to resist earthquakes [32]. Recommended measures include introducing expansion joints, implementing moisture control (e.g., drainage systems, waterproof coatings), and establishing a proactive maintenance program to address early-stage deterioration. Without these interventions, crack expansion and stiffness reduction could heighten seismic risks, compromising the building's long-term safety and functionality.

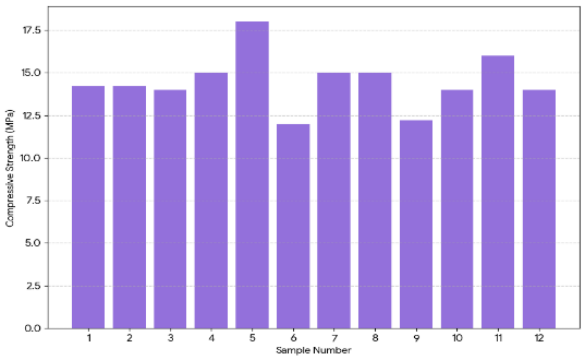



**Figure 2.** Compressive strength of wall 1 by Rebound test

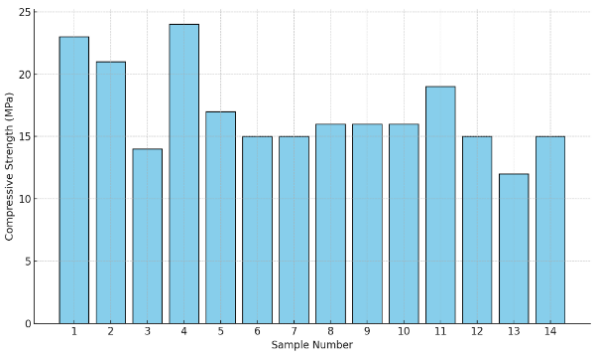



**Figure 3.** Compressive strength of masonry column by Rebound test

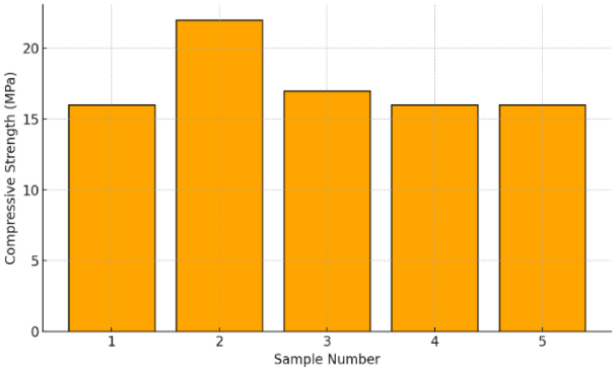



**Figure 4.** Compressive strength of Slab by Rebound test (2nd Floor, -90°)

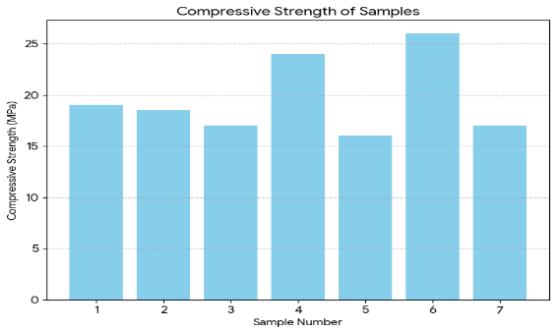



**Figure 5.** Compressive strength of Beam by Rebound test (-90°)

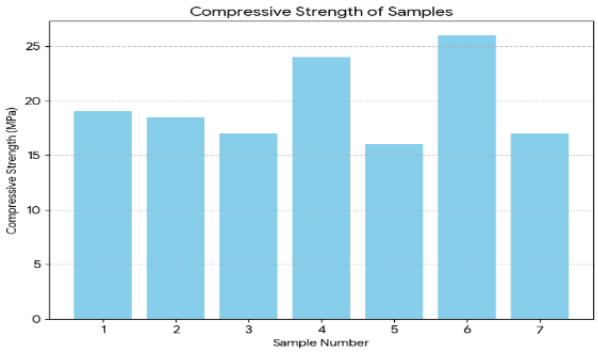



**Figure 6.** Compressive strength of Main Slab by Rebound test (1st Floor, +90°)

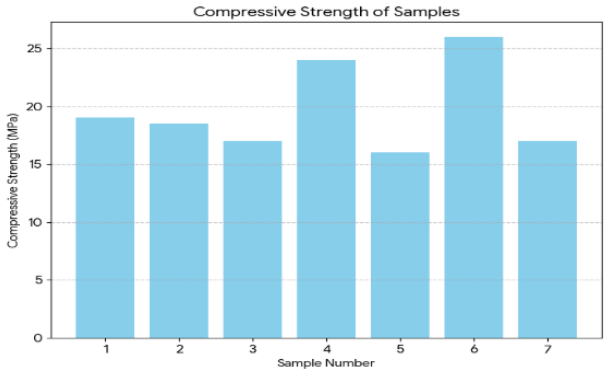



**Figure 7.** Compressive strength of Corridor Slab by Rebound test (+90°)

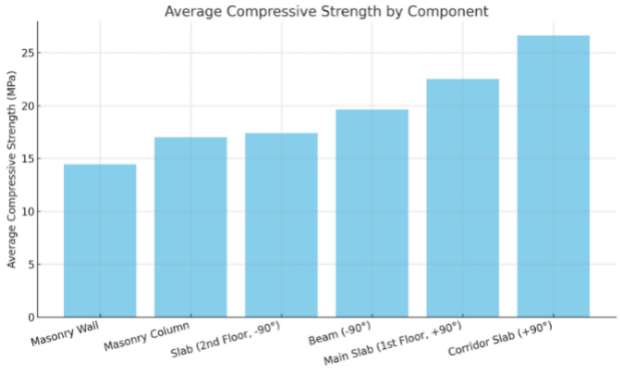



**Figure 8.** Graphical representation of strength of different part by Rebound test

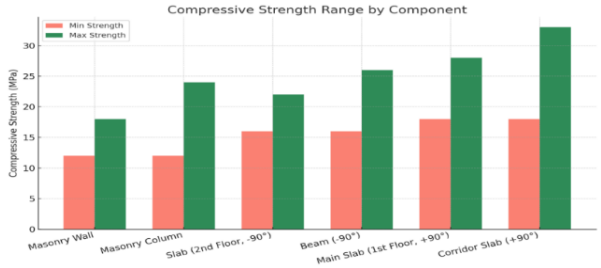



**Figure 9.** Variation in compressive strength for each member

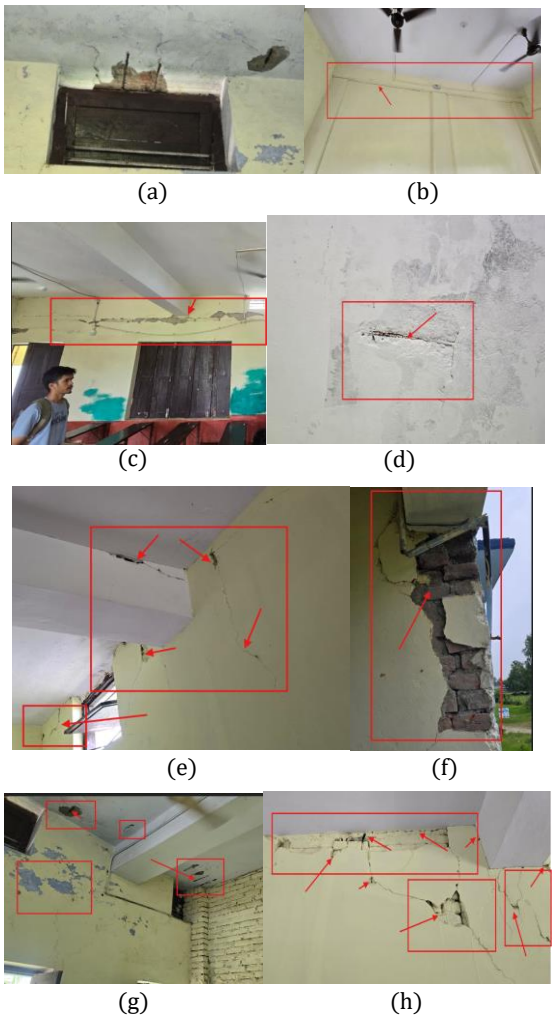



**Figure 10.** Defects observed in the building: (a), (d), (g) Accelerates deterioration of reinforcements and finishes; reduces durability and aesthetic quality; often due to environmental exposure and lack of protective coatings; (b) Longitudinal cracks near beam supports and slab joints (indicating poor bonding between structural and non-structural elements): (c), (e), (g), (h) Diagonal shear cracks around beam, wall corners, window and door openings (Signaling seismic vulnerability).

## 3.2 Thermal Comfort

Temperature monitoring showed indoor room temperatures reaching 35.9 °C (Table 1), while wall and slab surfaces were warmer still. On the second floor, slab surface temperatures exceeded 50 °C, highlighting significant solar heat gain through the uninsulated roof slab shown in **Table 1**. These findings align with Shrestha and Rijal [25], who observed that poorly insulated concrete roofs in Nepal's Terai region can cause prolonged overheating, particularly on upper floors. High thermal mass without adequate insulation traps and radiates heat well into the afternoon, creating discomfort that extends beyond peak outdoor temperatures. According to ASHRAE Standard 55 [33], such indoor conditions fall well outside the comfort range for occupied spaces, which may increase fatigue among occupants.

Ventilation performance was observed to be sub-optimal in several classrooms, where the calculated opening-to-wall ratios were low (below 20%) and some openings were obstructed or non-operational. The individual ratios are not tabulated in this paper. Inadequate cross-ventilation, particularly in buildings with elongated footprints, results in stagnant air zones and reduced air change rates. Substandard classroom ventilation rates have been associated with lower student achievement [34].

Temperature and relative humidity were recorded at three-time intervals (10:00, 13:00, and 15:00) in three sample rooms on August 24, 2025. The results revealed a clear diurnal heating trend, with all building elements warming steadily throughout the day. On the second floor, slab surface temperatures peaked at 51.43 °C (Sample 2) and 51.13 °C (Sample 3) by 15:00, indicating extreme heat gain from the roof. First-floor slabs remained significantly cooler, peaking at 35.5 °C shown in **Figure 11**. Relative humidity showed an inverse trend, starting higher in the morning (63–67%), dropping by midday, and reaching a low of 56% in the hottest second-floor room. The temperature humidity relationship confirmed that as indoor temperatures rose, air moisture content declined, resulting in a hotter and drier environment conditions that exacerbate occupant discomfort. This effect was most pronounced in upper-floor classrooms, where ceiling proximity to the uninsulated roof amplified heat gain [25], [33].

**Table 1**. Summarizing maximum room temperature, the maximum slab temperature, and minimum humidity for three sampled locations

| Floor Sample | Max Room Temp (°C) | Max Slab Temp (°C) | Min Humidity (%) |
|---|---|---|---|
| Sample 1 (1st Floor) | 33.3 | 35.5 | 65 |
| Sample 2 (2nd Floor) | 35.9 | 51.43 | 59 |
| Sample 3 (2nd Floor) | 35.5 | 51.13 | 56 |

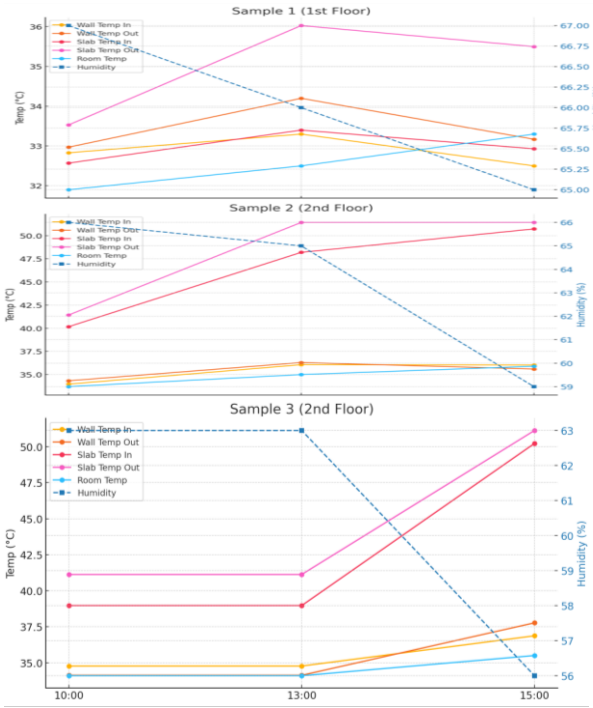



**Figure 11**. Temperature, Humidity and Time Graph (Diurnal Variation of Temperature and Relative Humidity in Sample Rooms)

### 3.3 Space and Accessibility

Measurements indicated that the lobby width is only 1.13 m, which is significantly below common circulation space standards for educational buildings. According to NBC 206:2015 [19], primary circulation corridors in public buildings should provide sufficient clear width for two-way pedestrian movement and efficient evacuation; a width of about 1.5–1.8 m is commonly recommended. The narrow lobby width in this building likely contributes to congestion during class transitions, particularly given the high daily occupancy.

### 3.4 Staircase Location and Flow

The staircases are positioned in a single corner of the building, creating a circulation bottleneck. Survey data revealed that 62% of respondents described the stairs as slightly crowded but manageable during peak class periods, while 36.4% described them as frequently congested or very crowded. A single corner staircase concentrates occupant movement at one point; multiple or more centrally located staircases would distribute movement more evenly and reduce congestion risk.

Toilets are located only on the ground floor, which is inconvenient for upper-floor users and increases unnecessary foot traffic in circulation areas. Research on school facilities by UNICEF has highlighted that inadequate distribution of sanitary facilities negatively affects student comfort, time-on-task, and hygiene compliance. For female students in particular, the absence of nearby facilities can lead to reduced attendance during certain periods of the month, impacting learning equity.

### 3.5 Overall Implications

The combination of narrow lobbies, corner-staircase placement, and insufficient sanitary facility distribution compromises both functional efficiency and safety. In normal operation, these constraints cause crowding, noise, and delays; in emergency scenarios, they could severely hinder evacuation speed, increasing risk to occupants.

### 3.6 Questionnaire-based Analysis

To complement the physical assessment of the Education and Humanities Building at FWU, a structured questionnaire was distributed among building users to gather perceptions regarding structural safety, comfort, accessibility, and maintenance. A total of 55 individuals participated, including students, teachers, administrative staff, and visitors.

### 3.7 Respondent Demographics

A total of 55 respondents participated in the survey. The majority were students (76.4%), followed by teachers (10.9%), visitors (9.1%) and administrative staff (3.6%) as shown in **Figure 12**. Most respondents were students, so the feedback primarily represents those who use the building daily for academic purposes.

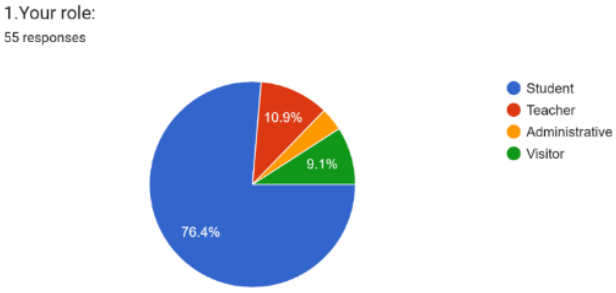



**Figure 12.** Respondent Roles Distribution

### 3.8 Faculty-wise Distribution of Respondents

Respondents came mainly from the Education faculty (54.5%) and Humanities (29.1%), followed by Engineering (10.9%), with single respondents (1.8% each) from Csit, Bsc CCSIT, and Science and Technology (**Figure 13**). This distribution suggests that the majority of respondents are regular users of

the building, especially from Education and Humanities, which aligns with the primary purpose of the building under study.

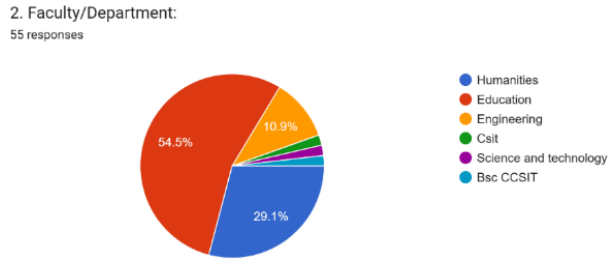



**Figure 13.** Faculty/Department-wise Respondent Breakdown

### 3.9 Duration of Building Use

When asked about how long they had been using the building, the largest proportion of respondents (50.9% of the 53 respondents who answered this question) reported using it for 1 to 3 years. About 22.6% had been using the building for 3 to 5 years, while 17% had more than 5 years of usage experience (**Figure 14**). A smaller group (9.4%) had used the building for less than one year. This shows that most participants had sufficient exposure to the building to provide meaningful feedback on its condition and functionality.

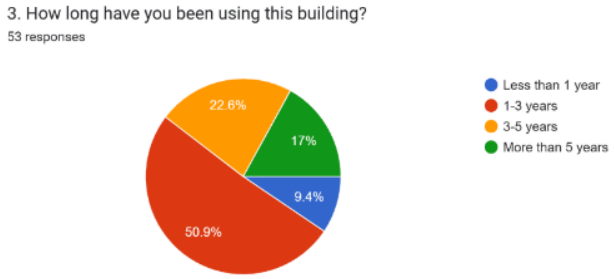



**Figure 14.** Duration of Building Use by Respondents

### 3.10 Observed Structural and Maintenance Issues

Analysis of the responses to Question 4 revealed that most users of the building have encountered considerable structural and maintenance issues in the Education and Humanities Building at Far-Western University. Cracks in the walls and beams were the most frequently noted problem, reported by 90.6% of the 53 respondents who answered this question (**Figure 15**). This high proportion raises urgent concerns regarding the building's structural stability since such cracks may indicate underlying weaknesses in masonry or reinforced concrete elements, especially in an area prone to seismic activity. If these issues are not addressed, they could jeopardize the long-term durability of the structure and heighten its susceptibility during seismic events. Furthermore, 83% of respondents noted issues such as peeling paint and rust on metal components, which strongly suggests environmental exposure and a lack of regular maintenance. The corrosion of metal parts not only detracts from the building's appearance but can also hasten the deterioration of reinforcement, compromising the structural system. Similarly, paint deterioration often points to deeper issues like moisture ingress or inferior quality finishes. Functional issues within the building were also reported. Roughly 40% of participants indicated overcrowding in staircases and corridors, highlighting inadequate circulation space. This situation not only causes inconvenience during busy times but also presents safety risks, as crowded escape routes can impede evacuation during emergencies. Additionally, 26% of respondents mentioned experiencing water leaks during rain, indicating flaws in the roofing systems, drainage design, or waterproofing applications. Ongoing leaks can lead to moisture-related complications such as dampness, mold growth, or long-term material deterioration. Other problems, including damaged stairs, uneven flooring, and specific defects, were reported less often but still deserve focused attention. Altogether, these findings underscore the critical necessity for a thorough structural assessment, waterproofing interventions, and enhanced space planning. Establishing routine maintenance schedules and ensuring prompt repairs will be vital for maintaining user safety, functional efficiency, and the lasting usability of the university's academic facilities.

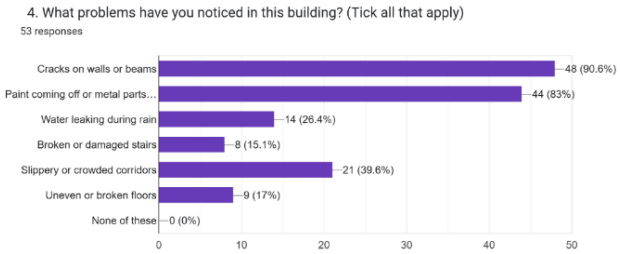



**Figure 15.** Problems Observed in the Building

### 3.11 Frequently Affected Areas in the Building

In addressing Question 5 **Figure 16**, participants pointed out particular building zones that face recurring issues, demonstrating that problems with deterioration and maintenance are not evenly distributed. Classrooms were mentioned by 60% of respondents as the areas most frequently affected, which has a direct impact on learning and user satisfaction. Ground floor areas were mentioned by 41.8%, likely due to significant foot traffic and extended exposure to environmental factors like water, dust, and general wear. Lobbies and corridors were identified by 36.4%, which is noteworthy as these areas are crucial for movement and emergency evacuation, influencing both convenience and safety. Other zones, such as stairs, restrooms, and labs, were mentioned less often, implying fewer prominent issues, although they still warrant attention in future maintenance considerations.

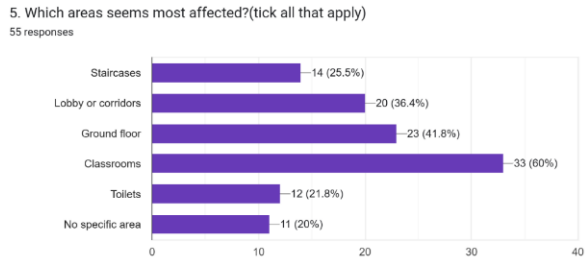



**Figure 16.** Most Affected Areas of the Building

### 3.12 Comfort Level of Classrooms

When participants were asked to rate the comfort level of the classrooms or rooms they use, a significant 57.4% of the 47 respondents who answered this question stated that the spaces were uncomfortable, while only 34.0% felt they were comfortable (**Figure 17**). Alarmingly, 8.5% rated the environment as very poor, indicating serious dissatisfaction with the learning or working environment. These results highlight the urgent need for improvements in classroom conditions, particularly in terms of seating, ventilation, lighting, and spatial comfort.

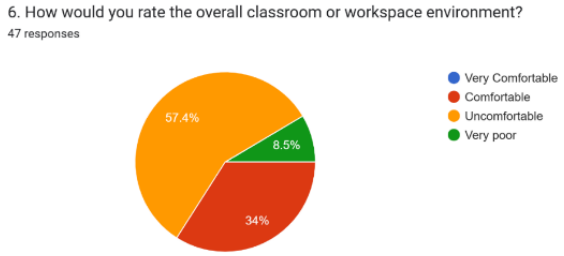



**Figure 17.** Respondents' Rating of Classroom Comfort

### 3.13 Factors Affecting Study or Work Conditions

Respondents were asked to identify the main factors that negatively impact their ability to study or work effectively within the building. A large majority (83.6%) pointed out that walls are dusty or cracked, while 78.2% reported that rooms are too hot or too cold, making thermal discomfort a significant concern (see **Figure 18**). Furthermore, 45.5% mentioned crowded stairs or corridors as a challenge during movement, and 34.5% cited excessive noise as another issue affecting concentration. Other factors such as poor lighting and unclear communication were marked by fewer respondents, indicating they were of lesser concern in comparison.

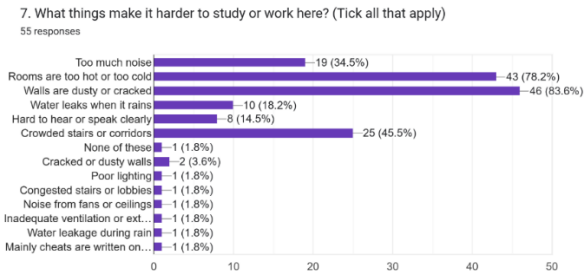



**Figure 18.** Factors Affecting Study and Work Environment

### 3.14 Staircase Condition During Busy Hours

When asked about the condition and usability of staircases during peak times, 62% of respondents reported that the stairs were slightly crowded but manageable, indicating a moderate level of congestion. However, 20% stated that the stairs were frequently congested and hard to pass through, while 16% described them as very crowded and unsafe, especially during class changes or emergencies as shown in **Figure 19**. These findings suggest a need for improved circulation space and better crowd management during busy periods.

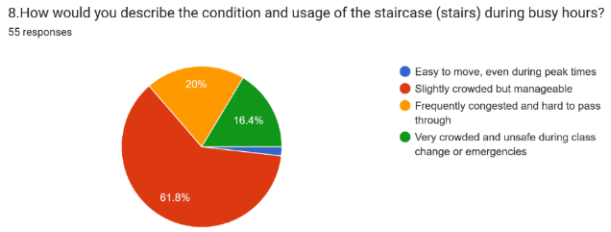



**Figure 19.** Crowding in Staircases During Peak Hours

### 3.15 Lobby and Corridor Conditions

Regarding the condition of lobbies and corridors, 45.5% of respondents reported that these spaces are sometimes crowded, especially during breaks. Additionally, 29.1% stated that the areas are often overcrowded and difficult to move through, while 23.6% believed that the corridors are poorly designed or maintained, contributing to discomfort and potential safety concerns as shown in **Figure 20**. These responses highlight the need for better spatial planning and regular upkeep to improve circulation and safety in common areas.

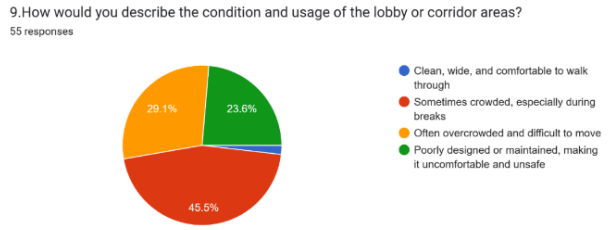



**Figure 20.** Conditions and Usage of Lobby/Corridor Areas

### 3.16 Perception of Indoor Air and Temperature Conditions

When asked about the air and temperature conditions inside classrooms and offices as shown in **Figure 21**, 52.7% of respondents described it as "somewhat okay", while 36.4% felt it was "uncomfortable". Additionally, 7.3% rated it as "very uncomfortable", indicating thermal discomfort and ventilation issues in many rooms. Only a small percentage considered the indoor environment to be very comfortable. These findings suggest a need for improved thermal regulation and ventilation systems to enhance comfort levels.

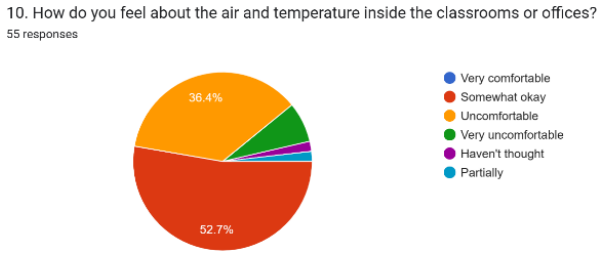



**Figure 21**. Perception of Indoor Air and Temperature Comfort

### 3.17 Safety and Emergency Preparedness

Survey results reveal significant shortcomings in the safety and emergency preparedness of the building. A substantial majority (87.3%) indicated that emergency exits are either difficult to find or blocked, while 9.1% were uncertain about their existence. The situation concerning fire safety is even more alarming: 92.7% of respondents mentioned they had not seen fire extinguishers or alarms, and 7.3% were unsure of their existence or operational status. Issues related to earthquake safety also surfaced as a major concern. Almost half (49.1%) of the participants indicated they felt unsafe staying inside during an earthquake, with 30.9% uncertain, and only 18.2% believing the building to be somewhat safe. These findings highlight the pressing need for clear emergency signage, effective fire safety measures, and better communication regarding earthquake preparedness. Tackling these issues is crucial for enhancing user confidence, protecting occupants, and ensuring the building adheres to fundamental safety and preparedness standards typically required in high-risk areas.

### 3.18 Frequency of Maintenance Activities

Survey findings reveal a concerning lack of clarity and uniformity in maintenance practices. Almost half of the respondents (49.1%) indicated they were not informed about the frequency of maintenance, pointing to inadequate communication or documentation. Around 32.7% claimed that maintenance is never performed, highlighting a significant shortfall in building maintenance. Only 16.4% reported having annual maintenance, with very few noticing more frequent interventions. This insufficient focus on regular upkeep not only hastens deterioration but also raises issues regarding safety, functionality, and the long-term viability of the building. Implementing consistent and clear maintenance schedules is crucial for ensuring user comfort and the structural integrity of the building.

### 3.19 Areas Needing Improvement

The survey findings highlight several pressing priorities for enhancing the building. The most pressing issue, noted by 98.1% of the 53 respondents who answered this question, was the need to repair the walls, stairs, or roof, indicating significant structural deterioration. Similarly, 69.8% pointed out the necessity for increased space in stairways and corridors, along with appropriate fire and emergency equipment, emphasizing concerns for safety and evacuation as shown in **Figure 22**. A total of 45% of respondents stressed the importance of cleanliness and hygiene, pointing to inadequacies in regular maintenance. Furthermore, 43% indicated a demand for additional classrooms or laboratories, suggesting that current facilities are either lacking or outdated. Collectively, these insights highlight the critical need for extensive improvements.

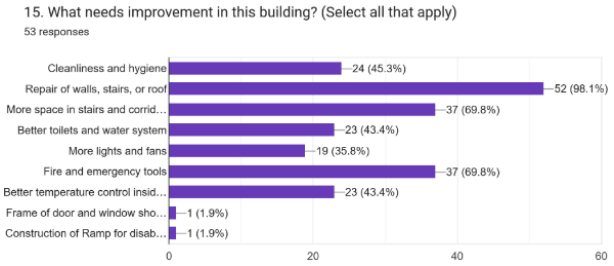



**Figure 22.** Areas Identified for Improvement

### 3.20 Perception of University's Commitment to Building Safety and Maintenance

When asked whether they believe the university authorities take building safety and maintenance seriously, nearly half of the respondents (49.1%) expressed no confidence in the university's commitment. Additionally, 47.3% were not sure about the university's efforts, indicating uncertainty or lack of visible action. Only a small fraction, 3.6%, felt that the university is indeed serious about ensuring the building's safety and upkeep. This suggests a widespread perception of inadequate attention to building maintenance and safety by the university management, highlighting the need for improved communication and visible efforts to reassure building users.

## 4 Conclusion

The assessment of the Education and Humanities Building at FWU reveals several critical insights into its structural integrity, environmental performance, user experience, and safety preparedness. From a structural standpoint, the building shows moderate strength in its load-bearing elements. The average rebound hammer test results indicate rebound-derived compressive strength estimates of 14.46 MPa for masonry walls, 17 MPa for masonry columns, and about 17.4 MPa for the second-floor slab, 19.6 MPa for beams, 22.5 MPa for the main slab and 26.6 MPa for the corridor slab— suggesting moderate strength, with localized low readings (below 13 MPa) in some masonry elements. These estimates are indicative and need confirmation by core tests or UPV. Visual observations of cracks and material wear support this assessment. Indoor environmental conditions are far from ideal. Temperature readings showed slab

temperatures up to 51.43 °C, and 57.4% of respondents rated classrooms as uncomfortable. In addition, 43.6% found the indoor temperature uncomfortable or very uncomfortable. These findings indicate poor thermal comfort. Likely contributors are the uninsulated roof slab and low opening-to-wall ratios. Effects on concentration and academic performance are suggested by the literature but were not measured in this study. Space and accessibility are also problematic. The narrow 1.13-meter-wide lobby, corner-located stairs, and absence of toilets above the ground floor make movement inconvenient and time-consuming especially during class changeovers. Crowding on stairs and in lobbies and corridors adds to discomfort and limits functional efficiency. Respondents reported low emergency preparedness: 87.3% found exits difficult to find or blocked, and 92.7% had not seen fire extinguishers or alarms. These conditions may pose risks in a fire or earthquake. No physical safety audit was conducted. Almost half of respondents (49.1%) felt unsafe staying inside the building during an earthquake. Survey responses indicate unclear or irregular maintenance. About 32.7% of respondents reported that maintenance was never performed, and 49.1% were not informed of its frequency. Cracked walls were reported by 90.6% of respondents and were also observed during inspection. Toilets are located only on the ground floor, which was observed during inspection and is inconvenient for upper-floor users.

## References


[1] M. A. O. Mydin, N. Sarpin, R. M. Zainol, R. Odeh, and M. N. M. Nawi, "The Impact of Climatological Factors on the Multifaceted and Multisystemic Deficiencies of Building Anatomy," *Journal of Advanced Research in Applied Sciences and Engineering Technology*, vol. 50, no. 1, pp. 308–329, Aug. 2025, doi: 10.37934/araset.50.1.308329.

[2] M. R. Pandey, R. P. Tandukar, J. P. Avouac, J. Lavé, and J. P. Massot, "Interseismic strain accumulation on the Himalayan crustal ramp (Nepal)," *Geophysical Research Letters*, vol. 22, no. 7, pp. 751–754, 1995.

[3] H. Chaulagain, D. Gautam, and H. Rodrigues, "Revisiting major historical earthquakes in Nepal: Overview of 1833, 1934, 1980, 1988, 2011, and 2015 seismic events," in *Impacts and Insights of the Gorkha Earthquake*, Elsevier, 2018, pp. 1–17. doi: 10.1016/B978-0-12-812808-4.00001-8.

[4] A. Eweda, T. Zayed, and S. Alkass, "Space-Based Condition Assessment Model for Buildings: Case Study of Educational Buildings," *Journal of Performance of Constructed Facilities*, vol. 29, no. 1, Feb. 2015, doi: 10.1061/(asce)cf.1943-5509.0000481.

[5] S. Russo and E. Spoldi, "Damage assessment of Nepal heritage through ambient vibration analysis and visual inspection," *Struct Control Health Monit*, pp. 1–18, 2020.

[6] B. Aryal, A. Dhungana, A. K. Mishra, and M. Bhandari, "Assessment of concrete strength in existing structures using nondestructive tests at Kachankawal Rural Municipality, Nepal," School of Engineering, Faculty of Science and Technology, 2021, doi: 10.5281/zenodo.6562652.

[7] İ. B. KARAŞİN, D. BAKIR, M. ÜLKER, and A. E. ULU, "The Structural Damages After Nepal Earthquakes," *IOSR Journal of Engineering*, vol. 07, no. 06, pp. 45–54, 2017, doi: 10.9790/3021-0706014554.

[8] H. R. Poudel and H. Chaulagain, "The Jajarkot Earthquake: Revealed the Vulnerability of Load Bearing Structures in Western Nepal," *Himalayan Journal of Applied Science and Engineering (HiJASE)*, vol. 5, 2024.

[9] D. Gautam and H. Chaulagain, "Structural performance and associated lessons to be learned from world earthquakes in Nepal after 25 April 2015 (MW 7.8) Gorkha earthquake," *Eng Fail Anal*, vol. 68, pp. 222–243, 2016, doi: 10.1016/j.engfailanal.2016.06.002.

[10] H. Varum, R. Dumaru, A. Furtado, A. R. Barbosa, D. Gautam, and H. Rodrigues, "Seismic performance of buildings in Nepal after the Gorkha earthquake," *Impacts and Insights of the Gorkha Earthquake*, pp. 47–63, 2018, doi: 10.1016/B978-0-12-812808-4.00003-1.

[11] A. Kumar, M. Arambepola, R. Mechler, and S. Hochrainer-Stigler, "Approach for national scale earthquake risk assessment: case study from Nepal," *In Proceedings of the 15th World Conference on Earthquake Engineering - WCEE*, pp. 1–10, 2012.

[12] B. K. Bohara, B. Abdellatif, J. Deupa, N. Mani Joshi, and S. Jagari, "Seismic Performance of Reinforced Concrete Buildings in Darchula, Nepal: A Fragility-Based Approach," *Journal of the Civil Engineering Forum*, pp. 295–306, Aug. 2025, doi: 10.22146/jcef.21159.

[13] B. K. Bohara, N. M. Joshi, and S. Jagari, "Impact of inadequate column performance and repair techniques on the seismic performance of RC buildings," *Discover Civil Engineering*, vol. 2, no. 1, p. 94, May 2025, doi: 10.1007/s44290-025-00253-5.

[14] B. K. Bohara, "Study of Common Construction Practices and Structural Defects in RC Buildings in Darchula District Far-Western Nepal," *Far Western Review*, vol. 1, no. 2, pp. 117–137, Dec. 2023, doi: 10.3126/fwr.v1i2.62137.

[15] Y.-J. Park, "A Review of the United Nations' School Disaster Safety," *Journal of the Korean Society of School Health*, vol. 29, no. 3, pp. 140–148, Dec. 2016, doi: 10.15434/kssh.2016.29.3.140.

[16] N. Ghimire and H. Chaulagain, "Seismic vulnerability assessment of reinforced concrete school building in Nepal," *Asian Journal of Civil Engineering*, vol. 22, no. 2, pp. 249–262, Feb. 2021, doi: 10.1007/s42107-020-00311-6.

[17] B. K. Bohara et al., "Seismic fragility curves for non-engineered low-rise commercial building in Far Western Nepal: A case study of Darchula," *Journal of NAST College (JONC)*, vol. 1, no. 1, pp. 57–76, 2025.

[18] A. Borosnyói, "NDT assessment of existing concrete structures: Spatial analysis of rebound hammer results recorded in-situ," *Engineering Structures and Technologies*, vol. 7, no. 1, pp. 1–12, Dec. 2015, doi: 10.3846/2029882x.2015.1085331.

[19] Department of Urban Development and Building Construction (DUDBC), "NBC 206:2015 Architectural design requirements," Government of Nepal, Ministry of Urban Development, Kathmandu, Nepal, 2015.

[20] Department of Urban Development and Building Construction (DUDBC), "NBC 205:2024 Ready-to-use detailing guideline for low rise reinforced concrete buildings without masonry infill," Government of Nepal, Ministry of Urban Development, Kathmandu, Nepal, 2024.

[21] Department of Urban Development and Building Construction (DUDBC), "NBC 108:1994 Site consideration for seismic hazards," Government of Nepal, Kathmandu, Nepal, 1994. [Online]. Available: http://www.dudbc.gov.np/buildingcode

[22] P. Druķis, L. Gaile, and L. Pakrastiņš, "Inspection of Public Buildings Based on Risk Assessment," in *Procedia Engineering*, Elsevier Ltd, 2017, pp. 247–255. doi: 10.1016/j.proeng.2017.02.106.

[23] F. M. JR. Roy, "THE RELATIONSHIPS AMONG SCHOOL FACILITY CHARACTERISTICS, STUDENT ACHIEVEMENT, AND JOB SATISFACTION LEVELS AMONG TEACHERS," 2003.

[24] S. Sogol, H. Lisa, K. Marguerite, and W. Hans Peter, "Building Features in Schools That Influence Academic Performance," *Journal of Civil Engineering and Architecture*, vol. 12, no. 3, Mar. 2018, doi: 10.17265/1934-7359/2018.03.001.

[25] M. Shrestha and H. B. Rijal, "Investigation on Summer Thermal Comfort and Passive Thermal Improvements in Naturally Ventilated Nepalese School Buildings," *Energies (Basel)*, vol. 16, no. 3, Feb. 2023, doi: 10.3390/en16031251.

[26] M. Gupta, M. A. Khan, R. Butola, and R. M. Singari, "Advances in applications of Non-Destructive Testing (NDT): A review," *Advances in Materials and Processing Technologies*, vol. 8, no. 2, pp. 2286–2307, 2022, doi: 10.1080/2374068X.2021.1909332.

[27] P. Wargocki and D. P. Wyon, "Providing better thermal and air quality conditions in school classrooms would be cost-effective," *Build Environ*, vol. 59, pp. 581–589, Jan. 2013, doi: 10.1016/j.buildenv.2012.10.007.

[28] R. R. Parajuli and J. Kiyono, "Ground motion characteristics of the 2015 gorkha earthquake, survey of damage to stone masonry structures and structural field tests," *Front Built Environ*, vol. 1, Nov. 2015, doi: 10.3389/FBUIL.2015.00023.

[29] E. Pathirana and R. Savitha, "Condition assessment of RC structures: Perspective on school buildings in Sri Lanka," SSRN preprint, 2023. [Online]. Available: https://ssrn.com/abstract=4349525

[30] G. G. T. D. Wickramathilake and W. Hemachandra, "Enhancing the Durability and Resilience of School Buildings in Sri Lanka: An Integrative Study of Common Defects and Remedial Measures," in *Selected Proceedings of the 2nd International Engineering Research Symposium; IERS 2024; 14 Aug; Colombo, Sri Lanka*, T. N. Fernando, M. Siriwardhana, R. Dissanayake, M. Vithanage, J. G. Samarawickrama, and P. Gajanayake, Eds., Singapore: Springer Nature Singapore, 2025, pp. 48–67.

[31] B. K. Bohara, D. B. Kunwar, and B. Kunwar, "Torsional Irregularity Control in Irregular Plan RC Buildings through Optimized Shear Wall Placement: A Parametric Study," *Momentum International Journal of Civil Engineering (MIJCE)*, vol. 1, no. 2, pp. 32–43, Jul. 2025, doi: 10.64123/mijce.v1.i2.1.

[32] B. K. Bohara, K. H. Ganaie, and P. Saha, "Effect of position of steel bracing in L-shape reinforced concrete buildings under lateral loading," *Research on Engineering Structures and Materials*, vol. 8, no. 1, pp. 155–177, 2022, doi: 10.17515/resm2021.295st0519.

[33] ASHRAE, "ANSI/ASHRAE Standard 55-2004: Thermal environmental conditions for human occupancy," American Society of Heating, Refrigerating and Air-Conditioning Engineers, Atlanta, GA, USA, 2004.

[34] U. Haverinen-Shaughnessy, D. J. Moschandreas, and R. J. Shaughnessy, "Association between substandard classroom ventilation rates and students' academic achievement," *Indoor Air*, vol. 21, no. 2, pp. 121–131, 2011, doi: 10.1111/j.1600-0668.2010.00686.x.