Safety, Cost Analysis and Time Management in the Dismantling and Demolition of High-Rise Structures

[1]Bukka Jahangeer, [2]MA Hameed
[1]*Author, Lords Institute of Engineering and Technology, Hyderabad 500091, Telangana*
[2]*Assistant Professor-Civil Engineering, Lords Institute of Engineering and Technology, Hyderabad 500091, Telangana*

Abstract- Demolition of high-rise buildings is a critical process in urban development, requiring meticulous planning and advanced technology. This study examines key aspects influencing demolition operations—safety risks, cost considerations, and time management. A structured methodology involving literature reviews, field surveys, data analytics, and case studies was implemented. The findings emphasize the importance of training, risk assessment, waste management, and digital planning tools. Case studies from Secunderabad and Hyderabad highlight best practices and existing gaps in current procedures. The study proposes a practical framework that integrates sustainable practices, modern technology, and regulatory compliance for efficient and safe demolition projects.

Keywords- High-rise demolition, safety management, cost analysis, time scheduling, construction waste, urban renewal, controlled implosion, risk assessment.

1.INTRODUCTION

The demolition of high-rise buildings presents unique engineering, environmental, and economic challenges. As urban areas expand and aging structures become liabilities, the need for efficient and responsible demolition methods intensifies. Unlike low-rise demolitions, high-rise dismantling involves greater risk due to the scale, structural complexity, and proximity to surrounding infrastructure. Therefore, the process demands an integrated approach that accounts for worker safety, budgetary efficiency, regulatory compliance, and environmental impact.

This paper investigates the most pressing issues in high-rise demolition through the lens of safety, cost, and time. Safety concerns such as falling debris, dust exposure, and potential collapses necessitate stringent protocols. Simultaneously, accurate cost estimation is crucial for managing equipment rentals, labor, and disposal logistics. Finally, time management ensures that projects are completed within deadlines to minimize urban disruption.

2.LITERATURE REVIEW

Numerous studies have explored demolition technologies, safety frameworks, and sustainability practices in high-rise projects. Deepak Bansal et al. examined the environmental impact of explosive demolition and recommended retrofitting as an alternative.

Dahiya and Laishram (2023) introduced a hybrid demolition technique to optimize energy use and reduce waste. Joseph and Boominathan (2023) showcased the efficacy of controlled implosion, particularly in urban environments, emphasizing pre-demolition simulations and risk management.

Guang-cheng Yang et al. highlighted the role of concrete-supported blasting techniques in improving safety and reducing environmental impacts. Zhou (2022) focused on simulation-based risk analysis, showing that virtual modeling can prevent collapse and control debris flow. Clare M. Smith advocated for deconstruction over destruction to enhance material recovery and support circular economy goals.

Collectively, these works reveal growing interest in combining safety, sustainability, and digital technologies in demolition. However, there remains a lack of integrated frameworks that holistically address safety, cost, and time management in high-rise demolition.

3.METHODOLOGY

This research adopts a mixed-method approach involving literature review, primary and secondary data collection, case study analysis, and technology evaluation. The objective is to assess current demolition practices and propose a comprehensive framework for safe, cost-effective, and time-efficient high-rise demolition.

3.1 Research Steps:

1. Problem Identification – Pinpoint issues in safety, cost, and scheduling in urban high-rise demolitions.
2. Literature Review – Examine global research on demolition methods, environmental impact, and risk mitigation.
3. Primary Data Collection – Surveys and interviews with demolition engineers, safety officers, and site managers.
4. Secondary Data Review – Analysis of case studies, regulatory guidelines, and past demolition projects.
5. Data Analysis – Quantitative metrics and qualitative feedback synthesized to identify gaps and best practices.
6. Framework Development – A model integrating smart technologies, risk planning, and sustainable methods

3.2 Data Instruments:
Structured questionnaires (n=50 respondents)
In-depth expert interviews (n=10)
Case documentation from Hyderabad and Secunderabad projects
Statistical tools for response aggregation and trend analysis

4.DATA COLLECTION AND ANALYSIS

4.1 Primary Data Collection

A field survey was conducted among 50 demolition professionals including civil engineers, project managers, and safety officers. Key findings include:

- 92% emphasized the need for formal safety training.
- 85% conducted risk assessments regularly.
- 40% had adopted drone or sensor-based site monitoring.
- 72% cited permit delays as a major time management challenge.

4.2 Secondary Data Collection

Secondary sources included academic publications, project reports, and regulatory guidelines. Benchmarks were extracted for cost estimation, safety protocols, and demolition timelines. Key findings revealed:

- Most cost overruns were due to unexpected debris volume (30%) and equipment rentals (25%).
- Time overruns were common in traditional projects lacking digital scheduling tools.

4.3 Data Analysis

Statistical tools and response aggregation helped analyze trends:

Safety Practice Adoption:

- PPE Availability – 89%
- Risk Assessment – 85%
- Drone Monitoring – 40%

Cost Overrun Sources:

- Debris volume misestimation – 30%
- Equipment rentals – 25%
- Safety compliance – 20%

Time Efficiency:

- Traditional methods had a 10-week average delay.
- Digital tools reduced delays by 15% on average.

Case Studies

Case Study 1: Secunderabad Railway Terminal Building Demolition

Location: Secunderabad, Telangana, India
Structure: Heritage terminal building, approx. 70 years old
Project Authority: South Central Railway under the Amrit Bharat Station Scheme
Demolition Type: Controlled mechanical demolition
Duration: 12–15 days

Background

The Secunderabad station's old terminal building had become functionally obsolete, unable to accommodate the increasing passenger volume (approx. 1.5 lakh per day). A decision was taken to demolish it as part of a ₹720 crore redevelopment plan.

Demolition Process

- Heavy-duty hydraulic excavators and crushers were deployed.
- Manual dismantling of heritage features (doors, decorative columns) preceded the main demolition to allow material salvage.
- Night-time work windows were used to avoid interfering with peak train hours.
- Dust suppression was achieved using high-capacity mist cannons.
- Live structural health monitoring sensors were temporarily installed to ensure the adjacent platforms and rail lines were unaffected.

Safety Measures

- PPE compliance was strictly enforced.
- Access zones were sealed with fencing and 24/7 security patrols.
- Fire extinguishers, medics, and evacuation protocols were on standby.
- Nearby platforms had vibration monitors and pre-surveys to prevent settlement or micro-cracking.

Gaps Identified

- No archival 3D documentation was conducted to preserve historical data.
- Absence of a public waste management plan or debris tracking protocol.
- The project lacked separate cost allocation for the demolition phase, making benchmarking difficult.

Key Learnings

- Effective stakeholder coordination (railway officials, contractors, safety officers) minimized disruption.
- The project showcased efficient scheduling but missed sustainability opportunities in material recovery and heritage conservation.

Fig.4.1

Case Study 2: Demolition of Unauthorized High-Rise Floors in Nalandanagar, Upparpally

Location: Hyderabad, Telangana

Structure: Residential building (approved G+2, illegally built G+5)

Executing Authority: GHMC Town Planning Wing

Demolition Date: March 2025

Method: Combination of manual and mechanical demolition

Background

The Greater Hyderabad Municipal Corporation received multiple public complaints about unauthorized vertical expansion that violated safety norms. After issuing non-compliance notices and receiving no corrective action, the GHMC carried out forced demolition under municipal enforcement powers.

Execution Details

Top-down demolition began with manual removal of non-structural elements to avoid destabilizing the approved structure below.

Light-duty jackhammers and concrete cutters were used to dismantle slabs and beams on the 4th and 5th floors.

A crane-supported scaffolding system enabled safe access to the upper levels.

No implosion or explosive demolition was used due to proximity to occupied buildings.

Safety and Risk Management

- Demolition teams wore basic PPE, but no real-time monitoring systems (e.g., air quality, vibration sensors) were used.
- Minimal public communication resulted in crowd control issues on Day 1.
- No emergency medical unit was stationed on site.
- Evacuation of nearby residents was partial and temporary.

Cost and Regulatory Gaps

The total cost of the demolition was absorbed by the GHMC, with no cost recovery from the violating builder.
There was no cost-benefit study or damage audit conducted post-demolition.
Debris was not segregated, and waste went directly to landfill.

Delays and Inefficiencies

- Regulatory enforcement occurred months after initial complaints, highlighting procedural delays.
- Absence of a digital permit tracking system resulted in sluggish administrative action.
- Lack of predefined scheduling tools led to miscoordination between planning and enforcement departments.

Key Learnings

- Manual dismantling is viable for partial structural demolition in urban residential areas but increases worker risk and duration.
- There is a strong need for standardized SOPs in unauthorized structure removal.
- Integration of digital governance, like e-permitting and GIS mapping, would improve response times.

Fig.4.2

6.RESULTS AND DISCUSSION

6.1 Safety Findings

- High awareness of safety measures was reported, with 92% supporting formal training and 89% confirming PPE availability.
- However, smart monitoring tools like drones and real-time hazard sensors had low adoption (40%).
- Manual demolitions saw more safety incidents, while controlled implosions demonstrated safer outcomes due to advanced planning and simulations.

6.2 Cost Insights

- Major cost overruns stemmed from poor debris volume forecasting (30%) and long equipment rental durations (25%).

- Projects using waste recovery and material recycling achieved up to 25% cost savings.
- Lack of transparent budgeting and financial audits hindered post-project evaluation.

6.3 Time Management

- Permit-related delays and poor coordination were leading causes of project lag.
- Teams using digital planning tools (e.g., Gantt charts, BIM) completed projects 15% faster than traditional schedules.
- Real-time scheduling updates were missing in manual demolitions, leading to inefficiencies.

CONCLUSION

The study confirms that demolition of high-rise buildings is a multidisciplinary challenge requiring coordinated planning, modern technology, and stringent safety compliance. Safety practices are recognized but inconsistently enforced. Cost overruns often occur due to poor material and equipment planning. Delays are common where digital tools are not employed.

A proposed framework for future high-rise demolitions includes:

- Smart safety integration: Use of drones, AI risk monitoring, and IoT systems.
- Sustainable cost management: On-site segregation and recycling to reduce disposal expenses.
- Digital scheduling: Adoption of BIM, 4D simulations, and permit-tracking tools.
- Community engagement: Clear communication with affected stakeholders.
- Regulatory collaboration: Fast-track approval systems via liaison officers.

By applying these improvements, future projects can achieve greater efficiency, cost savings, environmental compliance, and public safety.

REFERENCES

[1] Deepak Bansal et al., Environmental concerns in explosive demolition, 2023.
[2] Devender Dahiya & Boeing Laishram, Hybrid demolition techniques, 2023.
[3] Anil Joseph & A. Boominathan, Controlled implosion methodologies, 2023.
[4] Guang-cheng Yang et al., Concrete-supported blasting in high-rise demolition, 2023.
[5] Xiaoguang Zhou, Simulation in blasting demolition risk management, 2022.
[6] Clare M. Smith, Circular economy in deconstruction, 2022.
[7] Marat Kuzhin, Safety systematization in demolition practices, 2022.
[8] Paul Kamrath, Top-down demolition procedures, 2022.
[9] Jun Zhu et al., Static-cutting techniques in urban demolitions, 2023.
[10] Erik K. Lauritzen, Construction and Demolition Waste (CDW) recycling strategies, 2021.
[11] Indian Standard IS 4031 and IS 12269 (various parts for cement testing and demolition planning).