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Paradigm Shift to Forensic Engineers for Addressing Structural Failures in India

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ABSTRACT

Urban sprawl and high-rise buildings are essential for meeting housing demands and optimising land use, thereby mitigating urban sprawl through vertical urbanisation in densely populated cities. This paper explores the evolution of forensic structural engineering through various case studies, emphasising the urgent need for forensic engineers and their recommendations following structural failures, including subsequent legal actions. Case studies of structural collapses in Bengaluru and Gurgaon are examined. In these instances, buildings were illegally constructed, resulting in fatalities. Forensic engineers, acting as consultants, discuss issues such as weak foundations, poor construction quality, and unauthorised vertical extensions, which violate building codes and bylaws. These violations have led to a disregard for quality and safety standards.

The study employs Normalised Differential Built-up indices using Geographic Information Systems (GIS) to assess the increase in the built-up index. This article reviews the utility matrix of forensic engineers and highlights their growing importance in recent years. Furthermore, the discussion underscores the significance of geotechnical engineering, the need for stringent building codes that focus on people, materials, and machinery, regular inspections, and effective disaster management. The analysis draws lessons for policymakers, builders, and the community aimed at preventing illegal construction practices and enhancing disaster management strategies, thereby reducing the risk of structural failures.

Keywords: Building by-laws, Construction Claims, Foundation failure, Urban sprawl, vertical urbanisation, Structural Failure,

INTRODUCTION

Urban sprawl is rapidly increasing due to migration, marginalisation, and the desire for modern amenities. With limited land for growth in cities, planners are shifting from slums to buildings to accommodate rising populations driven by the need for food, employment, and healthcare. This high density has led to calls for vertical urbanisation to optimise land use and energy efficiency in the face of environmental decline. The construction sector in India is disorganised and location-specific, influenced by financial growth, state policies, urban regulations, and building codes. Factors such as material supply, labour, and job opportunities drive urban agglomeration and migration (Aithal et al., 2016; Kumar et al., 2021; Li et al., 2025; Li et al., 2018; Getu et al., 2024).

As a forensic engineer, a structure collapses when it cannot carry the design load, causing undue distortion or cracks. The attributes are design errors, construction imperfections, faulty material, derisory maintenance, natural disasters, or external exposures. Forensic engineers investigate these failures by documenting the scene, collecting evidence, formulating and testing hypotheses about the cause, and acting as expert witnesses to determine accountability and prevent future occurrences. The external factors include unforeseen loads, soil

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structures, or environmental events. The primary goals are to establish the root cause of the failure, ensure safety for future structures, and offer an expert's report for legal proceedings (Chadchan et al., 2024**[6]**, Bhagabat et al, 2025[7], Mirani et al, 2025[8]).

India ranks at the top as the most populous country in the world. It has a population of 1.456 billion as of Aug 2025. Briskly rising urbanisation is predicted to surge from the present urbanisation level of about 35% to reach about 40% by 2030. The urban sprawl in India is occurring either on the outskirts of the city towards the suburbs, while skyscrapers are built in new satellite towns or shoot upward within the heart of the city. Well, some 600 million people are anticipated to move to the cities by 2030 (Behera et al, 2019[9], Mishra SP. 2024[10]).

Need for the study:

Structured norms or any codes for practice in conducting forensic investigations of collapsed structures exist in many countries, including India. Absence of scientific investigation procedures at times could not identify the person (owner, designer, construction engineer, or contractor) who defied the law. The appointment of the forensic structural engineers in case of structural collapse shall help the owner, as real estate is dominated by man, money, and power. They overlook the required credentials, and the first-hand report is biased, as observed in India (Heggade et al, 2024[11]).

REVIEW OF LITERATURE:

Structural failures are inextricably associated with the construction sector; in the present century, with innovative excellence in building architectures, they are presently minimised. The forensic mentors or consultants with disaster response and repair are more apt with the process of denting and restoring the distorted buildings, Parfitt et al, 2012[12], Czajkowska et al, 2021[13]. At the local and regional level, structural health intensive maintenance and damage exposure can be done through wide-ranging investigation, adherence to building by-laws, and immediate pertinent action can be taken to save the building from failure (Suzuki et al, 2023[14]).

Modern innovative methods by using BIM technology and Pizo-electric sensors can identify the structural defects that can cause its failures (Xu et al, 2024[15]). The structural failures are based on Risk Identification, Hazard classification, Risk assessment and measurement, and the Risk monitoring and response methods by using the failure models and effects analysis (FEMA) (Weiss et al, 2025[16]).

The causative driving factors for urban sprawl are socioeconomic, physical, proximity, neighbourhood, and regulation factors (Basu et al, 2023[17], Sharma et al, 2025[18]). The Meteorological disasters accompanied by anthropogenic activities have claimed lives and drawn civic resentment in various cities and their suburbs in India, which are being demolished (Khan et al., 2025[19]).

India shall have a demand for affordable housing shortage of 31.2 million units by 2030, attracting business of Rs 67 trillion by 2030. The present shortage is 10.1 million units, which attracts an alluring business for the real estate market and finance. Parallel illegal and below-standard constructions have reached the sky as a limit. Simultaneously, structural failures have become common in urban sprawls and cosmopolis clusters (Outlook Business.com) [20].

There is less control over the architects and civil Engineers to point out in case of structural failure, casualties, fatalities, and financial losses. Forensic engineers are trained personnel who act as a line of defence to analyse causes of failure, report, and help the police and the court as consultants. In the present investigation, two structural failures are taken and discussed. Structural failure and casualties have become common in urban sprawl.

Objective of the study:

The objective of the present investigation is to have a detailed analysis of building failures in India. They include

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1. To review the mechanisms of the structural failure, deterioration of construction materials, correlating with geomatics, and the geo-hazards of the area, with case studies.

2. Whether the failure is natural or anthropogenic, so that claims can be placed before the appropriate authority or legal actions against the construction contractor.

3. To discuss the utility matrix of the forensic structural Engineers in the construction domain in urban India.

METHODOLOGY:

The failure study of a building comprises a Structural Stability and Safety Assessment based on geography, geomorphology, meteorology, and environment, etc.

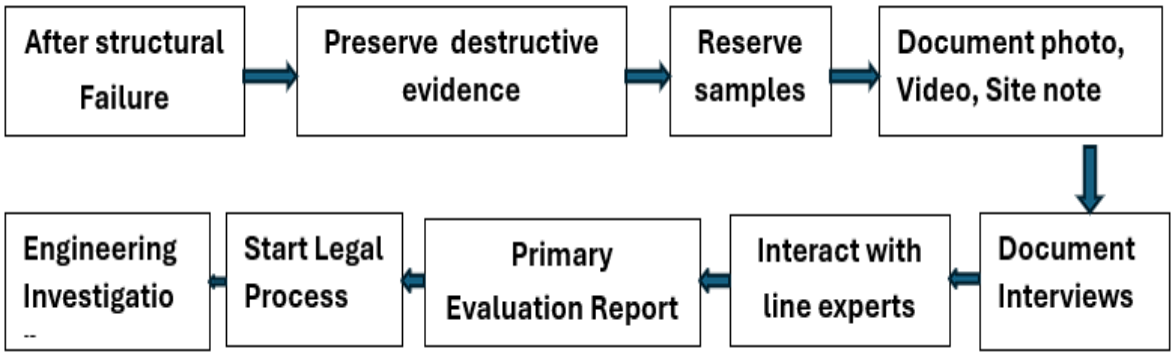

Fig. 1: The procedures to be followed by a Forensic Engineer after a building collapse.

To preserve evidence from destructive and perishable goods, as well as interviews with eyewitnesses regarding legal activities, interactions with experts, and forensic engineers, a comprehensive approach is taken. Relevant documents are collected for the investigation, including design drawings, estimates, specifications, bore logs, contract copies, site calculations, registers, logbooks, daily field reports, compliance documents, inspection and test reports, and all related files. Following an initial analysis, a preliminary report is created, which serves as the primary document, followed by a final report.

Forensic engineers assess structural failures by first providing an overview of the incident, including its background and context. They then identify the causes of the building collapse, examining factors such as human error, design flaws, and regulatory failures. The third section addresses the consequences of the incident, including loss of life and property and its impact on the community.

After a structural failure resulting in casualties, the forensic engineer must submit an immediate action plan. This plan should outline a safe approach for rescue efforts, avoid areas prone to further deterioration, isolate the incident zone from public access, and prevent further dismantling or demolition of critical areas (Kelvin et al., ICRI, 2021).

Role of Construction Engineers:

The practice of appointment of Forensic structural Engineers is remote in construction projects; now it warrants the appointment of forensic structural Engineers as consultants in the construction domain, so that the consultant can solve ambiguities from the owner, architect, designer, town planner, construction Engineers, contractors, legal personnel, etc. (Table 1).

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Table 1: The utility matrices of the forensic structural engineer in the construction domain

Utility	Stage of construction	Technical/routine	Methods to be applied	Instant/time taking
Owner	Service and construction	Safety, quality and durability	Technical, keep to the law	During & after construction
Architect	Before/during construction	Look, smart, HVAC facility	Technical and cost	Before construction
Town Planner	Before/during/after construction	Look, smart, HVAC facility	Technical/codal provision	urgent
Contractor	During construction	Quality and construction	Technical and material quality	Urgent and must for safety/quality
Banks	Construction	Purpose of business	procedural	Time to time
Insurance	Construction/failure	Settlement of claims	Procedure based	Time taking
During disputes	Construction/ payments	Resolution of disputes	Technical	Urgent

Source: Anitha et al., 2019[22]; Heggade VN 2024[11]

Study area:

Case study at Bengaluru:

Bengaluru, the capital city of Karnataka, has in recent years witnessed several incidents of building collapses, raising serious concerns about construction practices and urban safety. The rapid urbanisation, coupled with the rising cost of land, has led builders to stress vertical construction, often at the expense of structural safety. Many collapses have been traced to weak foundations, unauthorised additional floors, poor-quality materials, and negligence of safety regulations. Structural Engineers vs. Forensic Engineering

Structural engineers design and confirm the building's integrity analysis using Building Information Modelling (BIM) or Laser Scanning), and structural construction to abide by the IS codes of practice, ensuring the safety, stability, and gratifying the owner's needs. The Forensic Engineers focus on exploring the causes of failures of structural components and identifying defects, and recommend remedial solutions by consulting structural Engineers or pertinent legal actions if needed. Generally, structural engineers prepare and submit Structural Design Feasibility Reports, Procurement Inspection Reports, Structure's Adequacy Assessment Reports, and dilapidation reports. In contrast, the forensic Engineers stress on Failure Investigation Reports, Defect identification, Remediation Reports, and the Structural Expert Opinion Reports (Fig 2).

Geographical features

Bangalore is located in the south-eastern part of Karnataka state in India, on the Mysore plateau, which is a part of the larger Deccan plateau. It sits at an average elevation of 920 meters. The city is characterised by its relatively flat topography, with some hilly areas in the western parts, including the highest point,

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Doddabettahalli, at an elevation of 962 meters. Bangalore does not have any major rivers flowing directly through it. The South Pennar (Dakshina Pinakini) River originates near the Nandi Hills and passes nearby. The Vrishabhavathi River, which originates in Basavanagudi and is a tributary of the Arkavathi River, flows through the city.

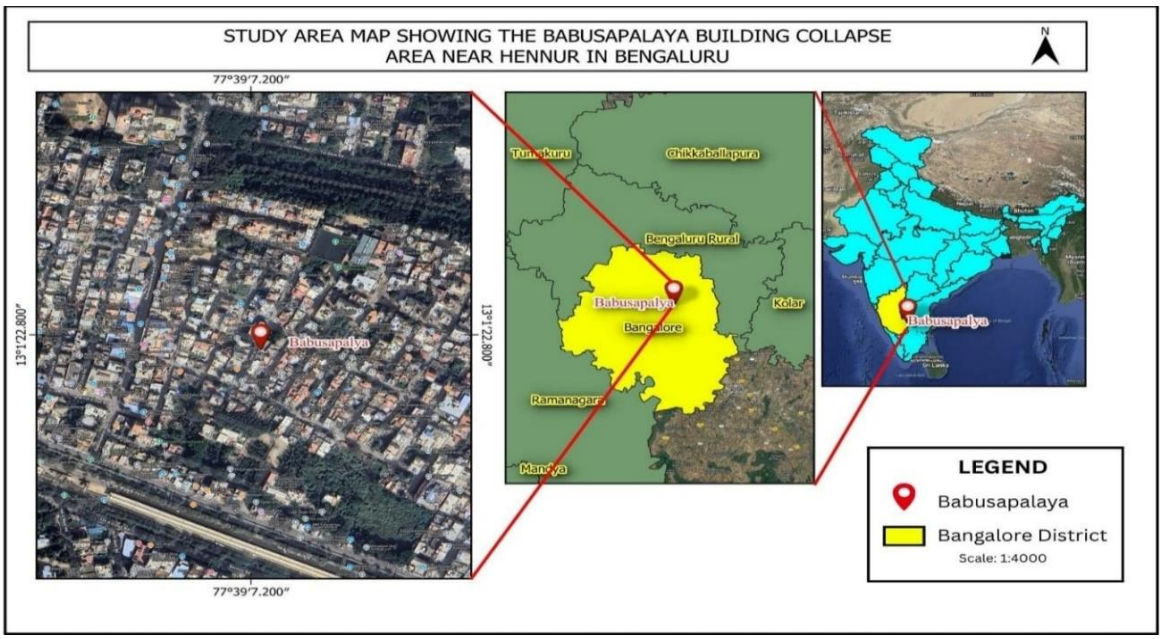

Fig 2: The Index map of the Bangalore building collapse

The soil in Bengaluru largely consists of red lateritic and clayey soils with underlying granitic gneiss, which provide moderate bearing capacity for construction but require proper foundation treatment to avoid settlement issues. The city experiences a tropical savannah climate, with mild summers, moderate winters, and significant rainfall during the southwest monsoon season. The average annual rainfall is about 970 mm, most of which occurs between June and September. Heavy downpours often lead to waterlogging and weaken poorly constructed foundations, making adherence to structural safety measures crucial in building practices.

Climate and Soil:

The city's geographical setting on the Deccan Plateau, with heavy seasonal rains, further aggravates the risk by weakening soil and unfinished structures. The building collapse stands as a stark reminder of these challenges, where unauthorised construction beyond approved limits and weak basement support led to a tragic loss of lives. Such incidents highlight the urgent need for stricter enforcement of building codes, transparent approval processes, and regular structural audits to ensure the safety of residents and workers in Bengaluru's fast-growing urban environment.

Geotechnical failures:

The causes of Geo-Technical failures may be due to the type of soil (Black cotton) or filling, Environmental, design deficiency, construction failure, Defective material, and lack of upkeep (annual repair and maintenance) of the structure. The environmental or earthy characteristics susceptible are cohesive soil (Black cotton), Frost heaves, Excess/less moisture content, collapsing, and organic matter in foundation soil, etc. The faulty design includes calculation errors, inappropriate use of load combinations in Building Information Modelling (BIM) software, differential settlements, soil creep, and deficient structural redundancy, etc. The other construction flaws are under/over compaction, improper materials, cracks, and shrinkage in CC/RCC, poor joint management, nearby water bodies and drains, etc. Failing the regular building repair and maintenance, defective centring and foundation, and upheaval may cause cracks in buildings. The differential settlement, floor, slab or foundation movement, and finally cause structural failure (Salena et al, 2018[23]).

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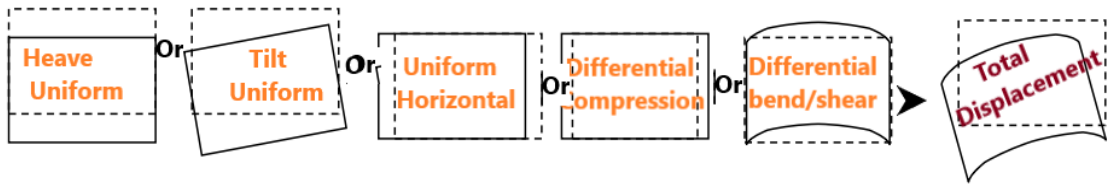

Fig. 3: The causes of foundation failure that result in structural collapse in India

The remedial measures that can be suggested are underpinning strip Foundation, Jacked Pile Underpinning, Needle (beams) and Piles, etc. Other procedures that can be recommended are pressure grouting. The role of the engineer in charge, the contractor's engineers should have adequate knowledge about the type of soil samples, pertinent controlling tests, and existing surface and underground drainage, Merah A, 2021[24].

Case detail

The building collapse in Bengaluru is an alarming case of structural failure in recent years, exposing the consequences of unauthorised construction and poor engineering practices. The structural details or under-construction buildings had obtained official permission for only four floors, but the builders had illegally extended it up to six (The Hindu 23 Oct 2023[25], The TOI 23rd OCT 2024[26]).

The construction of the six-storey building collapsed on 22 October 2024**,** around 3:40 p.m**.**, amidst intense monsoon rainfall. At the time of the disaster, approximately 20 to 21 labourers were present on the site. The structure initially buckled from below, the first floor collapsing before the entire building leaned and was affected. A total of 13 individuals were rescued by emergency teams, while the fatalities are eight, reflecting the severity and the challenging conditions aggravated by heavy rainfall.

Investigation reports

The investigation findings of failure were that "an under-construction mansion collapsed. The building had official permission for only four floors, but the owner illegally extended it to seven floors. On the day of the collapse, heavy rains further weakened the unstable structure, leading to a sudden cave-in. The preliminary inquiry revealed that the building's basement was structurally weak, and poor construction practices combined with violations of safety norms played a major role in the disaster. Following the incident, authorities arrested the builder and contractor for negligence and violation of building codes. The case highlighted the widespread issue of unauthorised construction in Bengaluru, where the pressure of urban land scarcity pushes builders to maximise vertical space without adhering to structural safety, ultimately endangering lives (As per local newspaper).

Causes of Failure:

The structural failure of the building, as per the English news daily, 24th Oct 2024, "The Hindu"

1. The building was illegal as its plan was sanctioned for a four-storied building, but construction was undertaken on the 7th floor.

2. The structure failed amidst torrential rain of 157mm in about 6 hours, as per the Bruhat Bengaluru Mahanagara Palike (BBMP), Yelahanka.

3. Despite the BBMP's notice to cease the construction activities before, the contractor continued construction using sub-standard building material and poor workmanship.

4. The basement was weak. The sizes of the foundation columns were underprovided, and the underscaled diameters of the steel added to the structural failure.

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5. During construction, material standards and quality control were overlooked, and the workers were inexperienced as local construction personnel.

Structural and Regulatory Factors

Common factors in such collapses include weak or poorly designed foundations, unauthorised addition of extra floors beyond the approved plan, and the use of substandard construction materials, lack of quality control, and lack of soil testing. In many cases, the soil conditions are not adequately assessed, leading to unstable bases for multi-storey structures. Heavy monsoon rains further weaken poorly constructed basements and foundations, accelerating the risk of collapse. On the regulatory side, lack of strict enforcement of building codes, corruption in approval processes, and inadequate monitoring of construction sites are recurring issues. Builders often bypass safety norms to maximise profits, while municipal oversight remains limited.

a.  b. 

c.  d. 

Fig 4: (a and b): The dilapidated building (The India Today), (c) The demolished building (The Hindu): (d) The structural failure from Back (The Mint)

The absence of periodic structural audits and insufficient penalties for violations allows unsafe buildings to continue rising in rapidly urbanising areas like Bengaluru. Together, these structural and regulatory failures create conditions where even minor stress factors—such as heavy rainfall or soil settlement—can result in catastrophic building collapses.

The Gurgaon Building collapse

The collapse of a building in Gurgaon, Haryana, on August 10, 2019, was a catastrophic event that shocked the nation. The incident resulted in the loss of several lives and injuries to many others, besides causing significant property damage. The building, which was under construction, collapsed due to a combination of factors, including poor construction practices, inadequate design, and lack of regulatory oversight. This review article aims to analyse the Gurugram building collapse, its causes, and consequences, and to identify measures that can be taken to prevent such incidents in the future.

Proceedings of the Structural Failure:

Gurgaon district in Haryana comprises 251 villages amidst agricultural land. Each village has a Dora (Abadi underdeveloped land) in the buffer zone of the core village, left for future expansion of the village. Sprawl. In

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the trans boundary area, having 5-7 storey buildings erected over 25 to 35 sqm. These buildings are constructed not abiding by building by-laws, building codes, and geotechnical specifications.

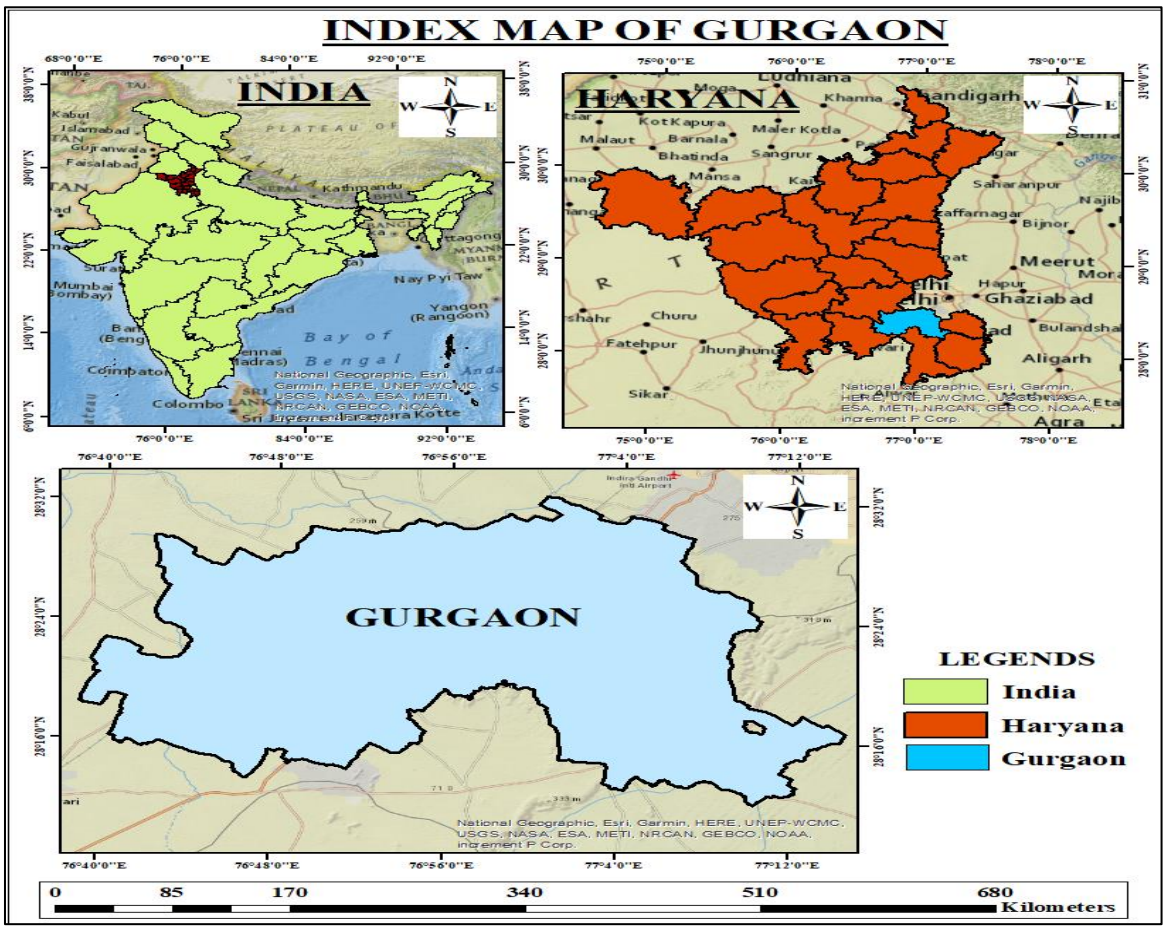

Fig 5: The Index map of the Gurgaon suburban areas in Ullash Nagar, building Failure

The safety concerns of the newly constructed multi-storeyed buildings are beyond the jurisdiction of the Municipal Corporation Gurgaon (MCG), and are under the Municipal Corporation Act 1973; rather, the Village panchayats look after the safety and risk apprehensions.

The building was constructed illegally in Gurgaon, on the southern peripheral road, where the building shares three fringed walls with the neighbour's walls behind a narrow approach. The building stands over about 70-100 sqm area proposed for a seven-story building within a crowded mesh amongst a cluster of buildings proposed for residential purposes, with a basement for use as an animal shed and parking of vehicles. The basement and the first floor were constructed. The ground floor was used for the purposes it was meant, and the first floor comprised four rooms where seven people died out of the nine people who were in the building during the ramification of the building. A lintel cast one day before, for the expansion of the 4th floor of the building, collapsed. The additional structure weakened the structure, and within 24hours, the structure not only failed, but the whole three-storied mansion was also dilapidated. The Basement, 1^{st,} and 2nd floors were constructed. During the construction of the separation wall (non-load bearing), which cannot take the dead load, the building collapsed within 14hours, indicating progressive collapse or disproportionate collapse, caused by faulty design or defective materials.

Causes and Consequences of Building Collapses:

Various causes for the structural collapse are faulty construction, design defects, Foundation failure, corrosion, degradation, natural disaster, sub-standard materials, overloading, inadequate maintenance, vibration, lateral forces, and human actions, etc. (Qui et al, 2025[27]). Research has shown that building collapses are often caused by a combination of factors, including design flaws, poor construction practices, and inadequate regulatory

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oversight (Adhikari et al.,2020[28]). In the case of the Gurugram building collapse, a combination of factors, including poor construction practices and inadequate design, contributed to the disaster. The collapse resulted in significant loss of life and property, as well as economic and social impacts on the local community (Wang et al.,2020,[29] Mishra et al, 2022[30], Monachese et al, 2025[31]).

Budding Challenges of Urban Flood

Urban flooding has posed a grievous concern in many cities in India, where rapid urbanisation and increasing impervious concreting surfaces and altered hydrological cycles (Mishra et al, 2020[32], Kumar et al.,2022[33]). Urban flooding contributes to building collapses by compromising the structural integrity of buildings and infrastructure. Sustainable urban drainage systems (SDS) can help to mitigate the risk of urban flooding by reducing the burden on traditional drainage infrastructure and promoting more natural hydrological processes (Tan et al.,2019). By adopting SDS, cities like Gurugram can reduce the risk of building collapses and promote more resilient and sustainable urban environments.

Here is a comparison table highlighting the key differences between the **Gurgaon building collapses** and the **Bangalore building collapses** based on available sources: TOI.

Table 2: The comparison of two illegal building collapses at Bengaluru and Gurgaon cities

Aspect	Gurgaon Building Collapse	Bangalore Building Collapse
Location	Gurgaon	East Bengaluru
Date	February 10, 2022	October 22, 2024
Cause	Living room floor collapsed (sixth floor), repair work ongoing; structural faults suspected.	An entire under-construction multi-storey collapsed; sub-standard materials, illegal extra floors beyond the approved plan, and violations.
Building Type	18-storey completed residential complex	7-storey under-construction building (approved for 4 floors)
Casualties	2 deaths, several injured, people trapped	At least 8-9 deaths, 13 rescued, many injured
Victims	Residents, including a bureaucrat's family	Labourers from Bihar, Andhra Pradesh, and Karnataka
Rescue Operations	NDRF, SDRF, fire brigade, police, and sniffer dogs are involved	NDRF, SDRF, police, and the fire department are involved
Accountability/Legal Action	FIR against the developer; CBI investigation	The owner and contractor were arrested for negligence
History of Complaints	Previous ceiling collapse, complaints to authorities	The area has recurring violations, poor civic amenities, and illegal constructions
Regulatory Issues	Structural audit ordered by the authorities	Violations: more floors than approved, weak structure, poor materials

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Quest for Urban Sprawl:

The Bengaluru city is expanding rapidly, and the horizontal expansion is changing the outskirt agricultural and rural lands to homestead land, and sporadically, unplanned multistorey buildings are built due to the development of the IT sector, educational hubs, health care units, and communication networks mainly in the fringe areas from 1990 onwards. This results in the conversion of green belt to residential projects and technological hubs. The rapid growth has triggered illegal constructions without compliance with planning, approved structural design, building by-laws, and RERA. (Fig. 6).

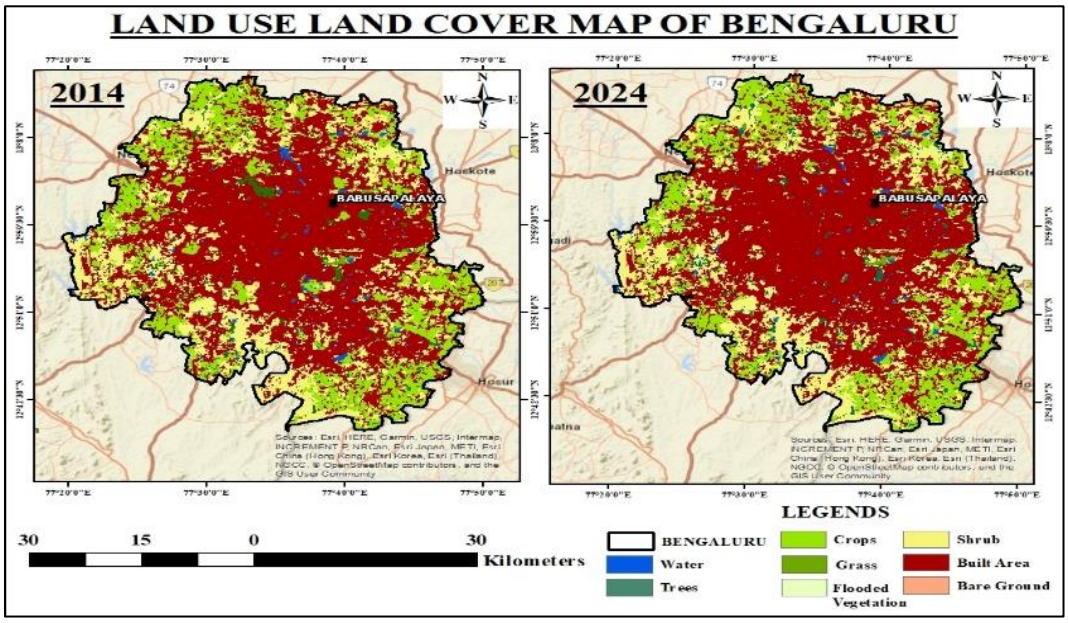

Fig. 6: The land use changes for built-up areas in extended Bengaluru city

Total area of extended Bengaluru (urban) considered = 2190 sq.km

Table 3: The built-up area changes in Bengaluru city between 2014 and 2024 (Table 3)

Sl.No.	2014		2024	
	Area(in sq km)	%	Area(in sq km)	%
Built-up area	1200	55	1530	70
Change detection	---	---	330	27.5

The Gurgaon city's sprawl is mainly considered for its rapid, decentralised, and often haphazard growth from its city's core, extending to the outskirt rural and suburban areas. This sprawl is accentuated by the economic growth from business, IT, and industrial growth, increasing migration, and connectivity to Delhi. The shift in buildings in the DORAS areas has reduced encroachment of agricultural land and fallow lands. The growth in the real estate business and the need for residential complexes led to encroachment and unplanned construction, and not adhering to any laws, regulations, or design principles. So, the challenges can only be fulfilled through the strict imposition of design criteria, town planning norms, and provisions laid by the federal institutions from time to time. The rise in the built-up areas in Gurgaon city is reflected in Table 3 and Figure 5, which warrants sustainable urban planning.

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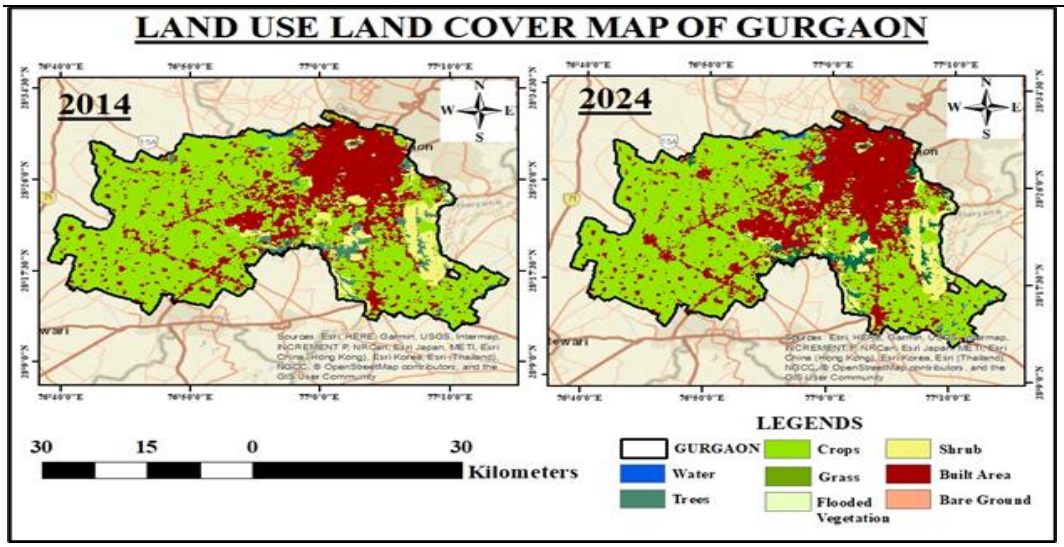

Fig. 7: The land use changes for built-up areas in extended Gurugaon city

Total area of Gurgaon = 1258 sq.km

Table 4: The built-up area changes in Gurgaon city between 2014 and 2024

Sl.No.	2014		2024	
	Area(in sq km)	%	Area(in sq km)	%
Built-up area	380	55	565	70
Change detection	---	---	185	48.7

Claims Arising from Building Collapses:

After the myth of building collapses invites significant claims and disputes, particularly in cases where deaths, injuries, and financial losses occurred. The owners, the affected/dead/injured people, and third parties can lodge contractual claims against architects, engineers, and other professionals and contractors if they were at fault (Adhikari et al.,2020)[28]. To minimise the risk of claims and disputes, it is warranted to adopt a proactive approach to risk management, including regular inspections and maintenance. By understanding the causes and consequences of building collapses, stakeholders can work towards creating safer and more resilient built environments.

DISCUSSION:

Analysis of the failure of structures is increasing in India due to the paucity of residential dwellings. Modern structural infrastructures lag in terms of their stability, monolithic, and longevity, caused by poor design, improper geotechnical investigations, foundation stability, degraded materials, and immature construction practices. The threats are stemming from ethical issues, non-abidance of construction practices, exacerbated corruption, and rapid township agglomeration. On collapse, the forensic Engineers explore the causes of dilapidation, in-situ inspections, interaction with witnesses, laboratory findings, destructive and non-destructive tests. Legal Challenges at times could not be met due to insufficient proofs in detailed tender call notices (DTCN), faulty construction procedures, maintaining proper quality control and timely inspections, and centralised data assortment, etc. (Singh et al. 2024[34])

A case study of a high-rise building in Jaipur serves as a pertinent example. To prevent disasters, it is essential to adopt a strategic planning and decision-making approach that includes an effective drainage system (for both sewage and sewerage). This should be complemented by optimizing the building's envelope design and

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implementing a proactive strategy for risk avoidance and management. It is crucial to understand the complexities and threats associated with structural failure in order to create a safe and resilient built environment (Chaturvedi et al., 2023).

The drivers of urban sprawl are mounting incomes, cheaper land availability in suburbs, low communication expenses, owning a house, and being near to work site, education, and health care inspire novice migrants to opt for free areas close to the core of the city. The Bengaluru and Gurgaon spread was towards the Barren or Abadi lands on the outskirts of the city. The affordability of these cheap land costs attracted migrants to urban sprawl by transforming Bengaluru's farmlands into construction sites for gated communities.

The players for Horizontal to vertical urbanisation: The paucity of land for construction, the high cost of real estate, and restrictions imposed by the developmental authorities for land allocation. In megacities, the developers and planners increase the FSI (Floor Space Index) or FAR (Floor Area Ratio) in the cores. The FSI or FAR is the ratio of a building's total floor area to the size of the plot. In the Bangalore suburbs, high-rise buildings are constructed.

The FSI is based on road width, the zoning, and plot size. Ranges for residential areas are about 1.5 to 2.75, but beyond the CBD (Central Business Dist.), it goes up to 3 or 4 (commercial properties). In the case of Gurgaon city, residential plots have an allowable FSI range between 1 and 1.45, while business/commercial zones allow for higher FSIs (2.5 to 4 or more) to regulate density and the height of the building, and finally complete urban growth. In both cases of building collapse, and the FSI norms are satisfied.

Societal Impact: The building collapsed in the Babusapalya incident, and Ullash village has a profound impact on society. Beyond the immediate loss of lives and injuries to workers and residents, such tragedies disrupt families, livelihoods, and entire communities. Many of the victims are migrant labourers from economically weaker backgrounds, and their deaths or injuries place a heavy burden on dependents who rely on daily wages for survival. Survivors often face long-term physical and psychological trauma, while displaced residents struggle with housing insecurity and financial losses.

Public sentiment in the aftermath of these collapses is marked by anger, fear, and distrust towards builders, contractors, and civic authorities. The government and the panchayat people threw mud at each other. Citizens frequently express frustration over the lack of accountability and the perception that officials collude with developers to bypass safety regulations.

Resentments for adherence to bylaws and codes: Protests, demands for stricter enforcement of building norms, and calls for compensation to victims' families are common. Media coverage intensifies these sentiments, amplifying public pressure on government agencies to act decisively. Collectively, these incidents erode confidence in urban governance and highlight the urgent need for reforms that prioritise public safety over rapid and unsafe urban expansion.

Building Envelope Design and Optimisation:

Building envelope design (BED) is a critical aspect of building projects, as it can significantly impact the energy efficiency, comfort, and safety of buildings (Singh et al.,2022[36]). Building envelope design can minimise the risk of structural Failure by reducing the impact of environmental factors, such as wind and seismic loads. With the optimised building envelope design, architects and engineers can create more resilient and sustainable buildings that are better equipped to withstand natural disasters and other external factors.

CONCLUSION

The recent building collapse highlights the growing risks associated with unauthorised construction, weak foundations, and inadequate regulatory oversight in Bengaluru's rapidly expanding urban environment. This tragedy not only resulted in the loss of lives but also revealed significant shortcomings in construction safety and urban governance.

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To create safer cities, it is essential to strictly enforce building codes, conduct regular inspections, and hold developers accountable, all of which should be supported by sustainable urban planning. Implementing stricter enforcement of building codes, providing effective training for construction authorities, and adhering to regulatory guidelines are necessary steps to reduce the risks associated with negligence.

To address the issue of negligence, urban residents in India should impose stringent actions to decrease the number of building collapses by ensuring safety in existing structures. Such measures are crucial to prevent future incidents and restore public confidence in the safety of urban infrastructure.

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