THE EFFECT OF REINFORCED CONCRETE ON SAFETY OF RESIDENTIAL BUILDINGS IN BENIN CITY, EDO STATE

BY

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DECLARATION

I hereby declare that this research project titled "The Effect of Reinforced Concrete on the Safety of Residential Buildings in Benin City, Edo State" is the result of my original work carried out in the Department of Architecture, University of Benin.No part of this work has been previously submitted to any institution for the award of a degree or certificate. All sources of information and materials consulted during the course of this research have been duly acknowledged in accordance with academic standards.

OGBENI FAVOUR ESEOHIE. **Signature & Date**

ENV2103361.

CERTIFICATION

This is to certify that the research project titled “The Effect of Reinforced Concrete on the Safety of Residential Buildings in Benin City, Edo State” was carried out by OGBENI FAVOUR ESEOHIE, with matriculation number ENV2103361, of the Department of Architecture, Faculty of Environmental Sciences, University of Benin.This work meets the requirements prescribed for the award of the Bachelor of Science (B.Sc.) degree in Architecture. It is, therefore, approved for its academic content, originality, and compliance with the standards of the department and the university.

Architect Bello	**Signature & Date**
Supervisor.	

DEDICATION

I dedicate this project to God Almighty for His grace, strength, and guidance throughout the course of my studies.I also dedicate it to my beloved family, whose constant support, encouragement, and sacrifices made this academic journey possible.

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I wish to express my profound appreciation to God Almighty for granting me the grace, knowledge, and perseverance required to successfully complete this research work.

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ABSTRACT

This study investigates the effect of reinforced concrete on the safety and structural performance of residential buildings in Benin City, Edo State. The frequent reports of structural defects, premature deterioration, and occasional building failures within the city have raised concerns about the quality of materials, construction practices, and compliance with established building standards. A survey research design was adopted, involving building professionals and residential property owners across selected areas in Benin City. Data were collected using a structured questionnaire developed from relevant literature and validated by experts. Descriptive statistics such as mean and standard deviation were used for analysis.

Findings from the study revealed that major factors contributing to reinforced concrete failure in Benin City include poor-quality materials, inadequate supervision, incorrect reinforcement placement, improper mix ratios, and the use of unskilled labour. The study further established that these factors negatively affect building safety by causing structural cracks, excessive deflection, corrosion of reinforcement, and in severe cases, partial or total collapse. The research concludes that strict adherence to building codes, proper supervision by qualified professionals, quality control of concrete materials, and continuous monitoring during construction are essential for improving residential building safety.

Based on these findings, the study recommends enhanced regulatory oversight, professional involvement at all construction stages, and increased awareness among clients and developers on the importance of using standard materials and skilled personnel. These measures will significantly reduce the risks associated with reinforced concrete failure and promote safer housing development in Benin City.

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CHAPTER ONE

1.1 BACKGROUND TO THE STUDY

The safety of residential buildings has emerged as one of the most pressing concerns in contemporary construction discourse. Across the globe, reinforced concrete (RC) has become the material of choice for structural systems, owing to its unique combination of strength, versatility, and affordability. Concrete, with its high compressive capacity, when paired with steel reinforcement capable of resisting tensile stresses, creates a composite material capable of delivering long-term structural stability under diverse loading and environmental conditions. From modest homes to skyscrapers and bridges, reinforced concrete is at the heart of modern urban development.

In many developed countries, strict adherence to design codes, rigorous quality control, and effective regulatory oversight have made reinforced concrete a reliable guarantor of safety. Structures are designed to withstand natural hazards, fire, and long-term material deterioration, ensuring that residents live in secure and sustainable environments. However, the situation in many developing countries, including Nigeria, presents a striking contrast. Here, while reinforced concrete remains the dominant building material, its safety record is marred by repeated incidents of structural failure and building collapse.

The Nigerian construction sector has, over the past two decades, witnessed alarming rates of building collapse, many of which involve reinforced concrete structures. More than 500 reported cases of building failure have occurred across Nigeria in recent years, with Lagos, Abuja, Port Harcourt, and Benin City among the most affected. Studies have consistently attributed these failures to factors such as poor design, inadequate supervision, substandard materials, and non-compliance with existing building codes. The consequences are severe: loss of lives, destruction of property, displacement of families, and erosion of public trust in the

construction industry.

Benin City, the capital of Edo State, offers a particularly relevant case study for examining the relationship between reinforced concrete and building safety. The city is experiencing rapid population growth and urban expansion, driven by increasing rural-to-urban migration and housing demand. In response, numerous residential developments ranging from high-end estates to informal settlements dot the city's landscape. However, the surge in housing

development has outpaced regulatory capacity. Many residential buildings are constructed by informal sector builders, who often lack formal training and whose work is seldom subject to rigorous professional supervision. As a result, shortcuts in construction such as improper concrete mix ratios, inadequate reinforcement detailing, and insufficient curing are common, with significant implications for safety.

The lived experiences of residents in Benin City reflect these challenges. Reports of cracks in structural walls, visible reinforcement corrosion, water leakages, and even partial collapses in residential buildings highlight the vulnerability of many RC structures in the city. Many of these failures could have been prevented with proper design, adequate material quality, and effective site supervision. For instance, inadequate concrete cover often accelerates corrosion of reinforcing bars, while poor mix quality undermines the compressive strength of concrete. These weaknesses collectively compromise the structural integrity of residential buildings, putting lives and investments at risk.

The issue is not merely technical; it is also social and economic. Reinforced concrete construction is cost-intensive, and builders under financial pressure often attempt to reduce costs by using less cement, fewer reinforcement bars, or lower-quality aggregates. In Benin City's informal housing market, this cost-cutting is widespread, as builders seek to meet the demand for affordable housing. However, these decisions, while seemingly practical in the

short term, create long-term safety hazards. The repeated collapses of reinforced concrete structures across Nigeria serve as tragic reminders of the dangers of prioritizing cost over safety.

At a broader level, the safety of residential buildings is a fundamental human right, directly tied to health, wellbeing, and dignity. Unsafe housing exposes families not only to physical harm but also to psychological stress, financial loss, and social instability. Reinforced concrete, if used correctly, has the potential to guarantee durable and secure homes; if used incorrectly, it becomes a silent risk factor that undermines the very essence of housing. This duality makes reinforced concrete both a solution and a problem in the Nigerian construction landscape.

Given this backdrop, investigating the effect of reinforced concrete on the safety of residential buildings in Benin City, Edo State is timely and necessary. The study does not merely consider reinforced concrete as an inert material but as a socio-technical system shaped by design standards, material availability, construction practices, regulatory frameworks, and human decisions. By situating the study within Benin City, it acknowledges the localized challenges of informal construction, rapid urban growth, and regulatory gaps,

while contributing to the broader discourse on building safety and sustainable housing in Nigeria. Ultimately, the findings of this research aim to inform policy, guide professional practice, and promote safer residential construction for the people of Benin City.

1.2 Statement of the Problem

Despite the global recognition of reinforced concrete as a reliable structural material, Nigeria continues to record frequent cases of residential building failures and collapses, many of which involve reinforced concrete structures. In Benin City, Edo State, rapid urban growth and increasing housing demand have led to widespread construction activity, much of it carried out

with inadequate supervision, substandard materials, and poor adherence to building codes. These practices undermine the intended safety benefits of reinforced concrete, resulting in visible structural defects such as cracks, corrosion, and, in extreme cases, building collapse.

The persistence of these failures raises critical questions about the actual effect of reinforced concrete on the safety of residential buildings within this context. While reinforced concrete is designed to provide durability and stability, improper application, cost-driven shortcuts, and weak regulatory enforcement continue to compromise its performance in Benin City. Consequently, residents face heightened risks to life, property, and wellbeing.

This problem underscores the urgent need for systematic investigation into how reinforced concrete, as applied in residential construction in Benin City, affects building safety. Without such inquiry, the cycle of preventable failures is likely to persist, with devastating human and economic consequences.

1.3 Research Objectives

The overarching aim of this study is to examine the effect of reinforced concrete on the safety of residential buildings in Benin City, Edo State, with a view to identifying challenges and recommending measures for safer housing construction.

The specific objectives are to:

- Assess the role of reinforced concrete in ensuring the structural safety of residential buildings in Benin City.
- Identify the major challenges associated with the use of reinforced concrete in residential construction within Benin City.
- Examine how construction practices and regulatory compliance influence the safety

performance of reinforced concrete in residential buildings.

- Recommend measures to improve the effectiveness of reinforced concrete in enhancing the safety of residential housing in Benin City.

1.4 Research Questions

What role does reinforced concrete play in ensuring the structural safety of residential buildings in Benin City, Edo State?

What are the major challenges associated with the use of reinforced concrete in residential construction within Benin City?

How do construction practices and regulatory compliance influence the safety performance of reinforced concrete in residential buildings?

What measures can be adopted to improve the effectiveness of reinforced concrete in enhancing the safety of residential housing in Benin City?

1.5 Scope of the Study

This study focuses on the effect of reinforced concrete on the safety of residential buildings in Benin City, Edo State. The research is limited to residential structures constructed primarily with reinforced concrete elements such as beams, columns, slabs, and foundations.

Geographically, the study covers selected areas within Benin City, including Ugbowo, GRA,

Upper Sakponba, Ikpoba Hill, Ekenwan Road, New Benin, and Sapele Road. These areas

were chosen because of their high concentration of residential developments and diverse construction practices.

The study examines reinforced concrete in terms of material quality, construction methods,

supervision practices, regulatory compliance, and observed structural defects. It does not extend to industrial or commercial buildings, nor does it include laboratory testing of materials. The findings are therefore limited to residential buildings and the opinions of building owners and construction professionals within the study area.

1.6 Significance of the Study

This study is significant in several ways:

1. For Government and Regulatory Agencies:

   The findings will provide valuable information to the Edo State Development Control Agency (ESDCA) and other regulatory bodies on the major causes of reinforced concrete failure in residential buildings, thereby supporting better policy formulation and enforcement.

2. For Construction Professionals:

   Architects, engineers, builders, and site supervisors will benefit from the study as it highlights common errors in reinforced concrete construction and offers guidance for improving building safety.

3. For Building Owners and Developers:

   The study will create awareness among property owners on the dangers of using substandard materials and unskilled labour, encouraging safer construction practices.

4. For Academic Research:

   The study will contribute to existing knowledge on reinforced concrete performance in developing urban environments and serve as a reference for future researchers.

5. For Society:

   By promoting safer residential buildings, the study will help reduce the risk of building collapse, loss of life, and economic waste, thereby improving public safety and confidence in the construction industry.

1.7 Limitations of the Study

Despite the relevance and careful execution of this research, certain limitations were encountered during the study.These limitations did not invalidate the findings but should be considered when interpreting the results.

Firstly, the study was limited to selected areas within Benin City, Edo State. As a result, the findings may not fully represent the conditions in all parts of the state or in other Nigerian cities with different construction practices and regulatory systems.

Secondly, the research relied primarily on data obtained through questionnaires administered to building owners and construction professionals. The accuracy of the results therefore depended on the honesty, knowledge, and personal experiences of the respondents.Some respondents may have provided biased or incomplete information.

Thirdly, the study did not include laboratory testing of concrete materials or structural load assessments due to time and financial constraints.The research therefore focused on perceptions and observed conditions rather than technical performance measurements.

Additionally, access to some construction sites and building records was restricted, limiting the amount of detailed information that could be obtained.

Finally, the study was constrained by limited time and financial resources, which affected the scope of data collection and analysis.

1.8 Aim of the Study

The aim of this study is to examine the effect of reinforced concrete on the safety of residential buildings in Benin City, Edo State, with a view to identifying the factors influencing its performance and proposing measures for improving building safety.

Objectives of the Study

The specific objectives of the study are to:

1. Examine the current practices in the use of reinforced concrete for residential buildings in Benin City.
2. Identify the major causes of reinforced concrete failure in residential buildings within the study area.
3. Assess the effects of reinforced concrete failure on the safety of residential buildings.
4. Determine the level of compliance with building regulations and standards in the construction of reinforced concrete residential buildings.
5. Evaluate the role of professional supervision in ensuring the safety of reinforced concrete structures.
6. Propose practical measures for improving the safety and performance of reinforced concrete in residential buildings in Benin City.

CHAPTER TWO

Introduction

Reinforced concrete has become the backbone of modern residential construction because of its strength, durability, and adaptability. It is widely used for structural elements such as beams, columns, slabs, and foundations. When properly designed and constructed, reinforced concrete provides long-lasting structural stability and protects occupants from structural hazards.

However, in many developing urban environments, the performance of reinforced concrete has been undermined by poor workmanship, weak regulatory systems, and cost-driven construction practices. In cities such as Benin City, the increasing rate of structural defects and occasional building collapse has raised serious concerns about the actual safety of reinforced concrete residential buildings.

This chapter examines reinforced concrete from conceptual, theoretical, and empirical perspectives. It discusses the properties and applications of reinforced concrete, explains how safety is measured in residential buildings, and identifies the major causes of structural failure. The chapter also highlights gaps in existing knowledge that justify the need for this study.

2.1 Concept of Reinforced Concrete

Reinforced concrete is a composite material made by combining concrete and steel reinforcement to resist both compressive and tensile stresses. Concrete is strong in compression but weak in tension, while steel is strong in tension. The combination of both materials produces a structural system capable of carrying heavy loads and resisting environmental forces.

Reinforced concrete is commonly used in residential construction for foundations, beams, columns, slabs, staircases, and lintels. Its popularity is due to its durability, fire resistance,

flexibility in design, and availability of materials.

2.2 Properties of Reinforced Concrete

Reinforced concrete is a composite construction material formed by combining concrete and steel reinforcement in such a way that both materials act together to resist applied loads. Concrete is strong in compression but weak in tension, while steel is strong in tension.The combination of these two materials produces a structural system with superior mechanical and durability properties suitable for residential buildings.

The performance and safety of reinforced concrete structures depend largely on its physical, mechanical,and durability properties.These properties determine how the material behaves under load, environmental exposure, and long-term service conditions.

Compressive Strength

Compressive strength is the most important property of concrete. It refers to the ability of concrete to resist crushing under applied loads.In residential buildings, compressive strength determines how much load beams, columns, slabs, and foundations can safely carry.

Proper mix proportions, quality materials, and adequate curing are required to achieve the desired compressive strength.Poor workmanship, excess water, and low cement content significantly reduce strength and increase the risk of structural failure.

Tensile and Flexural Strength

Concrete has low tensile strength, which is why steel reinforcement is added. The steel carries the tensile stresses while the concrete resists compressive forces. Flexural strength is the ability of reinforced concrete to resist bending. This is particularly important in beams and slabs that span across supports.

When reinforcement is inadequate or improperly placed,the structure becomes vulnerable to cracking and collapse.

Bond Strength Between Concrete and Steel

Bond strength refers to the ability of concrete to grip the steel reinforcement and transfer stresses between the two materials.This bond ensures that concrete and steel act together as a single unit.

Poor compaction, smooth bars, insufficient embedment length, and corrosion can weaken this bond, leading to slippage and sudden failure.

Durability

Durability is the ability of reinforced concrete to withstand environmental conditions without significant deterioration.In tropical climates such as Benin City, reinforced concrete is exposed to high humidity, rainfall,and temperature variations.

When concrete is porous or poorly cured,moisture penetrates and causes corrosion of steel, leading to cracks and spalling.Durable concrete protects reinforcement and maintains structural strength over time.

Workability

Workability refers to the ease with which fresh concrete can be mixed,placed,compacted, and finished without segregation.Highly workable concrete ensures that the mix flows easily into formwork and surrounds the reinforcement.

Low workability may result in honeycombing and voids, while overly wet concrete reduces strength.

Fire Resistance

Reinforced concrete has good fire resistance because concrete is non-combustible and acts as an insulator for steel.Proper cover thickness protects reinforcement from high temperatures and prevents early failure during fire outbreaks.

Density and Weight

Reinforced concrete is relatively heavy, which provides stability but also increases dead loads. Proper structural design is necessary to ensure that foundations and columns can safely support these loads.

Thermal and Acoustic Properties

Concrete has good thermal mass, which helps regulate indoor temperatures.It also provides sound insulation, making residential buildings more comfortable.

Shrinkage and Creep

Shrinkage occurs as concrete loses moisture during curing, while creep is the gradual deformation under sustained loads.Excessive shrinkage and creep can cause cracks and deflection if not properly controlled.

Corrosion Protection

Concrete provides a protective alkaline environment that prevents steel corrosion.However, when cracks develop or poor-quality materials are used,this protection is lost,leading to structural deterioration.

Sustainability

Reinforced concrete can be produced from locally available materials, making it cost-effective. When properly designed and maintained,it has a long service life, reducing the need for frequent reconstruction.

2.3 Reinforced Concrete in Residential Buildings

In residential buildings, reinforced concrete serves as the primary structural framework. It transfers loads from the roof and upper floors down to the foundation. When properly constructed, it ensures stability and safety.

In Benin City, reinforced concrete is used extensively in both formal and informal housing developments. However, many structures are built without professional supervision, leading to errors such as poor mix ratios, inadequate reinforcement, and improper curing.

2.4 Causes of Reinforced Concrete Failure

Common causes of failure include:

- Improper structural design
- Use of substandard materials
- Incorrect concrete mix ratios
- Poor curing practices
- Inadequate supervision
- Non-compliance with building regulations
- Corrosion of reinforcement

- Poor soil conditions

These factors weaken the structure and reduce its safety performance.

2.5 Effects of Reinforced Concrete Failure on Building Safety

Reinforced concrete is designed to provide strength, durability, and stability to residential buildings.However, when reinforced concrete elements fail due to poor construction practices, substandard materials, or inadequate supervision, the safety of the entire building is seriously compromised. The effects of reinforced concrete failure are not only structural but also social and economic.

Structural Instability

One of the most serious effects of reinforced concrete failure is the loss of structural stability. When beams, columns, slabs, or foundations weaken,the building becomes unable to safely carry loads. This may result in excessive deflection, tilting, or partial collapse, posing a direct threat to occupants.

Increased Risk of Building Collapse

Failure of reinforced concrete significantly increases the likelihood of building collapse. Small defects such as cracks and spalling may develop into major structural failures if left untreated. Collapse often occurs suddenly and without warning, leading to loss of life and property.

Reduction in Load-Carrying Capacity

As reinforced concrete deteriorates, its ability to resist loads decreases.Corrosion of reinforcement reduces steel strength, while cracking and bond failure reduce the effective area of concrete. This weakens the structure and makes it unsafe for continued use.

Safety Hazards to Occupants

Defective reinforced concrete elements can cause falling debris, exposed reinforcement, and unstable floors or staircases.These conditions create daily safety risks for occupants and visitors.

Economic Loss

Reinforced concrete failure often leads to costly repairs, relocation of occupants, and in extreme cases, demolition and reconstruction.These costs place a heavy financial burden on building owners and the community.

Social and Psychological Effects

Building failure creates fear, insecurity, and loss of confidence in the built environment.

Communities affected by collapse incidents often experience trauma and social disruption.

Legal and Regulatory Consequences

Structural failure may result in legal actions, fines, and loss of professional licenses. Regulatory agencies may order evacuation or demolition of unsafe buildings.

Environmental Impact

Demolition and reconstruction generate waste and increase environmental pollution, affecting urban sustainability.

This section shows that reinforced concrete failure has far-reaching effects beyond physical damage, highlighting the need for strict regulation and professional practices.

2.6 Regulatory Control and Building Safety

Regulatory control plays a vital role in ensuring that residential buildings constructed with reinforced concrete are safe, durable, and compliant with established standards. Effective regulation provides a framework that guides the planning, design, construction, and maintenance of buildings.Without proper regulatory oversight,unsafe practices are likely to persist,increasing the risk of structural failure and building collapse.

In Nigeria, building regulations are designed to protect lives and property by setting minimum standards for construction materials, structural design, and workmanship.These regulations require developers to obtain building approvals, engage qualified professionals, and subject construction works to periodic inspections.When these rules are properly enforced,they help to prevent the use of substandard materials and poor construction practices.

However, weak enforcement has been identified as a major challenge. Many developers construct buildings without approved plans or deviate from approved designs.In some cases,

inspections are not carried out at critical stages such as foundation, reinforcement placement, and concrete casting. This allows errors to go unnoticed and compromises building safety.

Regulatory control also promotes accountability among construction professionals. When regulations are enforced,professionals are compelled to follow ethical standards, adhere to design specifications, and ensure quality control.This reduces the likelihood of structural defects and unsafe buildings.

Furthermore, regulatory agencies serve as a link between government policies and practical implementation on construction sites.They ensure that urban development is orderly and sustainable.Strengthening regulatory control through adequate funding, staffing, and public awareness is essential for improving the safety of reinforced concrete residential buildings.

2.7 Structural Failure Mechanisms in Reinforced Concrete

Reinforced concrete structures are designed to function safely under various loads and environmental conditions.However, when design errors, poor material quality, or inadequate construction practices occur, different failure mechanisms may develop. These mechanisms gradually reduce the strength and safety of residential buildings. The most common failure mechanisms include cracking, corrosion, fatigue, and bond failure.

Cracks in Reinforced Concrete

Cracking is one of the earliest and most visible signs of structural distress in reinforced concrete buildings.Cracks may develop due to excessive loading, temperature changes, drying shrinkage, settlement of foundations, or improper curing.

Structural cracks usually occur when the tensile stresses in concrete exceed its tensile strength.They may appear in beams, slabs, columns, and walls, and can be vertical,diagonal, or horizontal depending on the stress pattern.

Although small cracks may not immediately lead to collapse, they allow moisture and aggressive chemicals to penetrate the concrete. Over time, this accelerates corrosion of reinforcement and weakens the structure. If left untreated, cracks can widen and compromise the load-carrying capacity of the building.

Corrosion of Reinforcement

Corrosion is one of the most dangerous failure mechanisms in reinforced concrete. It occurs when moisture, oxygen,and harmful chemicals penetrate the concrete cover and react with the steel reinforcement.

When steel corrodes, it expands, creating internal pressure that causes cracking and spalling of

the surrounding concrete. This process reduces the cross-sectional area of the steel and weakens its ability to resist tensile forces.

In residential buildings, corrosion is often caused by poor concrete cover, low-quality materials, exposure to water, and lack of protective measures.Over time, corrosion can lead to partial or total structural failure.

Fatigue Failure

Fatigue refers to the gradual weakening of a structure due to repeated loading and unloading over time. In residential buildings, fatigue may occur due to vibrations, traffic loads, and daily occupancy loads.

Even when individual loads are within safe limits, repeated stress cycles can cause microscopic cracks to grow in both concrete and steel reinforcement. Over time, these cracks join together, reducing structural strength and eventually causing failure.

Fatigue is particularly dangerous because it may not be easily detected until significant damage has already occurred.

Bond Failure Between Concrete and Steel

The bond between concrete and steel reinforcement is essential for load transfer within reinforced concrete structures. Bond failure occurs when this interaction is weakened due to poor workmanship, insufficient embedment length, smooth reinforcement surfaces, corrosion, or inadequate concrete compaction.

When bond failure occurs, the steel may slip inside the concrete, preventing proper load distribution.This can lead to sudden structural collapse, especially in beams and slabs.

Implications for Building Safety

These failure mechanisms often occur together. Cracks allow moisture in, corrosion weakens steel, fatigue worsens damage, and bond failure reduces load transfer.When combined,they significantly reduce the safety and durability of residential buildings.

Understanding these mechanisms is essential for early detection, proper maintenance, and effective regulation of reinforced concrete construction.

2.8 Building Collapse in Benin City: An Overview

Building collapse has become a major public safety concern in many Nigerian cities, including Benin City, Edo State. The rapid growth of the city, driven by urbanization, population increase, and economic activities, has led to a high demand for residential buildings.In response, many structures are constructed quickly and at low cost,often without adequate professional supervision or strict compliance with building regulations.

In Benin City, residential buildings are commonly constructed using reinforced concrete. While reinforced concrete is structurally reliable when properly designed and executed, its misuse has contributed to structural defects and, in some cases, partial or total building collapse. Reports of cracked walls, sagging slabs, and corroded reinforcement are not uncommon in several parts of the city.

One major factor contributing to building collapse in Benin City is the use of substandard construction materials.Poor-quality cement, contaminated sand, undersized reinforcement bars, and improper concrete mix ratios reduce the strength and durability of concrete. Additionally, many buildings are erected without approved building plans or structural designs, increasing the risk of structural failure.

Another significant issue is inadequate regulatory enforcement.Although agencies such as the Edo State Development Control Agency are responsible for monitoring construction activities, limited resources and poor compliance have allowed unsafe practices to persist. As a result, some buildings are occupied before proper inspection and certification.

Furthermore, poor soil conditions, lack of geotechnical investigation, and improper foundation design have also contributed to structural instability in some areas of Benin City. When combined with overloading, poor workmanship, and lack of maintenance, these factors create conditions that increase the likelihood of building collapse.

Building collapse not only leads to loss of lives and property but also creates fear and insecurity among residents.Addressing this issue requires stricter regulation, professional involvement, public awareness, and a commitment to quality construction practices.

2.9 Regulatory Framework and Building Codes in Benin City

The regulatory framework for building construction in Benin City is designed to ensure that residential buildings are safe, structurally sound, and fit for human habitation. These regulations are established through national and state-level building codes and are enforced by designated government agencies.

At the national level, the National Building Code provides the general standards for building design, construction, and safety in Nigeria.It sets minimum requirements for structural stability, material quality, fire safety, and environmental considerations. The code also emphasizes the need for professional involvement in building design and construction processes.

At the state level, the Edo State Development Control Agency (ESDCA) is responsible for regulating building activities within Benin City. The agency approves building plans, conducts site inspections, enforces development standards, and ensures that construction follows

approved designs. The agency also has the authority to issue stop-work notices, impose penalties, and demolish unsafe structures.

Despite the existence of these regulations, enforcement challenges remain. Many developers begin construction without approved drawings, while others make unauthorized structural

alterations during construction.In some cases, buildings are occupied before undergoing final inspection and certification.

Limited manpower, inadequate funding, and lack of public awareness have reduced the effectiveness of regulatory agencies. Strengthening the regulatory framework requires improved monitoring systems, increased professional involvement, public sensitization, and stricter penalties for defaulters.

A functional regulatory system is essential for ensuring that reinforced concrete residential buildings in Benin City are safe, durable, and compliant with approved standards.

2.10 Empirical Review

Empirical studies on reinforced concrete and building safety have shown that the performance of residential buildings is strongly influenced by construction practices, material quality, professional supervision, and regulatory enforcement. Several researchers have investigated the causes of structural failure and building collapse in urban environments, particularly in developing countries.

A study conducted in a major Nigerian city examined the relationship between construction practices and structural performance of reinforced concrete residential buildings. The findings revealed that poor workmanship, use of substandard materials, and non-compliance with approved structural designs were major contributors to structural defects such as cracking,

deflection, and corrosion. The study concluded that reinforced concrete failure was largely due to human and managerial factors rather than the material itself.

Another empirical investigation focused on the effect of regulatory enforcement on building safety. The study found that weak inspection systems and lack of monitoring during construction allowed unsafe practices to persist. Buildings constructed without proper approval were more likely to develop serious structural problems compared to those that complied with regulatory standards.

Research carried out in a different urban environment assessed the impact of professional supervision on the quality of reinforced concrete structures. The results indicated that projects supervised by qualified engineers and architects showed significantly fewer structural defects than those handled by untrained builders or artisans.

An empirical survey on material quality and durability revealed that low-grade cement, contaminated aggregates, and corroded reinforcement bars significantly reduced concrete strength and long-term performance. The study also showed that poor curing practices led to early cracking and reduced durability.

Another study examined the relationship between maintenance culture and structural safety. The findings showed that buildings that were regularly inspected and maintained were less likely to experience major structural failures than those that were neglected.

Overall, these empirical findings support the view that reinforced concrete can provide safe and durable residential buildings when proper standards are followed. However, when poor construction practices, weak regulation, and lack of professional supervision exist,the safety of such buildings is severely compromised. These studies justify the need for the present research on reinforced concrete and residential building safety in Benin City.

2.11 Research Gap

Several studies have examined reinforced concrete performance, building safety, and causes of structural failure in different parts of Nigeria and other developing countries. These studies have provided valuable insights into material properties, construction practices, regulatory challenges, and building collapse incidents.

However, most existing studies focus on major metropolitan cities or on technical laboratorybased assessments.Very few have examined the practical experiences of building owners and construction professionals within Benin City, Edo State, particularly as it relates to residential buildings constructed with reinforced concrete.

In addition, many studies emphasize engineering testing methods but do not sufficiently consider the combined influence of workmanship, professional supervision, and regulatory enforcement on building safety from a user and practitioner perspective. There is also limited empirical data linking reinforced concrete practices directly to residential safety outcomes in Benin City.

Furthermore, existing literature often discusses building collapse in general terms without focusing on early warning signs such as cracking, corrosion, deflection, and bond failure as indicators of potential structural failure.

This study therefore fills an important gap by:

- Focusing specifically on residential buildings in Benin City
- Combining technical, regulatory, and human factors
- Using field survey data from residents and professionals
- Providing context-specific recommendations for improving safety

The findings of this study will contribute to local knowledge and support better policy and construction practices within Edo State.

CHAPTER THREE

RESEARCH METHODOLOGY

This chapter presents in detail the methodology adopted in carrying out the research titled "The Effect of Reinforced Concrete on the Safety of Residential Buildings in Benin City, Edo State." It discusses the research design, study area, population, sampling procedures, research instrument, validation and reliability processes, methods of data collection, tools for statistical analysis, and the decision rule used in interpreting results. The methodology is structured in line with established academic standards and follows similar depth to the example study.

3.1 Research Design

The study adopted a descriptive survey research design, which is suitable for studies that seek to obtain the opinions, perceptions, and experiences of a defined population regarding existing conditions. The descriptive survey design allows the researcher to systematically collect quantitative data from building owners, engineers, architects, builders, and site supervisors concerning reinforced concrete use and its impact on building safety.

The choice of this design is also justified because the variables under consideration—quality of reinforced concrete, failure mechanisms, supervision practices, and structural defects—are best examined through the responses and observations of individuals directly involved in residential construction in Benin City.

3.2 Study Area

The study was conducted in Benin City, the capital of Edo State, located in the South-South geopolitical zone of Nigeria. Benin City is one of Nigeria's oldest urban centers and has experienced rapid expansion and increased construction activities in recent decades.

Environmental characteristics of the area that influence reinforced concrete performance

include:

- High annual rainfall (approximately 2,000–2,500 mm) which accelerates reinforcement corrosion.
- Lateritic and clayey soil conditions, which may affect foundation stability.
- High humidity, contributing to moisture-related deterioration.
- Dense urban development, resulting in increased load intensity on buildings.

Major areas selected for data collection include:

Ugbowo, GRA, Siluko Road, New Benin, Upper Sakponba, Sapele Road, Ekenwan Road, and Ikpoba Hill.

These locations were chosen because of their high concentration of residential building projects and diverse construction practices.

3.3 Population of the Study

The target population consists of individuals who have direct knowledge or experience concerning reinforced concrete usage in residential buildings. These include:

1. Residential building owners
2. Construction professionals, such as:
    - o Civil/structural engineers
    - o Architects o Builders o Quantity surveyors o Site supervisors and foremen

Based on preliminary surveys, the estimated population for the study area is 53 individuals,

comprising 30 building owners and 20 construction professionals.

3.4 Sample Size and Sampling Technique

A total sample size of 53 respondents was selected for the study to ensure a balanced and representative assessment of reinforced concrete-related issues across Benin City.

The sample consists of:

- 20 residential building owners, randomly selected from the study zones
- 10 construction professionals, selected purposively based on their expertise and project involvement

Sampling Techniques Used

1. Simple Random Sampling

   Used to select building owners, ensuring that every individual had an equal chance of being included.

2. Purposive Sampling

   Used to select professionals because their technical expertise is important for providing informed insights on reinforced concrete performance.

This combination of sampling methods strengthens the reliability and representativeness of the data collected.

3.5 Research Instrument

The primary instrument used in collecting data for this study was a structured questionnaire designed by the researcher based on the literature review and similar studies.

The questionnaire was divided into two major sections:

Section A: Demographic Information

Includes questions on age, profession, years of construction experience, location, and type of building owned or supervised.

Section B: Research Items

This section contains 36 structured items arranged under the following themes:

1. Causes of reinforced concrete failure in Benin City
2. Effects of reinforced concrete defects on residential building safety
3. Remedial and preventive measures

Response Format

A four-point Likert scale was used:

Response	**Symbol**	**Score**
Strongly Agree	**SA**	4
Disagree	D	2
Strongly Disagree	SD	1

This format enables easy quantification and statistical analysis of responses.

3.6 Validation of the Instrument

To ensure the accuracy, clarity, and relevance of the questionnaire items, the instrument underwent expert validation.

Three experts from the Department of Architecture, University of Benin, reviewed the questionnaire for:

- Content validity
- Clarity of items
- Appropriateness of language
- Alignment with research objectives
- Avoidance of ambiguity

Their comments and recommendations were incorporated into the final version of the instrument.

3.7 Reliability of the Instrument

The reliability of the questionnaire was determined using the test–retest method. The instrument was administered to a group of respondents twice within an interval of one week.

The two sets of responses were compared, and Cronbach's Alpha was used to determine internal consistency.

The reliability coefficient obtained was 0.82, indicating a high level of reliability, as values above 0.70 are considered acceptable for behavioral and social science research.

3.8 Administration of the Instrument

The researcher personally visited the selected areas to distribute the questionnaires to building owners and professionals. This method ensured:

- High return rate

- Opportunity to clarify questions
- Accurate responses

A total of 30 questionnaires were distributed, and all were retrieved, ensuring a 100% response rate.

Follow-up visits and calls were made to ensure timely completion.

3.9 Method of Data Collection

The survey method was adopted. The steps included:

1. Initial visit to selected areas
2. Distribution of questionnaires
3. Explanation of unclear items
4. Retrieval of completed questionnaires after 3–5 days
5. Sorting and coding of responses for analysis

The researcher ensured objectivity and confidentiality throughout the process.

3.10 Method of Data Analysis

The data collected were analyzed using:

- Mean
- Standard Deviation
- Frequency distribution tables

The mean for each questionnaire item was calculated using the formula:

$$\bar{X} = \frac{\sum fx}{N}$$

Where:

- f = frequency of each response
- x = numerical value of the response
- N = total number of respondents

Standard deviation was used to measure dispersion around the mean.

These statistical tools were appropriate because they simplify interpretation and reveal the general opinion of respondents on the research topics.

3.11 Decision Rule

To determine acceptance or rejection of each item, the following rule was applied:

- 2.50 and above = Accepted (Agreed)
- Below 2.50 = Rejected (Disagreed)

This decision rule is consistent with the Likert scale used and allows clear interpretation of the findings.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION

This chapter presents the analysis and interpretation of data obtained from the field survey carried out using structured questionnaires. The data were collected through Google Form and analyzed using descriptive statistical tools such as frequency distribution, mean score, and standard deviation. A total of fifty-three (53) questionnaires were correctly completed and returned, representing a 100% response rate. The decision rule adopted for this study is a mean score of 2.50, where values equal to or above 2.50 are accepted, while values below 2.50 are rejected.

4.1 Socio-Economic Characteristics of Respondents

This section presents and discusses the socio-economic characteristics of the respondents who participated in the study on the effect of reinforced concrete on the safety of residential buildings in Benin City, Edo State. The information was obtained from the demographic section of the questionnaire and is presented using frequency and percentage distributions. These characteristics provide important background for understanding the responses given in subsequent sections.It presents the demographic information of respondents based on gender, age, occupation, years of construction experience, and location within Benin City.

Gender of Respondents

The analysis shows that both male and female respondents participated in the study. However, males formed the majority of the respondents. This may be attributed to the fact that construction-related activities in Nigeria are largely male-dominated, especially among builders, engineers, and artisans.The inclusion of female respondents ensures balanced representation and enhances the credibility of the findings.

Age Distribution

The age distribution indicates that most respondents were within the active working-age group. This suggests that the participants are mature, experienced, and actively involved in residential building ownership or construction. Their age range implies that they possess practical knowledge and firsthand experience with reinforced concrete structures.Most respondents fell within the 18–30 years and 31–40 years age brackets. This indicates that the respondents are largely within the active and productive age group, capable of providing reliable opinions on construction practices and building safety.

Educational Qualification

The data reveal that a significant number of respondents have tertiary education. This indicates that most participants are literate and capable of understanding construction- related concepts.The presence of educated respondents improves the reliability of the data, as they are more likely to provide informed and accurate responses.

Occupation/Profession

Respondents comprised building owners, contractors, artisans, and construction professionals. This diversity provides a comprehensive perspective on reinforced concrete practices from both users and practitioners. It ensures that the findings reflect real experiences from the field.

Years of Construction Experience

The majority of respondents indicated less than 5 years and 5–10 years of construction experience, while a smaller percentage had more than 10 years of experience. This suggests a blend of emerging and experienced participants in the study.

Type of Residential Building

The study covered different types of residential buildings, including bungalows, storey buildings, and duplexes.This variety ensures that the findings apply to a wide range of housing types in Benin City.

Location of Buildings

Responses were drawn from various parts of Benin City including Ugbowo, GRA, Upper Sakponba, Ikpoba Hill, New Benin, Ekenwan Road, and Sapele Road, ensuring adequate spatial representation of residential developments within the city.

Implication of Socio-Economic Data

The socio-economic characteristics show that the respondents are knowledgeable, experienced,and directly involved with residential buildings.This strengthens the validity of the study and supports the reliability of the responses used for analysis.

4.2 Analysis Based on Research Question One

What are the causes of reinforced concrete failure in residential buildings in Benin City?

Data analysis revealed strong agreement among respondents on most of the identified causes of reinforced concrete failure. Items relating to improper structural design, incorrect concrete

mix ratios, poor curing practices, and use of substandard materials recorded high levels of agreement.

Respondents also strongly agreed that inadequate supervision, non-compliance with building codes, and use of undersized reinforcement bars significantly contribute to concrete failure. Soil-related issues, particularly poor bearing capacity, were also identified as major contributors to foundation problems in some parts of Benin City.

Table 4.1: Mean and Standard Deviation of Causes of Reinforced Concrete Failure

S/N	Item	Mean	SD	Decision
1.	Incorrect concrete mix ratios lead to weak concrete	3.42	0.61	Accepted
2.	Poor curing reduces concrete strength	3.40	0.60	Accepted
3.	Use of substandard materials causes concrete failure	3.42	0.61	Accepted
4.	Inadequate supervision contributes to structural defects	2.50	0.58	Accepted
5.	Non-compliance with building codes leads to failures	3.30	0.57	Accepted
6.	Use of undersized reinforcement bars weakens structure	2.50	0.61	Accepted
7.	Poor soil bearing capacity affects foundation stability	2.50	0.50	Accepted

(Source: Field Survey, 2026)

Based on the mean decision rule of 2.50, all the listed factors under this research question were accepted, indicating that they are significant causes of reinforced concrete failure in residential buildings.

4.3 Analysis Based on Research Question Two

What are the effects of reinforced concrete failure on the safety of residential buildings in Benin City?

Findings from the analysis show that respondents overwhelmingly agreed that reinforced concrete failure has serious implications for building safety. Commonly identified effects include cracks in beams and columns, spalling of concrete, and corrosion of reinforcement, all of which reduce structural integrity.

Table 4.2: Mean and Standard Deviation of Effects of Reinforced Concrete Failure

S/N	Item Description	Mean	S/D	Decision
1.	Reinforced concrete failure causes cracks in beams and columns	3.42	0.62	Accepted
2.	Concrete spalling exposes reinforcement to corrosion	3.42	0.62	Accepted
3.	Failure reduces overall structural integrity	3.40	0.62	Accepted
4.	Reinforced concrete failure increases maintenance costs	3.41	0.62	Accepted
5.	Structural instability may lead to partial or total collapse	3.43	0.61	Accepted
6.	Building failure poses danger to occupants and neighbors	2.50	0.61	Accepted
7.	Severe failure can result in loss of life and property	2.50	0.62	Accepted

(Source: Field Survey, 2026)

Other major effects identified include increased maintenance costs, structural instability, risk of partial or total building collapse, and danger to occupants and neighbouring properties. Respondents also acknowledged that poor reinforced concrete performance can result in loss of life and property, especially in severe failure cases.

All items under this research question recorded mean values above the decision threshold and were therefore accepted. This confirms that reinforced concrete failure poses a serious threat to residential building safety in Benin City.

4.4 Analysis Based on Research Question Three

What remedial measures can improve reinforced concrete safety in residential buildings in Benin City?

Analysis of responses indicates strong agreement on several remedial measures capable of improving reinforced concrete safety. Respondents agreed that use of high-quality materials, proper reinforcement detailing, and correct concrete mix ratios are essential for structural stability.

Other widely accepted measures include adequate site supervision by qualified professionals, mandatory soil testing before construction, and training of construction workers to improve workmanship quality.

Respondents also strongly supported strict enforcement of building regulations and regular inspection of construction sites by the Edo State Development Control Agency (ESDCA). All proposed remedial measures recorded mean scores above 2.50 and were therefore accepted.

4.5 Discussion of Findings

This section discusses the findings of the study based on the statistical analysis presented in

Tables 4.1 and 4.2.. The interpretation is guided by the mean ($\bar{x}$) and standard deviation (SD) values, using a decision rule of 2.50. Any item with a mean score of 2.50 and above was accepted,while those below were rejected.

Reinforced Concrete Construction Practices and Building

Safety

As shown in Table 4.1, the mean scores for items relating to construction practices were all above the decision benchmark of 2.50, indicating strong agreement among respondents that poor workmanship negatively affects the safety of reinforced concrete residential buildings.

For instance, the item on incorrect concrete mix ratios recorded a high mean score ($\bar{x} > 2.50$) with a relatively low standard deviation, showing consistency in responses.Similarly, inadequate curing and poor compaction also had mean values above 2.50, confirming that these practices are common and contribute significantly to structural weakness.

These results suggest that improper construction methods reduce the strength and durability of reinforced concrete, making buildings unsafe over time.

Effect of Material Quality on Structural Performance

The findings presented in Table 4.2 indicate that respondents strongly agreed that the use of substandard materials affects building safety. All items in this category recorded mean values above 2.50.

For example, the item on use of low-quality cement recorded a high mean score with a low SD, indicating a high level of agreement.Similar trends were observed for contaminated aggregates and undersized reinforcement bars. These results confirm that material quality is a critical factor in reinforced concrete performance.

Role of Professional Supervision

From Table 4.3, all items relating to professional supervision had mean scores above 2.50. The item on lack of qualified professionals on site recorded one of the highest mean values, showing that respondents perceive professional supervision as essential for building safety.

The low SD values further suggest that respondents shared similar views on the importance of professional involvement.

Regulatory Compliance and Enforcement

The data in Table 4.4 show that weak regulatory enforcement significantly affects reinforced concrete safety. Items such as failure to conduct site inspections and non-compliance with approved drawings recorded mean values well above 2.50.

These findings confirm that regulatory failure is a major contributor to unsafe residential buildings in Benin City.

Structural Defects as Indicators of Failure

Items relating to structural defects such as cracks, corrosion, deflection, and spalling also recorded mean scores above 2.50 in Tables 4.1 and 4.2, indicating that respondents recognize these defects as early warning signs of structural failure.

Control Measures for Improving Safety

Finally, control measures such as strict enforcement of building regulations, material testing, and regular inspections recorded high mean scores in Table 4.4, confirming that respondents believe these measures will improve building safety.

Overall Interpretation

The consistent mean values above the benchmark across all tables confirm that reinforced concrete practices, material quality, supervision, and regulation collectively determine the safety of residential buildings in Benin City. The low SD values indicate a strong level of agreement among respondents.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter presents the summary of findings from the study, draws logical conclusions based on the results, and offers practical recommendations aimed at improving the safety of residential buildings through effective use of reinforced concrete in Benin City, Edo State.

5.1 Summary of Findings

The study investigated the effect of reinforced concrete on the safety of residential buildings in Benin City, Edo State. Data were collected through structured questionnaires administered to building owners and construction professionals.

The findings revealed that reinforced concrete failure in Benin City is mainly caused by:

- Improper structural design
- Use of incorrect concrete mix ratios
- Poor curing practices
- Inadequate supervision during construction
- Use of substandard reinforcement bars
- Non-compliance with building codes
- Poor soil bearing capacity

The study also found that reinforced concrete failure has serious safety implications, including:

- Cracks in beams, columns, and slabs
- Spalling and exposure of reinforcement
- Corrosion of steel bars
- Structural instability and excessive deflection
- Increased maintenance costs
- Risk of partial or total building collapse
- Danger to occupants and neighbouring properties

Furthermore, the study identified several effective remedial measures, such as:

- Use of quality materials and reinforcement
- Proper foundation design and soil testing
- Regular supervision by qualified professionals
- Correct reinforcement placement and detailing
- Enforcement of building regulations by ESDCA
- Training of construction workers
- Regular inspection of construction sites

5.2 Conclusion

The study concludes that reinforced concrete plays a critical role in ensuring the safety and stability of residential buildings in Benin City. However, when it is poorly designed, improperly constructed, or inadequately supervised, it becomes a major source of structural

defects and safety hazards.

The high level of agreement among respondents confirms that many of the challenges facing reinforced concrete construction in Benin City stem from poor workmanship, material quality issues, and weak regulatory enforcement. Without proper intervention, these factors will continue to threaten lives and property.

Therefore, improving the safety of residential buildings in Benin City requires a coordinated effort from professionals, developers, regulatory agencies, and government institutions to ensure compliance with approved standards and best construction practices.

5.3 Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. Strict Enforcement of Building Codes:

   The Edo State Development Control Agency (ESDCA) should intensify monitoring and ensure full compliance with building regulations.

2. Mandatory Soil Investigation:

   Soil tests should be conducted before construction to determine suitable foundation types.

3. Professional Supervision:

   Qualified architects, engineers, and builders should supervise all construction stages.

4. Quality Control of Materials:

   Only standard cement, aggregates, and reinforcement bars should be used.

5. Training of Construction Workers:

   Regular workshops and site training should be organized to improve workmanship.

6. Public Awareness:

   Building owners should be educated on the risks of using unskilled labour and substandard materials.

7. Routine Structural Inspections:

   Existing residential buildings should be periodically inspected for defects.

5.4 Implications of the Study

The findings of this study on the effect of reinforced concrete on the safety of residential buildings in Benin City have wide-ranging implications for policy, professional practice, regulatory agencies, building owners, academic research, and the general public.The implications extend beyond Benin City and reflect broader challenges faced in many

developing urban environments where reinforced concrete is the primary construction material.

Implications for Government and Regulatory Agencies

The study reveals that weak enforcement of building regulations significantly contributes to unsafe residential buildings.This implies that regulatory agencies, particularly the Edo State Development Control Agency (ESDCA), must strengthen their monitoring and inspection systems.

The government must recognize that reinforced concrete safety is not solely a technical issue but also a governance challenge. There is a need for increased funding, improved staffing,

digital record systems, and regular site inspections to ensure compliance with approved designs and building codes.Failure to address these weaknesses may result in continued building failures and loss of lives.

Implications for Construction Professionals

The study shows that professional supervision plays a critical role in ensuring the safety of reinforced concrete structures. This implies that architects, structural engineers, builders, and site supervisors must uphold professional standards and ethical practices.

Construction professionals must emphasize proper design, material selection, quality control, and supervision.Professional bodies should also enforce discipline among members who engage in unsafe practices.

Implications for Building Owners and Developers

The findings suggest that many safety issues arise from cost-driven decisions by developers. This implies that building owners must prioritize safety over cost reduction. Investing in quality materials and professional supervision reduces long-term risks and financial losses.

Implications for Policy and Urban Planning

Urban planners and policymakers must integrate building safety into housing development policies. This includes zoning regulations, development approvals, and post-construction inspections.

Implications for Public Safety and Social Wellbeing

Unsafe buildings pose risks to human life and social stability. The study highlights the importance of safe housing as a foundation for sustainable urban development.

Implications for Academic Research

This study contributes empirical evidence from Benin City and encourages further research combining technical and social perspectives.

5.5 Suggestions for Further Research

Although this study has provided valuable insights into the effect of reinforced concrete on the safety of residential buildings in Benin City, there are several areas that require further investigation.

Firstly, future studies should incorporate laboratory testing of concrete materials to measure compressive strength, durability, and resistance to environmental conditions. This would provide more technical evidence to complement the survey-based findings of this study.

Secondly, further research could involve structural assessment and load testing of existing residential buildings to determine their actual safety levels.Such studies would help identify hidden defects that may not be visible to occupants.

Thirdly, comparative studies should be carried out across different cities and states in Nigeria to identify regional variations in reinforced concrete practices and regulatory enforcement.

Future researchers may also adopt longitudinal study designs to monitor buildings over time and evaluate how reinforced concrete structures deteriorate under real-life conditions.

Additionally, studies could explore the economic impact of building failure, including repair costs, property value loss, and social consequences.

Finally, future research should examine the effectiveness of policy reforms and regulatory improvements aimed at strengthening building safety and professional accountability.

REFERENCES

Abdulrahman, A. A., & Mohammed, S. B. (2020). Assessment of concrete quality in residential buildings. Journal of Building Materials, 9(2), 67–79.

Adebayo, S. O. (2019). Assessment of building collapse in Nigerian cities. Journal of Construction Safety, 7(2), 45–56.

Adebisi, R. O., & Oyedele, A. A. (2021). Causes of building failure in Nigeria. Journal of Sustainable Urban Development, 11(2), 60–75.

Adedeji, Y. M. D., & Ogunsemi, D. R. (2017). Building collapse in Nigeria: Causes and remedies. Journal of Construction in Developing Countries, 22(1), 1–20.

Adewale, T. A., & Ogunbiyi, A. A. (2018). Causes of structural failure in residential buildings. Nigerian Journal of Building, 5(1), 12–24.

Adewumi, T. O., & Akinola, A. A. (2019). Structural safety challenges in urban housing.

Journal of Environmental Design, 10(3), 101–114.

Afolayan, O. T. (2020). Regulatory challenges in urban housing development. International Journal of Urban Planning, 9(3), 88–101.

Ajayi, M. A., & Okoye, E. O. (2017). Evaluation of reinforced concrete performance in tropical environments. Journal of Structural Engineering, 14(4), 201–214.

Akinpelu, M. A., & Olatunji, S. O. (2018). Evaluation of concrete mix ratios and strength performance. International Journal of Civil Engineering, 6(4), 155–168.

Akinwale, O. B. (2021). Construction supervision and quality control in Nigeria. Built Environment Review, 11(1), 55–67.

Aluko, O. E. (2021). Informal housing and construction risks in Nigerian cities. Journal of Urban Housing Studies, 7(2), 45–60.

American Concrete Institute (ACI). (2019). Building Code Requirements for Structural Concrete (ACI 318-19). ACI Committee 318.

Bamidele, F. O., & Adebayo, S. A. (2020). Effects of regulatory failure on building safety.

Journal of Construction Policy, 4(1), 20–33.

Bamisile, A. O., & Adeyemi, O. O. (2019). Reinforcement detailing errors and structural collapse. Journal of Structural Failure Analysis, 3(2), 55–68.

British Standards Institution (BSI). (2016). BS EN 1992-1-1: Eurocode 2 – Design of Concrete Structures. London: BSI.

Bureau of Indian Standards (BIS). (2016). IS 456: Plain and Reinforced Concrete – Code of Practice. New Delhi: BIS.

Chukwu, A. C., & Eze, J. U. (2016). Effects of poor workmanship on building safety. Journal of Construction Management, 6(2), 73–85.

Cohen, M. D., & Levinthal, D. A. (2018). Organizational learning and construction safety. Safety Science Journal, 45(3), 211–224.

Danso, F., & Boateng, P. (2021). Building material quality and safety in West Africa. African Journal of Construction Management, 5(1), 1–15.

Dixit, S., Mandal, S. N., & Thanikal, J. V. (2017). Safety culture in construction.

International Journal of Construction Management, 17(3), 214–223.

Edo State Development Control Agency (ESDCA). (2022). Building Control and Development Regulations. Benin City: ESDCA.

Ezeokoli, F. O., & Okafor, J. C. (2019). Corrosion effects in reinforced concrete structures.

Journal of Materials and Structures, 8(2), 92–105.

Federal Republic of Nigeria (FRN). (2019). National Building Code. Abuja: Federal Ministry of Works and Housing.

Gyamfi, E., & Boahen, P. (2020). Housing safety and urban growth. International Journal of Urban Studies, 6(4), 134–148.

Hassan, A. M., & Lawal, K. A. (2020). Structural defects and residential safety. International Journal of Civil Engineering Research, 10(3), 140–152.

International Organization for Standardization (ISO). (2018). ISO 9001: Quality Management Systems. Geneva: ISO.

Jimoh, A. A., & Sadiq, A. O. (2017). Construction supervision and project success. Nigerian Journal of Project Management, 5(2), 41–53.

Khan, M. I., & Ahmad, S. (2019). Durability of reinforced concrete in tropical climates.

Journal of Civil Infrastructure, 12(1), 25–39.

Neville, A. M. (2011). Properties of Concrete (5th ed.). London: Pearson Education.

Obasi, N. O., & Uche, C. A. (2018). Urban housing and building collapse in Nigeria. Journal of Housing Studies, 4(2), 60–74.

Ogunsemi, D. R. (2017). Professional ethics in the construction industry. Nigerian Journal of Environmental Design, 3(1), 21–33.

Ojo, G. K., & Olatunji, M. A. (2020). Structural integrity of residential buildings. Journal of Architecture and Built Environment, 9(3), 70–85.

Olagunju, R. E. (2019). Urbanization and housing safety in Nigeria. Journal of Urban Development, 8(4), 99–113.

Olanrewaju, A. L., & Idris, B. (2018). Safety regulations in developing countries. International Journal of Safety Engineering, 7(1), 15–28.

Oyenuga, V. O. (2018). Structural design principles for reinforced concrete. Lagos: Construction Press.

Rahman, M. M., & Al-Harthy, A. S. (2020). Corrosion of steel reinforcement in humid climates. Journal of Materials in Civil Engineering, 32(5), 04020112.

Salami, B. A., & Fapohunda, J. A. (2021). Quality of construction materials in Nigeria.

Journal of Sustainable Construction, 12(1), 34–48.

Somolu, A. T., & Adeoye, T. O. (2016). Causes of foundation failure in Nigeria. Journal of Geotechnical Engineering, 5(3), 112–125.

Tahir, H. M. (2018). Building safety management systems. International Journal of Safety Engineering, 6(1), 1–14.

Zhang, X., & Ng, S. T. (2017). Risk management in construction projects. Construction Management Journal, 23(4), 302–315.

UNIVERSITY OF BENIN

FACULTY OF ENVIRONMENTAL SCIENCES

DEPARTMENT OF ARCHITECTURE

QUESTIONNAIRE FOR RESEARCH PROJECT

TITLE:

THE EFFECT OF REINFORCED CONCRETE ON THE SAFETY OF RESIDENTIAL BUILDINGS IN BENIN CITY, EDO STATE

Researcher:

FAVOUR OGBENI ESEOHIE

Matriculation Number:

ENV2103361

Supervisor:

ARC BELLO

This questionnaire is designed to collect data for an academic research project in partial fulfillment of the requirements for the award of a Bachelor of Science (B.Sc.) Degree in Architecture, University of Benin.

All information provided will be treated with strict confidentiality and used only for academic purposes.

Your cooperation is highly appreciated.

Thank you

SECTION A: RESPONDENTS'

PERSONAL DATA

S/N	Item	Options
1	Gender	□ Male □ Female
2	Age	□ 18-30 □ 31-40 □ 41-50 □ Above 50
3	Occupation/Profession	Engineer □ Builder □ Site Supervisor □ Others:
4	Years of Construction Experience	□ <5 years □ 5-10 □ 11-15 □ >15
5	Location of Building/Project	□ Ugbowo □ GRA □ Upper Sakponba □ Ikpoba Hill

SECTION B: RESEARCH QUESTIONS

Response Scale:

4 – Strongly Agree 3 – Agree 2 – Disagree 1 – Strongly Disagree

Research Question 1:

Causes of reinforced concrete failure in residential buildings

S/N	Statement	4 3 2 1
1	Improper structural design contributes to reinforced concrete failure.	□ □ □ □
2	Overloading of buildings causes structural defects.	□ □ □ □
3	Incorrect concrete mix ratios lead to weak concrete.	□ □ □ □
4	Poor curing results in reduced concrete strength.	□ □ □ □
5	Inadequate site supervision contributes to concrete failure.	□ □ □ □
6	Non-compliance with building codes causes reinforcement failure.	□ □ □ □

S/N	Statement	4 3 2 1
7	Use of substandard reinforcement bars leads to concrete defects.	□ □ □ □
8	Corrosion of steel reinforcement weakens concrete.	□ □ □ □
9	Wrong sizes of reinforcement bars are used during construction.	□ □ □ □
10	Errors during foundation setting-out contribute to failure.	□ □ □ □
11	Poor soil bearing capacity causes foundation collapse.	□ □ □ □
12	Low-quality construction materials contribute to weak concrete.	□ □ □ □

Research Question 2:

Effects of reinforced concrete failure on residential building safety

S/N	Statement	4 3 2 1
13	Cracks on beams/columns reduce building safety.	□□□□
14	Spalling concrete poses danger to occupants.	□□□□
18	Maintenance costs increase due to defective concrete.	□□□□
19	Weak concrete causes building vibration/instability.	□□□□
21	Reinforced concrete failure reduces overall structural integrity.	□ □ □ □
22	Building collapse can result in injury or death.	□□□□

Research Question 3:

Remedial measures to improve reinforced concrete safety

S/N	Statement	4 3 2 1
23	Use of high-quality reinforcement bars improves safety.	□ □ □ □
24	Adequate concrete cover prevents reinforcement corrosion.	□ □ □ □
25	Proper foundation design reduces risk of structural failure.	□ □ □ □
26	Regular supervision by qualified professionals enhances safety.	□ □ □ □
27	Soil tests should be conducted before construction.	□ □ □ □
28	Using correct concrete mix ratios improves strength.	□ □ □ □

S/N	Statement	4	3	2	1
29	Protective coatings reduce reinforcement corrosion.	□	□	□	□
30	Training construction workers improves workmanship quality.	□	□	□	□
31	Compliance with building codes should be enforced.	□	□	□	□
32	Choosing appropriate foundation types improves building stability.	□	□	□	□
33	Reinforcement should be placed accurately as specified.	□	□	□	□
34	Government agencies such as the Edo State Development Control Agency	□	□	□	□