THE EFFECT OF REINFORCED CONCRETE ON SAFETY OF RESIDENTIAL BUILDINGS IN KATSINA STATE

BY

SABI'U MUSA
2017/3/68146TI

DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

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A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION, SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA NIGER STATE. IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF TECHNOLOGY (B.TECH) IN INDUSTRIAL AND TECHNOLOGY EDUCATION.

AUGUST, 2021

DECLARATION

I hereby declare that this project titled: “The Effect of Reinforced Concrete on Safety of Residential Buildings in Katsina State” is a collection of my original research work and it has not been presented for any other qualification anywhere. Information from other sources (published or unpublished) has been duly acknowledged.

SABI'U MUSA
2017/3/68146TI

_____
Signature & Date

CERTIFICATION

The project titled: “The Effect of Reinforced Concrete on Safety of Residential Buildings in Katsina State” by SABI'U MUSA, Matric number 2017/3/68146TI an undergraduate student of the Department meet the regulations governing the award of the degree of Bachelor of Technology in the Department of Industrial and Technology Education, School of Science and Technology Education, Federal University of Technology, Minna and it is approved for its contribution to scientific knowledge and literary presentation.

Dr. Ibrahim Dauda
Supervisor

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Signature & Date

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Head of Department

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Signature & Date

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External Supervisor

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Signature & Date

DEDICATION

I dedicate this project to my parents, Alhaji MUSA and Rahma as well as my wife Juwaira.

ACKNOWLEDGEMENTS

In the Name of Allah the beneficial the merciful the master of the day of judgement. I express my gratitude to Almighty Allah who made it possible toward the end of my Programme.

My thanks goes to my project supervisor Dr Ibrahim dauda for guidance and his sacrifice despite his tight schedules, in finding out time to guide me during the process of carrying out this reseach may Almighty Allah continues bless,guide, Protect, and Reward him in all his endeavors.

My Sincere thanks goes to my Parents Alhaji Musa and Rahma for their Sacrificed of everything Right From Primary school Up to this Level of Education and gaved all support needed in my study, in order to see that I lift to the stage which every parents want their child to reached. I also extended my thanks to the head of Department Dr I Y Umar, Project Coordinator Dr A. M. Hassan and all others Lecturers in the Department of Industrial and Technology Education, Federal University of Technology Minna, For impacted my life Positively, I Pray may Almighty Allah reward them all for their effort.

My sincere gratitude goes to my wife Juwaira of her Patient for been lonely during the programme, I also extended my thanks to my brothers, Friends and all others lover's for their prayers advises may Almighty Allah reward them all.

ABSTRACT

The study examined the effects of reinforced concrete on safety of residential buildings in Katsina State. A survey research designed was adopted to study. The study was concluded in Katsina state. The total Population for the study was thirty (30) respondents. Simple random sampling technique was used to randomly selected samples of 20 Building owners and 10 Engineers were conducted which. Questionnaires were used to collect data from the Engineers and Building owners. Three research questions were formulated to guide the study. A total of thirty six (36) Items questionnaires was developed by the researcher and was validated by three (3) expert from the Department of Industrial and technology Education, Federal University of Technology Minna and was used for data collection for the study. Data Collected were analyzed using statistical tools frequency count, mean, and t-test. The findings of the study revealed that, poor quality materials, substitute of reinforcements members, Inadequate supervision and faulty construction are the major causes of reinforced concrete failure in Katsina State. Based on the findings it was recommended that, adequate supervision should be adopted by Professionals to ensure that building are constructed accordingly and standard ratio of materials are being used. All buildings codes and regulations stipulated by the ministry of works and housing in the country are followed.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Residential building refers to a building in which sleeping accommodation is provided for normal residential purposes with cooking facilities or without cooking or dining facilities, and includes single or more family dwellings lodging or boarding houses, hostels, dormitories, apartment houses, flats and private garages of such building. Residential building means any public building which is used for sleeping or lodging purposes and includes any apartment house, rooming house, hotel, children's home, community−based residential facility or dormitory but does not include a hospital or nursing home (Itopa, 2009). Due to the aforementioned reasons, there is need for well erection of the residential structure with the materials that will be able for carrying both direct and indirect forces and the weather effects, not just for a recent but for the long period of time, hence the use of concrete is being recommended for residential buildings.

Residential building is defined as the building which provides more than half of its floor area for dwelling purposes. In other words, residential building provides sleeping accommodation with or without cooking or dining or both facilities (Anupoju, 2018). Residential Building is defined as the building which sleeping accommodation is provided for normal residential purposes. It is provided with or without cooking or dining or both facilities. Residential building includes one or two story or multi-family dwelling, lodging or rooming houses, dormitories, and apartment houses (Masterman, 2002)

Residential building can be describe as any structure constructed with all necessary basic facilities needs of a person to serves as a purpose of a person domicile to enjoy his comfortable life time without challenges of building needs in his community. Due to the aforementioned reasons, there is need for well construction of the residential structure, with the materials that will be capable of resisting both direct and indirect forces and the weathering effects, not just for a moment but for the long lasting time, hence the use of concrete is being adapted.

The residential building can be owned by an individual or co-operative association. Each resident or resident household has membership in the co-operative association. In non-equality co-operative members have occupancy right to a specific suite within the housing co-operative as outlined in their occupancy agreement or proprietary lease which is essentially a lease. In ownership co-operatives occupancy rights are transferred to the purchaser by way of the title transfer. The major function of the residential building is for the accommodation, both for private and the public users.

According to an economist that says human wants is unlimited and that there are limited resources with which wants can be satisfied. And this has lead to the absolute maximization and utilization of the said available resources to man which include fixed and liquid assets. This is one of the reasons why the conservation of land to safe place was adapted, which led to the construction of high rise building in town and mostly in well developed countries, for the fact that human being resides in, and other valuables are kept in these buildings; safely of the structure under all forces that may be applied must be guaranteed.

Recently, reinforced concrete has proven to be the cheapest retail that can effectively resist these forces like (wind force, direct force and indirect force) and other force that may be applied within the building, which can be found into various shape. The need for the forces stability of

this structure under these factors has brought a challenge to the engineer; hence the reinforced concrete design is concern.

Concrete is refers to the hard, strong construction materials that comprises of the mixture of sand, part of gravels, pebbles, broken stones, or dross in a motor or cement mixture. It is also known as the mass formed by the particles. Concrete could also be seen as the mixture of gravel, pebbles or broken stone with cement or withtar, used for side walks, roadways, foundations, and especially for submarine structure. Some many issues has lead to the construction of different types of building like bungalow and storey building in order to save money. (Griffith, 1995)

Lately reinforced concrete has thrust to be the low cost retail that can effectively resist these force like (wind force, direct force and indirect force) and other force that may be applied within the building, which can be found into various shape. The need for the forces stability of this structure under these factors has brought ac challenge to the engineers; hence the reinforced concrete design is concern.

Reinforced concrete is a combination of traditional mass concrete with reinforcements. This combination is made to resist the compressive strength of concrete and tensile strength of steel simultaneously. In reinforced concrete, the components work together to resist many different loading. Concrete resists compression and steel reinforcement resist tension forces. Reinforced concrete, as man economic building material, is very world known nowadays. It is widely used in many types building around the world, along with many advantages.

1.2 Statement of the Problem

The effects of reinforced concrete is one of the problem that avoid building to last longer in Katsina State. In this situation a structure can be design to serve its purposes and to last longer

for many years but sometimes it may not reach even half of the years that is expected to last for. Every engineer and the client need their structure to last longer but sometimes effect of reinforcement happen since at the construction stage. The question here is that why in Katsina State we are facing this problems? Especially we can pride to say that we have good suitable sub soil which the structure can rest on, so what purposes makes these problem happen? Are the problem of engineers? Or the materials that are using? Or the soil bearing capacity? I would study the reason why these problems happening in Katsina. Hence the research seeks to find out the effect of reinforced concrete on safety of residential building in Katsina State.

1.3 Research Questions

1.What is the causes of reinforced concrete failure in Katsina State.

2. What is the effect of reinforced concrete on safety of residential building in Katsina State.

3. What is the remedial measures to the effect of reinforced concrete in Katsina State.

1.4 Purpose of Study

The purpose is to find out the effect of reinforced concrete on safety of residential building in Katsina State, especially to identify the following;

1. fatigue of reinforced concrete on safety of residential building in Katsina.
2. The measures taking to overcome the effect in Katsina State.
3. Shear and bond failure of reinforced concrete on safety of residential in Katsina State.

1.5 Significant of the Study

The result of this project will be benefit to the construction industries, the society generally and professional bodies like Nigerian institute of builders. This will help in maximizing the qualities

of the structure which it may served the satisfaction to both client and engineers. By the way of good organizing of the members technically and coordination of the skills which will help in following the good codes and standard of building regulations. And it will eradicate the effect of reinforced concrete beams.

properly. It will also help in knowing the suitable ways of attaining the external and internal forces that the reinforcements can carry for proper structure stability.

1.6 Scope and Limitation of the Study

This is the ways to ensure that constructions are in safe with all standard required base on the using an appropriate design of the structure and the sound material to be used. The materials to be used in reinforced concrete structures may be lead to many damage and serious danger. But the scope will reduce the damages of the reinforced concrete due to over loading only., where the damages would be correct to some extent, level of performance in reasonable amount by some methods. The methods are by restore and by strengthen the reinforcements in concrete that will enhance the bonding techniques of the performance of reinforced concrete beams. The goals have planned to achieve by the experimental study on reinforced concrete beam elements. When rehabilitation have made the crack depth will be limited and the deflection would be arrest to restored the load bearing capacity of the beam damage with the aid of ferry cement which has a highly ductile materials with best arresting mechanism.

1.7 Limited State Design BS 8110

BS 8110 is British standard for the design and construction of reinforced and prestressed concrete structure. The British standard came into existing as a result of the discrepancies

between the materials behaviour by elastic analysis and the one occur in practices .Limit state design needs structure to satisfies two criteria principles, which are ;

1. Ultimate limit state

2. Serviceability limit state

Where the limit state is a different performance criteria that must be meet when the structure is subjected to load, which may eventually lead to protection for checking of cracks. While limit state design refers to a design processes uses in structural engineering. This is a condition of a structure above which it no longer met the relevant design criteria. The condition refers to a degree of loading action on a structure while the criteria is a structural fitness for use, durable or any other design requirements. A structure design by limit state design is proportion to sustain all action likely to occur during it's design life and to initially fit for use with an appropriate level of reliability for each limit state.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Effect of Reinforced concrete

Robert (1973). Concrete is one of the greatest inventions in the field of construction engineering. Nevertheless, concrete is known for its low tensile strength and as such has been limited in its utilization in its earlier years of invention. Today, the versatility of concrete have greatly increased. The addition of steel reinforcement to concrete mix compensates for the tensile weakness of concrete. The combined mix of both concrete and steel reinforcement is called reinforced concrete and is the second generation of concrete after the unreinforced mass concrete. Today, reinforced concrete is one of the most important materials used in the design of structural members worldwide. It is a composite material per excellence and it is widely used because of its constituents.

The two materials, concrete and reinforcing steel have complementary properties. Concrete is very good in compression, and thus possess a high compressive strength but very weak in tension. This is compensated with the introduction of steel reinforcements in the concrete mix, since steel has a comparatively high tensile strength. Steel notably will give way to buckling when subjected to lower compressive stresses, and as such both concrete and steel provide complementary support to each other, compensating for the weaknesses in the properties of each material. But the reinforcing steel material used in Nigeria is of low quality and is likely one of the factors contributing to frequent building collapses. Also every components of concrete including the aggregate size has an enormous effect on the quality such that the general compressive strength is very easily compromised. Around the world, there are possibly more

buildings constructed with wood than any other structural material. Many of these buildings are single-family residences, mostly bungalows or single storied buildings, but many larger apartment dwellings as well as business and industrial buildings also use wood framing. The use of timber in the construction industry has both economic and aesthetic appeal to the designer and the clients. The ability to construct timber structures with a minimal amount of specialized tools and equipment has put the timber structures in great advantage over other building materials. Moreover steel and reinforced-concrete design have received undue attention with respect to timber design as not sufficient attention is given to it in most Colleges and Universities, and as such timber design in Nigeria is unknown and very scarce in relation to steel and reinforced concrete designs. Timber is natural occurring and is largely utilized as non-major load bearing components in the construction and building industry in Nigeria since it can be found in large quantities in the tropical rain forest parts of Nigeria without having adequate knowledge of the properties. Timber is the most abundant natural occurring and renewable construction material available and has been used since pre historic times. Building elements formed from timber can be dated back to as far as 400,000 years ago making timber the oldest, most common and widely known building material globally, as it can be used for any form of structural element such as beams, columns, walls, roof trusses, floors etc.

Timber is characterized with tremendous insulating properties, light weight and aesthetic appeal. The extent of its usage by professionals in the Nigerian building industry is determined by the availability and perception of the material rather than the understanding of the material. With its known structural property, timber is still not used anywhere near its full potential in the building sector. This is due to the fact that many clients, architects, designers and engineers do not see wood as a building material that can rival concrete and steel. Because much technological

attention have not been paid to timber in Nigeria, durability, high structural reliability and serviceability are not generally associated with timber and as such adequate expertise, sufficient skill and knowledge are needed to fully value and realize the potential of timber as a building material in Nigeria. Concrete has been a prevalent construction material for most residential buildings in Nigeria and due to its escalating cost, provision of affordable residential apartments for the low income earner has been a difficult challenge in a developing countries like Nigeria. It is therefore of necessity to motivate stakeholders to alternative building materials that will not only rival concrete in cost, but also serve as a viable competitor in terms of sustainability, maintenance, constructability and client satisfaction in all necessary ramifications. With this in mind, timber has been selected as the alternative material to rival concrete in the Nigerian building sector and this research studies both concrete and timber materials from different points of view to give the Nigerian client, architect, engineer and builder the justification to choose one of these materials over the other in order to meet the needs of the society.

The response of a system to dynamic excitation depends on the interaction between the forcing function and the system. In practice, change in material properties due to aging, fatigue, or the experience of a hazard are major challenges to the designer. This chapter discusses the effect of material deterioration on the dynamic properties of reinforced concrete structures with consideration to strain compatibility. Aging and loss of steel bond to concrete have significant effects on dynamic response. Aging causes a drop in compressive strength, hence in axial and flexural capacity, altering column interaction diagrams, or beam-column joint strength. The effect of aging in standing structures can be measured through coring and lab tests, but loss of bond is harder to evaluate because its mechanism is interior to structural members. Causes of bond deterioration include poor concrete mix, placement, or protection from chemical agents.

However, well-designed mixes and placed materials may lose bond when subjected to an earthquake. Steel bond testing was performed and documented in literature, but there is still a gap in field data. A mathematical model is developed to illustrate the relationship between bond loss and concrete frame stiffness. Field assessment and remedial measures are discussed for structures that are suspected of, or diagnosed with, loss of bond. If the structure is salvageable, such effects call for specialized repairs as a preventive measure against subsequent events. But if loss of bond during an earthquake goes into an irreversible deformation range, the possibility of collapse increases or the structure becomes a candidate for disposal (Michel, 2015)

Resistance of reinforced concrete structural elements to hard projectile impact is a complex problem that has been extensively studied by mainly empirical means. Common design of reinforced concrete elements to resist hard projectile impact is carried out by calculating their proper thickness utilizing existing formulas. The reinforced concrete element resistance to the impact is expressed by its concrete compressive strength. The current design formulas do not allow the design of high- strength concrete barriers, as they are limited to normal strength concrete, nor do they include other parameters that may affect the barrier's resistance. These other parameters include the aggregate type and size and the reinforcement ratio, as well as the reinforcing bar diameter and spacing, etc. Some of these parameters and their effect on the barrier's performance were examined in a laboratory experimental study.

The specimens in this study were made of normal and high-strength concrete (NSC and HSC, respectively), polymer concrete (PC), and concrete with a front face layer of basalt aggregates. The reinforcement consisted of steel mesh near the plate's rear faces and included smooth and deformed steel reinforcing bars, small diameter (0.5-mm) steel wires, and woven and nonwoven steel meshes. A limited number of specimens included hooked steel fibers. Different

reinforcement ratios and reinforcement spacings have been examined. At the end of each test, measurements of the rear face damage (crater size and volume) were documented, and the specimen's perforation resistance (and its dependence on projectile velocity) was evaluated. These results indicate the advantage of HSC and PC in enhancing perforation resistance, and the effect of the different concrete and reinforcement properties on the rear face damage level of the perforated barrier (David, 1999).

Corrosion of steel in reinforced concrete is one of the main issues among construction stakeholders. The main consequences of steel corrosion include loss of cross section of steel area, generation of expansive pressure which caused cracking of concrete, spalling and delaminating of the concrete cover. Thus, it reduces the bond strength between the steel reinforcing bar and concrete, and deteriorating the strength of the structure. The objective of this study is to investigate the structural effects of corrosion damage on the performance of reinforced concrete beam. A series of corroded reinforced concrete beam with a corrosion rate of 0%, 20% and 40% of rebar corrosion is used in parametric study to assess the influence of different level of corrosion rate to the structural performance. As a result, the used of interface element in the finite element modelling predicted the worst case of corrosion analysis since cracks is induced and generate at this surface.

On the other hand, a positive linear relationship was sketched between the increase of expansive pressure and the corrosion rate. Meanwhile, the gradient of the graph is decreased with the increase of steel bar diameter. Furthermore, the analysis shows that there is a significant effect on the load bearing capacity of the structure where the higher corrosion rate generates a higher stress concentration at the mid span of the beam. This study could predict the residual strength of reinforced concrete beam under the corrosion using the finite element analysis. The experimental

validation is needed on the next stage to investigate the quantitative relation between the corrosion rate and its influence on the mechanical properties (Hamidun, 2018).

According to Isa yuksel (2021). The aim of this paper is to present the different effects of reinforcement corrosion on reinforced concrete buildings. A hypothetical five-storey reinforced concrete building frame was designed for this purpose. Three different modes of action were selected – corrosion on the ground floor alone, corrosion on one facade and corrosion on two neighbouring facades of the building. For each mode of action, different corrosion scenarios were selected, which were arranged in terms of mass loss from zero to 15% in ascending order an in 3% steps. Pushover analyses of the building were performed for each corrosion scenario and the results of these analyses were used to perform a structural performance evaluation conforming to Eurocode 8. A general decrease in structural performance was determined with significant changes in the dynamic characteristics of the building. The level of decrease depended on the corrosion scenarios and the modes of action. Important structural behaviour alterations and premature damage occurrences were found, in addition to a reduction in the displacement ductility of the building. For severe-corrosion scenarios, reductions in moment and curvature capacities could shift the structural behaviour of the load-bearing members from ductile to non-ductile.

2.2 Basis of Fatigue

Fatigue failures inrelation to structures are well-known technical problem. Since in the 19th century several fatigue failures had recognized and the investigation was carried out. Research on fatigue was done by August Wohler(2003). He finds out that a single load application, may down the static strength of a structure, which did not do any damage to the structure. But if the same load was repeated many times it could induce a complete failure. In the 19th century

fatigue was thought to be a mysterious phenomenon in the material because fatigue damage could not be seen. Failure apparently occurred without any previous warning. In the 20th century, we have learned that repeated load applications can start a fatigue mechanism in the material leading to nucleation of a small crack, then the crack growth, and ultimately to complete failure. The history of engineering structures until now has been marked by difference fatigue failures of machinery, moving vehicles, welded structures, air crafts. From time to time such failures have caused catastrophic accidents, such as an explosion of a pressure vessel, a collapse of a bridge, or another complete failure of a large structure most fatigue problems did not reach the headlines of the newspapers but the economic impact of non-catastrophic fatigue failures has been notables. Fatigue of structures is now generally recognized as a significant problem (Shutz,1996).

Fatigue is a failure mechanism that involves the cracking of materials and structural components due to cyclic (subjected) stress. While applied stresses may be tensile, compressive or torsional, crack initiation and propagation are due to the tensile component. One of the intriguing factors about fatigue development is that fatigue cracks can be initiated and propagated at stresses well below the yield strength of the material of construction (these stresses are usually thought to be related to elastic deformation, not plastic deformation.Callister Jr,(2014).

2.3 Classification of Fatigue in Structural Component

Fatigue in Concrete Concerns Security and Stability of Flyovers concern about fatigue in concrete is increase in important concrete structures such as flyovers. In flyovers and pacify structures when loading in the form of repeated cycles occurs for a large number of concrete undergoes phenomena of fatigue. Busy flyovers in congested urban areas when display cracks in riding surface witness falling of chunks of the concrete phenomena creates panic in users.

Basically Fatigue and failure of concrete is a rare phenomenon. It is not a usual mode of failure of concrete structures. This work deals with important parameters of fatigue strength of component materials under cyclic loading and codal provisions illustration of a bridge and or flyover affected by fatigue are suitably dealt with Hobbacher AF,(2016).

Fatigue is typically a governing limit state for marine structures. Welded joints are the weakest links in that respect. Physics involve several resistance dimensions, a range of scales and distinct contributions in different stages of the accumulative damage process. Fatigue damage criteria developed over time have been classified with respect to type of information, geometry, parameter and process zone including plane and life region annotations. The criteria are evaluated regarding model in capabilities, showing up to what extent governing physics are taken into account. Modelling developments and trends towards complete strength, multi-scale and total life criteria have been identified. Incorporating all four interacting fatigue resistance dimensions: material, geometry, loading & response and environment translates into a complete strength fatigue damage criterion. Considering macro, meso and micro-scale information provides a multi-scale fatigue damage criterion. Correlation of crack initiation and growth requires matching intact and cracked geometry parameters, revealing a total life fatigue damage criterion Adepipe O,(2015).

2.4 Effect of Materials Properties

Difference researchers have studied the effect of such factors as cement content, water/cement ratio, curing conditions, age at loading, amount of entrained air and type of aggregate. Except for the latter factor, there is general agreement that these factors affect fatigue strength in a proportionate manner to the static strength of the concrete, as directly given by the previous expressions for fatigue strength. Furthermore, the fatigue strength of mortar is also comparable

to concrete when expressed as a function of compressive strength. In practice, structural concrete members are normally subjected to randomly varying loads with periods of rest. In laboratory tests on concrete specimens subjected to varying flexural stresses, rest periods were beneficially increasing the fatigue strength at 107 cycles, expressed as fmax/fc by about 10%. Low amplitude cyclic loading interspersed in higher amplitude loading also has a beneficial effect.Girolami, L(2012).

In this study, we investigate the influence of material properties on the mobility of granular flow through granular column collapse experiments using the Smooth Particle Hydrodynamics method and a continuum constitutive model capable of describing the nonlinear responses of granular materials. Numerical simulations are systematically compared with available experimental data and well-established empirical laws to validate the capability of this numerical approach for simulating the dynamics of granular flow. Based on this validation, a series of numerical experiments is conducted to investigate the effects of strength properties, density and stiffness properties on the run-out distance and energy evolution of granular flows, which were unclear or contradictorily reported in previous experimental studies. We found that as the friction angle increases, the material is less mobilised and hence the run-out distance is shorter. In addition, a denser state facilitates its mobilisation associated with a greater volume expansion during the collapse. The density and stiffness properties of granular materials, nonetheless, have negligible effects on the deposit morphology and run-out distance of granular flow. To further quantify the effects of material properties, the run-out scaling law of granular flow, which describes the relationship between the run-out distance and the initial geometry of granular columns, is analysed and shown to be significantly influenced by the friction and dilation of the materials (Nhu & Ngugen, 2020).

2.5 Fatigue of Concrete

Fatigue of concrete refers to the phenomenon of rupture under repeated loadings, each of which is smaller than a single static load that exceeds the strength of the material. Fatigue is exhibited when a material fails under stress applied by direct tension or compression, torsion, bending, or a combination of these actions. Concrete fatigue is due to long term low amplitude force or stress, with many cycles occurring over the life of the structure that leads to concrete fracture. This can happen in tension, shear, and Fatigue on failure zones. Concrete fatigue is addressed by one internationally accepted code:

2.6 Fatigue of Reinforcement

The main parameters associated with fatigue of reinforcement are reviewed with particular attention given to conditions related to highway bridges. Fatigue testing can be either axial in air or by bending of reinforced concrete beams. Eventually is experimentally less convenient but simulates more closely the service environment. Endurances can be influenced by type of steel, geometry and size of the bars, nature of the loading cycle, welding and presence of corrosion. The relative behavior of butt welded joints is considered and it is shown that the reduction in fatigue strength commonly attributed to flaws and to the stress concentrations associated with welds does not always occur for bending fatigue of reinforced concrete beams.

2.7 Fatigue OF Reinforced Concrete

Fatigue is a progressive brittle failure of a structural element under repeated cyclic or fluctuating loads which may reduce the life of structures. This paper gives a complete information about the fatigue behavior of reinforced concrete beam with mineral admixtures. The fatigue behavior of reinforced concrete beam depends on the size of the beams, support conditions, number of

fatigue cycles, loading limits, frequency and amplitude of loading applied. The influence of mineral admixtures in fatigue life of structure with respect to the relationship between the number of fatigue cycles and the stress developed in the beam due to fatigue loading.

2.8 Fatigue Failure in Reinforced Concrete Structure

Due to the fact that structures are becoming slenderer the traffic volume is increasing, the axel loads are larger, and the traffic speed limits are higher the interest of fatigue in concrete structures has increased during the last few years. Concrete fatigue is mainly a problem of offshore structures, railway sleepers and bridges because these types of structures are often exposed to repeated loading. This project is focused on reinforced concrete bridge deck. With increased axel loads the condition for our bridges have changed and many existing bridges are nowadays required to carry larger loads than what they were originally designed to carry.

2.9 Shear and Bond Failure

The effect of shear, torsion and bond are in many a cases quite closely related. For example the development of inclined cracking will increase in the absence of adequate shear reinforcementthat lead to increased stress in the flexural steel which may affect the bond strength. On the other hand slip of reinforcement in an adequately reinforced member may induce a shear failure particularly in prestressed beams. A difference of investigations of the shear fatigue behavior of both non-prestressed and pre-stressed beams have been find out. It has been observed that the shear fatigue strength of non-prestressed beams without web reinforcement was approximately 60% of their static shear strength. Fractures of stirrup reinforcement have been reported in fatigue tests on both non-prestressed and prestressed beams.

Designers should recognize that inclined cracking will occur at lower stress under cyclic loading than under static loading. This of course is generally regarded as the limit state in a beam without web reinforcement. The number of cycles will be related to the tensile fatigue strength of the concrete. Non-prestressed beams without web reinforcement will therefore have lower shear fatigue strength than prestressed beams. For design, the shear fatigue strength should probably not be taken greater than one-half of the static design shear strength. Pre-stressing contributes to the shear strength of a beam without web reinforcement by imposing a compressive stress in regions where inclined cracks may originate. The shear fatigue strength of these members may be estimated by reducing portion of the contribution which is dependent on the tension in the concrete to one-half of the usual value.

Torsion

Information on the torsion fatigue resistance of concrete members is limited. A recent research testified that the fatigue properties of plain and prestressed concrete under torsion were about the same as those of concrete under compression or flexure. Unintended or unrecognized structural interactions may induce torsion in slabs and beams. These torsion forces may be surprisingly large in cracked members, where the resistance is dependent on the tensile strength of the concrete. Under cyclic loading the torsion may cause cracking that will subsequently contribute to the deterioration of the member. In torsion, as in shear, it was found that the primary stresses are redistributed to the bars after cracking, and that the torsion stiffness is reduced. However, failures occurred due to fatigue of the concrete rather than the steel.

Bond

Research review on bond fatigue leads to the conclusion that in the absence of cracks in the anchorage zone, the bond strength for 1 million cycles will be about 60% of the static strength. When cracking occurs, the bond fatigue strength will be strongly dependent on shear effects.

Two areas are of particular importance for bond fatigue - railroad ties and pre-stressed beams with blanketed strand. The fatigue resistance for these cases is relatively to the static resistance, sometimes very low, about 40-60%; And therefore it is very important to consider this in design. The shear fatigue failure is highly dependent if the beam is provided with shear reinforcement or not. In total the fatigue shear resistance is higher with shear reinforcement than without, but it is dependent on the different types of fatigue loading.

Beams without shear reinforcement have two different modes in which shear fatigue failure can occur. Either the beam can fail when a diagonal crack has propagated across the entire section, or by crushing in the concrete in the compressive zone above the shear crack, Figure 2.1b. When the beam is provided with shear reinforcement it can fail in four different ways. They are fatigue in the shear reinforcement, fatigue in the longitudinal reinforcement where it is crossed by a shear crack, fatigue in the compressed concrete above the shear crack and fatigue in the compressed concrete in the web, see Figure 2.1a

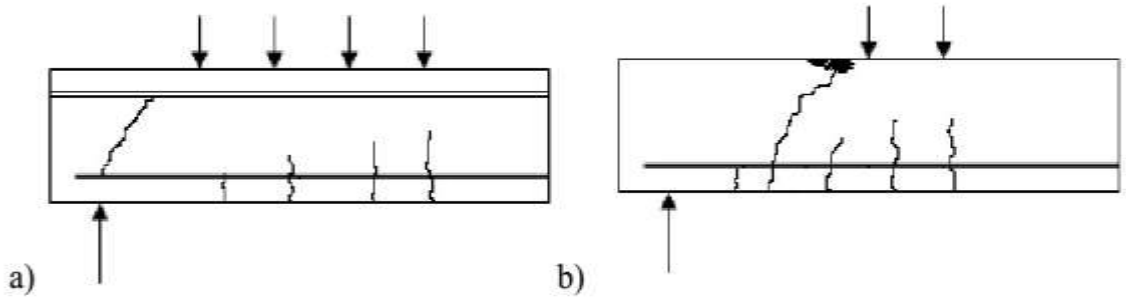

Figure 2.1 Possible shear fatigue failure modes in beams without stir ups

:a) excessive development of diagonal cracking.

b) fatigue of concrete in compression above the shear crack.

2.10 Structural Reability

Corrosion of steel bars in concrete is a major problem reducing concrete structure life time that must be considered in the design of structures. Many parameters involved in corrosion propagation contain different uncertainties; therefore, probabilistic analysis should be performed. In this research proposed a reliability analysis method for reinforced concrete frames subjected to simultaneous corrosion and static loads. It consists of the analysis of an arbitrary 2 dimensional frame at each time step to take into consideration, the steel bars mass loss due to corrosion.

2.11 Limit State Principles

All comprehensive design specification is written to establish an acceptable level of safety. There are many methods of attempting to provide safety and the method inherent in many modern bridge design specifications, including the specification is probability based on reliability analysis. The method for treating safety issues in modern specifications is the establishment of "limit state" defined groups of events or circumstances that could cause a structure to be unserviceable for its original intent.

The LRFD and Euro code specifications are written in a probability-based limit state format requiring examination of some, or all of the limit states defined below for each design component of a bridge.

2.11.1 Ultimate Limit States (ULS): are mostly related to the loss of load carrying capacity. When an Ultimate Limit State is exceeded, a catastrophic failure of the structure occurs, such as collapse or loss of operability. Ultimate limit state can be the formation of a plastic hinge, crushing of concrete, buckling or loss of stability. These are the limit state considered in a reliability-based design code.

2.11.2 The serviceability limit state: deals with restrictions on stress, deformation, and crack width under regular service conditions. These provisions are intended to ensure the bridge performance accept during its design life.

2.11.3 The fatigue and fracture limit state: deals with restrictions on stress range excursions. These provisions are intended to limit crack growth under repetitive loads to avoid fracture during the design life of the bridge.

2.11.4 The strength limit state: this intended to makesure that the strength and stability for both local and global are provided to resist the statistically significant load combinations that a bridge will experience in its design lifetime. Extensive distress and structural damage may occur under strength limit state conditions but overall structural integrity is expected to be maintained.

2.11.5 The extreme event limit state: is intended to makesure that the structural survival of a bridge during a major earth quake or when collided by a vessel vehicle or ice flow where the foundation is subject to scour that would accompany a flood of extreme recurrence usually considered to be 500years. These provisions deals with circumstances which are considered to be specific occurrences for whose return period that is significantly greater than the design life of the bridge. The joint probability of these events is extremely low, and therefore they are

specified to be applied separately. Under these extreme conditions the structure is expected to undergo considerable inelastic deformation by which locked-in force effects due to temperature effects, creep, shrinkage, and settlement will be relieved.

2.12 Failure Events and Basic Random Variables

In reliability analysis of technical systems and components the main problem is to evaluate the probability of failure corresponding to a specified reference period. However, other non-failure states of the considered component or system may be of interest, such as excessive damage, unavailability. In general any state which may be associated with consequences in terms of costs, loss of lives and impact to the environment are of interest. In the following I will not differentiate between these different types of states but for simplicity refer to all of them as being failure events, however, putting in mind that also non-failure states may be considered in the same situation. It is convenient to describe failure events in terms of functional relations which if they are fulfilled that, the considered event will occur. A failure event may be described by a functional relation between, the limit state function g(x) in the following way:

$F = \{g(x) \leq 0\}$(2.8) Where the components of the vector x are realizations of the so-called basic random variables. X representing all the relevant uncertainties influencing the probability of failure. In Equation (2.8) the failure event F is simply defined as the set of realization of the function $g(x)$, which is zero or negative. As already mentioned, other events other than failure may be of interest in reliability analysis and example. in reliability updating problems also events of the following form are

Highly relevant: $\mathbf{I=\{}\boldsymbol{h}\mathbf{(}\boldsymbol{x}\mathbf{)=0\}(2.9)}$

Having defined the failure event the probability of failure may be determined by the following integral: (2.10)

Where $f_{\mathbf{x}}(x)$ is the joint probability density function of the random variables $\boldsymbol{X}$. This integral is, however, non-trivial to solve and numerical approximations are expedient. The acceptability criteria are most based on engineering judgment (arbitrary decision). For instance, consider a beam that fails if the moment due to the loads exceeds the moment carrying capacity. Then the corresponding limit state function can be written as follows:

$$g = g(x_1, x_2, x_3, \ldots\ldots, x_n) = R - Q \tag{2.11}$$

where R represents the resistance (moment carrying capacity), Q represents the load effect (total moment applied) and x_i represent the random variables of load and resistance such as dead load, live load, length, depth. The limit state function represents the boundary beyond which the structure is no longer functions. The probability of failure, P_f, is equal to the probability that the undesired performance will occur. Mathematically, this can be expressed in terms of the limit state function as:

$$P_f = P(R\text{-}Q < 0) = P(g < 0) \tag{2.12}$$

If both R and Q are continuous random variables, then each has a probability density function (PDF) such as shown in Figure 2.3. Furthermore, R-Q is also a random variable with its own probability density function. This is also shown in Figure 2.3. The probability of failure corresponds to the shaded area in Figure 2.3. Specifically the probability of failure is: (2.13)

Where $F_R(x)$ is the CDF of resistance R and $f_Q(x)$ is the probability density function of the load Q.

Because there are often multiple random variables that determine R and Q, the evaluation of equation (2.14) cannot be calculated as this would require complex and time consuming numerical techniques. Therefore there is often insufficient data to fully define the basic variables needed for this numerical procedure in order to obtain acceptable accuracy.

Therefore, it is convenient to measure structural safety in terms of a reliability index.

2.13 Reliability Index

A formal definition of the reliability index is that it represents the shortest distance from the origin of standard space (reduced variable space) to the limit state line $g(Z_R, Z_Q) = 0$, in the reduced variables space, as shown in Figure 2.4, where Z_R is the reduced random variable for resistance and Z_Q is the reduced variable for load. The reduced form of a random variable, *X*, is given by: (2.14).

There are various procedures available for calculation of β. These procedures vary with regard to accuracy and required input data.

The reliability index, β, is related to the probability of failure, P_f, by:

$$\beta = -\Phi^{-1}(P_f) \qquad (2.15)$$

where Φ^{-1} is the inverse standard normal distribution function.

To overcome the invariance problem of the FOSM method, Hasofer and Lind (1974) proposed a modified reliability index formulation, the Advanced First Order Second Moment reliability moment (AFSOM). In this method, the limit state function is evaluated at a point known as the "design point" instead of the mean values. The design point is located on failure surface, g = 0, and since this point is a priori unknown, an iteration technique must be used to solve for the

reliability index. As it was done in the FOSM method, the Hasofer-Lind method consists by first transforming each of the random variables into standard normal space. As before, the Hasofer-Lind reliability index is defined as the shortest distance from the origin of the reduced variable space to the limit state function or failure surface g =0 as presented in Figure (2.3)

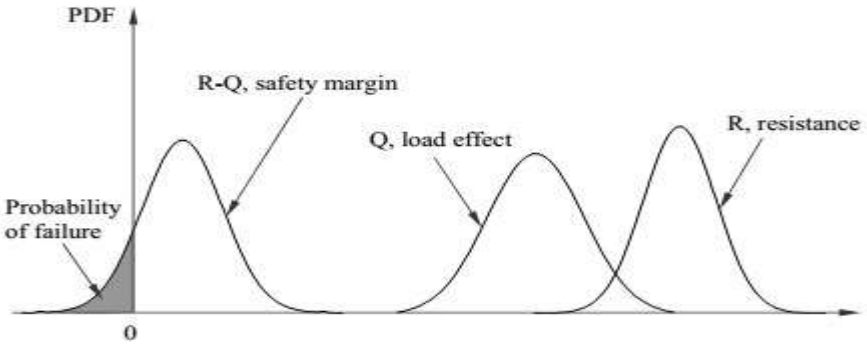

Figure 2.2: Probability Density Function of load, resistance, and safety margin(David, 2010)

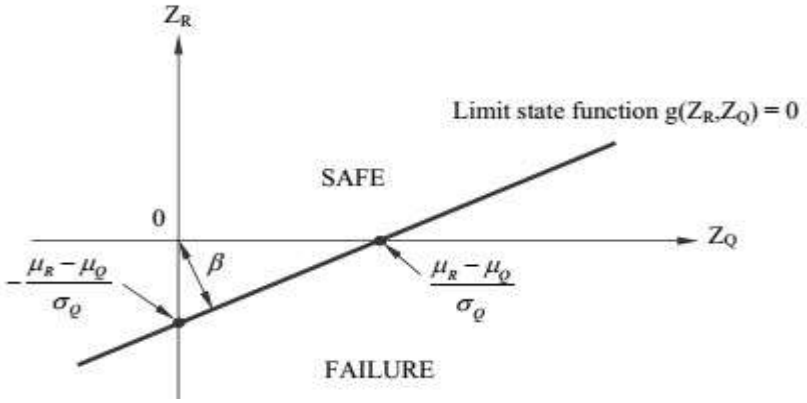

Figure 2.3. Reliability index as shortest distance to origin (David, 2010)

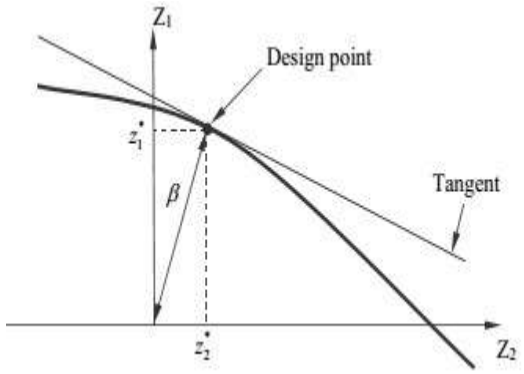

Figure 2.4: Hasofer-Lind reliability index(David, 2010)

2.14 Empirical Studies

The involvement and input of professionals in the building industry from the design to the construction of the buildings; including the supervision at every stage is vital if standards are to be maintained. As find out by Rotimi (2012) the absence of such results into a project failure and poor functional performance; as buildings that meet the desired performance requirements that add value to national asset stock. However, in some cases, these standards are not comply to and services of non qualified professionals are employed thereby constituting reinforcements effects. According to Tomori (2010) It was been noted that every aspect of building planning process from the architectural design through to the mechanical, electrical, structural engineering, construction and maintenance require proper supervision and quality input by professionals and stakeholders in the construction industry. Nevertheless, in some cases, building projects are not executed in accordance with the set down rules and consequently results effects to the reinforcements.

Uche (2015). Incomplete project definition at schematic design phase create difficulty in obtaining tangible cost estimate. This research work attempted to establish a time saving quantification model of architectural and structural design relationship for faster estimation of cost of concrete in column bases of residential duplexes. It collated substructure cost predictive variables of 30 residential duplexes from participating construction and cost professionals and crafted and validated from analyzed statistics. 5 predictive models for quantifying cost of substructure concrete. It established among others that volume of concrete in column base cannot be estimated from linear regression model based on block work girth alone, but from a multiple regression of floor area and block work girth. It recommended the evolved model as adequate and fit for the forecast of volume and cost of concrete at column bases at sketch design stage when there is no detailed plan.

Yiannis (2012) Determining the budget is a fundamental process for the development of infrastructure projects for three main reasons: 1) it establishes a cost baseline that integrates project scope and quality requirements along with sponsor's funding limits. 2) it constitutes a performance measure during the whole project's life-cycle, and 3) it affects the competitiveness of the bid. Budgeting and cost estimation methods vary in terms of complexity and accuracy, but, most important, in the way they address contingency reserves in the total budget. The aim of this research is to explore the most applicable budgeting methods for infrastructure projects with regard to the inclusion of risks related costs to the overall budget and demonstrate the capacity of stochastic processes for optimizing overall budgets. Case- based reasoning, multiple regression analysis, Monte Carlo simulation and deterministic methods are briefly presented in terms of theoretical approach, requirements, accuracy and integration of risks. Two prevailing budgeting methods, namely the deterministic and Monte Carlo simulation are applied on a real case of

reinforced concrete works for a building project. The comparison of the results highlights the two major findings of this research: a) stochastic processes provide more accurate justification of the contingency reserves required for inclusion of risks in budgets of infrastructure projects, and b) stochastic processes are optimum for the definition of realistic contingency reserves that, in turn, results to more competitive bids. The research concludes with the suggestion that stochastic processes should be used for risk based budgeting of infrastructure projects.

Stanley and Ekweozor (2020). The traditional method of quantifying reinforced concrete steel reinforcements via taking off can be tedious, time consuming and prone to errors which can affect project success due to cost and schedule overruns, disputes and in certain cases, outright abandonment. In Nigeria, some quantity surveyors have developed 'rule of thumb' techniques to quantify reinforcements in order to beat pre-contract datelines based on their past experience, but there are still not widely accepted and a unified formulae or empirical basis of generating these quantities is still lacking. This study thus, developed easy-to-apply, time saving regression models for predicting the quantities/weight and material cost estimates of 16mm, 12mm and 8mm diameter high yield reinforcement bars in beams of varying sizes, using the volume of beam concrete as the independent or predictor variable. Data on concrete volume, weight of Y16, Y12 and Y8 reinforcement was collected via taking off/measurement process from 30 structural drawings of frame buildings of varying nature obtained from registered structural engineers and analyzed using correlation and regression statistics. Results indicate high coefficients of determination (R2) ranging from 0.82 to 0.92 which indicate that the predicted values from a forecast models fit with the real-life data. Thus, 3 predictive models were advanced as follows: WY16= -811.265+ 177.339 (Vc) ;WY12= -510.189 + 63.218(Vc); WY8 = -43.273+ 22.533 (Vc), where: W = reinforcement weight and Vc = volume of concrete. The study concludes that

concrete volume is a good predictor variable when establishing the weight of reinforcement in beams. The import of these predictive models for construction cost professionals cannot be overemphasized for ease and accuracy of feasibility estimating, preparation of bills of quantities, material ordering, auditing construction costs, vetting consultants' estimates and contractors' quotations. Vinit and Robert H. Lee(1973).

The results of a study of the sustained load effects on the interior reinforced concrete columns in rectangular building frames are presented. The variables, considered are the column slenderness ratio and the level of sustained loads. The behavior under sustained loads is predicted by using a time-dependent stress-strain diagram for concrete. It is found that the column capacity decreases as the slenderness ratio and level of sustained load increase.

2.15 Summary of the Literature Reviewed

The take a look at confirmed that the concrete is that the maximum common fabric applied in enterprise because of it excessive energy that it is, particularly while introduced with the reinforcements in it. The Reviewed on concrete confirmed that the improvement have to lifestyles lengthy if right widespread nice substances have been been used and selected of all essential substances for creation have to be followed to keep away from any failure in enterprise because of the homes occupants and their homes.

The outcomes of ferroconcrete has happened way to severa troubles in enterprise that can purpose be threatened to the proprietor on his lifestyles and his homes due to the fact while there may be impact in concrete or reinforcements additionally in different fabric hired in enterprise. So there may be need to ensured first-rate erection of a shape right supervision and using a valid substances for creation to keep away from all the ones troubles noted above.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

This chapter is focused on research design, population sample and techniques, the instrument for research, collection of data and the method of data analysis are well presented. The purpose of this project work is to carried out a survey research on the effect of reinforced concrete on safety of residential buildings in Katsina State.

3.1 Research Design

The study adopted the survey research design to determine the effect of reinforced concrete on safety of residential buildings in Katsina State. The survey research design will enabled the researcher to collect data from the building owners and engineers from the area of research. The survey research is consider appropriate as the opinion of the respondent will be sought through structured questionnaire.

3.2 Area of Research

The area of research is Daura emirate area in Katsina State, north west zone of Nigeria. To determine the effect of reinforced concrete on safety of residential building in that area where research was carried out. Due to the problems facing in the area on most of residential buildings.

3.3 Population of the Study

The population of the study comprised of the twenty (20) building owners and ten (10) engineers, these make the total of thirty (30) respondents in the area of research which is the daura Emirate in Katsina State.

3.4 Sample and Sampling Techniques

The simple sampling techniques method was used to check the respondents of twenty (20) residential owners and ten (10) engineers in the area of research was used, which the area is Daura Emirate in Katsina State.

3.5 Instrument for Data Collection

The instrument for data collection was a structure questionnaire developed by the researcher from the review of related literature. The questionnaires were divided into two section. Which are section A and section B. Section A comprised of personal information of the respondent while section B comprised a list of questionnaires under the research questions with the views of carrying out on the effect of reinforced concrete on safety of residential buildings in Katsina State.

3.6 Validation of the Instrument

The instrument for the data collection was validated by the the three (3) expert from the Department of Industrial and Technology Education, Federal University of Technology Minna in order to ascertain the appropriateness of the questionnaire items before it was used for data collections.

3.7 Reliability of the Instrument

A test re-test Method was used to ascertain the reliability of the questionnaire using cronbach Alpha statics. The reliability of the Instrument was found to be.

3.8 Administration of the Instrument

The Instruments were administered by the researcher to the respondents for the selection of the appropriate option that is deserve base on the respondents knowledge and after selected the researcher was collected back for assessment of the **findings.**

3.9 Method of Data Collection

The survey method of data collection was used to distribute a questionnaire to the respondents which are building owners and Engineers. Thirty (30) questionnaires was used to collect data. The researcher went to the area and gave the questionnaires in order to give their responses, for the research findings to be appropriate. The researcher visited the engineers and re-visited them for the purpose of the research to be appropriate.

3.10 Method of Data Analysis

The data collected from the respondents was analyzed Using mean and standard deviation, t-test statistics was used to test the hypotheses at 0.5 level of significance. The data collected by the researcher was analyzed using mean, standard deviation and t-test as statistical tools. A four-point rating scale was employed with the following response.

Alternative value		Abbreviation	Rating
Strongly Agree	=	“SA"	4
Agree	=	“A”	3
Disagree	=	“D”	2
Strongly Disagree	=	"SD"	1

4+3+2+1 =10 =2.5

4 4

The mean response of each item was obtained by using the following formula

Mean= £fx/N

Where

£ = Summation of

X = normal value of option (mean)

N = number of response of an item

F = frequency of response of each option

= Grand mean of each item

3.11 Decision Rule

To determine the level of acceptance, mean response. 2.50 And above was considered agreed or accepted. While mean response of 2.49 and below was equally considered disagreed or rejected. For testing hypothesis ± 1.68 will be the critical value, any item that has its t- value equal or less than t- critical was considered not significant, and any item that has its calculated t- value above t-critical was considered significant.

CHAPTER FOUR

4.0 PRESENTATION AND DATA ANALYSIS

This chapter deals with the presentation and analysis of data collected with respect to the research questions formulated for this study, the result of data analysis for the research questions presented.

4.1 Research Question One

What are the causes of reinforced concrete failure in Katsina State?

Table 4.1: Shows the Mean responses of respondents on the causes of reinforced concrete failure in Katsina State. where I have N1= 20 N2=10

S/N	Questionnaire Items	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_{AV}$	Remarks
1	Improper structural design like foundation	3.65	3.40	3.523	Agreed
2	over loading the structure	3.40	3.20	3.30	Agreed
3	Lack of using the standard ratio of materials	3.30	3.40	3.35	Agreed
4	concrete uncovered areas of the reinforcement	2.90	2.70	2.80	Agreed
5	Negligence from building operators	2.75	2.40	2.575	Agreed
6	Weather condition in the environment	2.35	2.80	2.575	Agreed
7	Substitute of the real steel to be use	2.85	3.20	3.025	Agreed
8	Lack of bearing capacity of the soil	3.20	3.10	3.15	Agreed
9	Errors during setting out of the structure	3.15	2.90	3.025	Agreed
10	Incorrect placement of a steel	3.10	3.20	3.15	Agreed
	Incorrect selection of concrete materials	2.90	3.00	2.95	Agreed
12	Chemicals attack on concrete structure	2.85	3.00	2.925	Agreed

N1= Number of building owners, N2 =Number of Engineers, $\bar{X}_1$Mean of building owners, $\bar{X}_2$= Mean of Engineers, $\bar{X}_{AV}$= Average Mean of building owners and that of Engineers.

The data presented in table 4.1 revealed that the respondents agreed with all the Items listed with the mean scores ranging from 2.575 --- 3.523 all the listed Items from 1 to 12 was agreed by the respondents.

4.2 Research Question Two

What are the effect of reinforced concrete on safety of residential building in Katsina State?

Table 4.2 Shows the Mean Responses of Respondents on the effect of reinforced concrete on safety in Katsina State. N1= 20. N2= 10

S/N	Items	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_{AV}$	Remarks
1	crack on plaster due to corrosion on reinforced bars	3.10	3.10	3.10	Agreed
2	High level of salty underground water be consider	2.30	2.40	2.35	Disagreed
3	Collapse of building structure sometimes	3.15	3.20	3.225	Agreed
4	Increase in maintenance budget	2.25	2.20	2.225	Disagreed
5	Maintenance frequency should be increase	3.30	3.20	3.25	Agreed
6	There should be increase in maintenance quality	2.90	2.40	2.65	Agreed
7	There should be bending of lintel	3.15	3.00	3.075	Agreed
8	It should be threatens to the failure of the structure	3.05	3.20	3.125	Agreed
9	Effect will delaying the ongoing project	3.15	3.10	3.125	Agreed
10	Material wastage and money	3.20	2.70	2.95	Agreed
11	Over time working on the site	2.85	2.40	2.625	Agreed
12	Inadequate support for foundation	2.95	2.70	2.825	Agreed

N1= Number of building owners, N2 =Number of Engineers, $\bar{X}_1$= Mean of building owners, $\bar{X}_2$= Mean of Engineers, $\bar{X}_{AV}$= Average Mean of building owners and that of Engineers.

The data presented in table two (2) revealed that the respondents disagreed with Items 2 and 4 with the mean scores ranging from the 2.225 to 2.35 while Items 1,3,5,6,7,8,9,10,11 and 12 had

agreed with the mean scores ranging from or between 2.625 to 3.225 was agreed by the respondents.

4.3 Research Question Three

What are the remedial measures or approach to the effect of reinforced concrete concrete in Katsina State?

Table 4.3: Shows the Mean Responses of respondents on the remedial measures or approach to the effect of reinforced concrete in Katsina State. N1= 20, N2= 10

S/N	Items	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_{AV}$	Remarks
1	Selection of reinforcement for resistant to corrosion	3.10	3.20	3.15	Agreed
2	Protective concrete layer according to Euro code 2	3.20	3.30	3.25	Agreed
3	Proper design and construction of the foundation	3.40	3.40	3.40	Agreed
4	Application of bitumen and of polymer emulsion	3.15	3.10	3.175	Agreed
5	Choice of the good sound concrete materials	3.05	3.20	3.125	Agreed
6	supervision from the early stage of a construction	3.20	3.30	3.25	Agreed
7	Testing the bearing capacity of the soil early	3.30	3.20	3.25	Agreed
8	choosing the appropriate type of foundation	3.10	3.10	3.10	Agreed
9	Enough deep of excavation area of the foundation	3.25	3.40	3.325	Agreed
10	Reinforcements are placed in right position	3.30	3.20	3.25	Agreed
11	Standard ratio of concrete materials should be used	3.10	3.10	3.10	Agreed
12	Using enough size of steel should be consider	3.35	3.30	3.325	Agreed

N1= Number of building owners, N2 =Number of Engineers, $\bar{X}_1$= Mean of building owners, $\bar{X}_2$= Mean of Engineers, $\bar{X}_{AV}$= Average Mean of building owners and that of Engineers.

The data presented in table 4.3 revealed that the respondents agreed with all the Items listed with the mean scores ranging from or between the 3.10 to 3.40 was agreed with all the listed Items from number one (1) to number twelve (12) by the respondents.

The finding related to the causes of reinforced concrete failure in Katsina State.

Both the respondents agreed with all the following Items concerning the causes of reinforced concrete failure in Katsina State.

1. Improper structural design like foundation.
2. over loading the structure.
3. Lack of using the standard ratio of materials.
4. concrete uncovered areas of the reinforcement.
5. Negligence from building operators.
6. Weather condition in the environment.
7. Substitute of the real steel to be use.
8. Lack of bearing capacity of the soil.
9. Errors during setting out of the structure.
10. Incorrect placement of a steel.
11. Incorrect selection of concrete materials.
12. Chemicals attack on concrete structure

Finding related to the effect of reinforced concrete on safety in Katsina State. Both the Respondents and Engineers agreed with all the following Items listed concerning the effect of reinforced concrete on safety of residential building in Katsina State.

1. crack on plaster due to corrosion on reinforced bars.

2. Collapse of building structure sometimes.

3. Maintenance frequency should be increase.

4. There should be increase in maintenance quality.

5. There should be bending of lintel.

6. It should be threatens to the failure of the structure.

7. Effect will delaying the ongoing project.

8. Material wastage and money.

9. Over time working on the site.

10. Inadequate support for construction.

Finding related to the remedial measures or approach to the effect of reinforced concrete on safety of residential building in Katsina State.

Both the respondents and Engineers agreed with all the following Items listed concerning the remedial measures or approach to the effect of reinforced concrete on safety of residential building in Katsina State.

1. Selection of reinforcement for resistant to corrosion.

2. Protective concrete layer according to Euro code 2.

3. Proper design and construction of the foundation.

4. Application of bitumen and of polymer emulsion.

5. Choice of the good sound concrete materials.

6. supervision from the early stage of a construction.

7. Testing the bearing capacity of the soil early.

8. choosing the appropriate type of foundation.

9. Enough deep of excavation area of the foundation.

10. Reinforcements are placed in right position.

11. Standard ratio of concrete materials should be used.

12. Using enough size of steel should be consider.

4.4 Discussion of Findings

The following findings were made from the effect of reinforced concrete on safety of residential building in Katsina State.

The findings of this study were presented according to the research questions generated.

The findings in table 4.1; shows that all the Items listed from number one 1,2,3 up to number twelve had agreed with the statements on the causes of reinforced concrete failure in Katsina State while none of them disagreed with the statements. This shows that most of the effects or causes of reinforced concrete failure are man made errors as a result of Improper compliance to the building code and building regulations.

The findings in table 4.2; shows that the statements 2 and 4 disagreed on the effect of reinforced concrete on safety in Katsina State. While the number one (1) Three (3) Five (5) up to number twelve had agreed with the statements.

It was observed that most building owners are usually affected with the effects of reinforced concrete in Katsina State and Nigeria in general. Effects of reinforced concrete usually leads to the loss of lives and properties at the detriment of the properties owner who at the end of it, all do not have any option left than to bear the risk of incurring the loss expenses. Insurance company should make sure builders in construction company compliers to building code and regulations and use proper material for the right structure before taking building insurance.

The finding in table 4.3 shows that all the statements on the table was agreed by all the respondents from number one up to the number twelve, statements agreed with all the Items listed concerning the remedial measures or approach to the effect of reinforced concrete on safety of residential building in Katsina State.

According to (Adam, 2016). The only problem with this discovery is that it is an expensive technology for the country which is developing to afford. However Engineers should lay more emphasis on good design to prevent effect like corrosion. And educating general public on corrosion and on protecting steel from it. It was observed as a serious problem in building stability, steel corrosion is receiving close attention in Australia with the setting up of corrosion centre, charged with the responsibility of developing corrosion preventing strategies. While in Nigeria, efforts should be fitting toward good design and construction because of our current level of development. Government has not been seen it seriously enforce building regulations to check the rampant cases of the effects of reinforced concrete. Professional also has role to play. They should spend time to produce accurate designs and reduce their professional charges, which scare away developers to seek the cheapest services of quacks. The study observed that effect of reinforced concrete can be controlled or to reduce if the client is ready to pay for a high quality materials and for expert professional services. Other causes according to, they include factors

such as omission, carelessness, absence of proper supervision of the project, using of substandard materials, alteration of approved drawing and curruption in our Nigerian system.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter deals with the summary of the findings, the implications of the study, conclusion, recommendations and suggestions for further researchers.

5.1 Summary of the Study

The research work was design to assess the effect of reinforced concrete on safety of residential building in Katsina State. It focused on the causes of reinforced concrete failure, the effect of reinforced concrete, and the remedial measures or approach to the effect of reinforced concrete on safety of residential building in Katsina State.

The related literature on the causes of reinforced concrete failure are bad design poor quality of materials and construction methods improper foundation, Inadequate maintenance, overloading the structure and the rest of them. The effects of reinforced concrete and the remedial measures to the effects of reinforced concrete were reviewed.

The instrument for data collection was questionnaires: The items were formulated based on the research questions that were administered to building owners and the engineers in Katsina State. A total of twenty (20) building owners and ten (10) engineers were drawn from the area for the study.

Analysis of the data collected revealed that overloading the structure poor quality of materials and construction methods, improper foundation are measures causes and effects of reinforced concrete failure in Katsina State.

The statistical tools used in the analysis were frequency count mean and t-test.

5.2 Implications of the Study

The findings of this study has the following Implications; poor quality of materials, foundation failure, Inadequate maintenance, overloading the structure, and lack of bearing capacity of soil. The finding further revealed that high cost charges on the part of the consultants also pave way for cheap labour with little experience of building specifications. The finding shows that professional have role to play , they should spend their time to produced an accurate design and reduce their professional charges, which scare away developers to seek the cheap services of quacks.

5.3 Contributions to knowledge

The study has create avenue for students and institution to know that, the effects of reinforced concrete on safety of residential building should be taught on how to take a proper brief from the client, skills of giving a useful advice as well as Implication of alteration during construction . And also students in the institution should be taught to take cognizance of the Importance of structural stability and dipper knowledge taught at all school level.

5.4 Conclusion

The following conclusions were drawn based on the research finding of the study. In mitigating effects of reinforced concrete in Katsina State or Nigeria in general, the engineers being a key player in a building industry, also has duties of coordinating all the operations of allied professions; To make sure that all specifications are followed and inline with the design and satisfaction of the client.

The design of building does not only involve the design and aesthetics, but must be functional, safe and economical to suit the need and purpose of which it is intended as such, the engineer must ensure that the right materials are specified for both the interior and exterior of the building.

Site visit during construction must be ensured in order to ensure the standard and quality are adhered to. This will avert many peoples dishonestly parade themselves as engineers, designing and supervising buildings and eventually construction as noted, these obviously contributed to the increase in the number of effects of reinforced concrete in the country and should be discouraged by ensuring that perpetrators are dealt with by the professional bodies and law enforcement agents; Ensuring that only registered professionals supervised the building site.

5.5 Recommendations

Based on the findings of the study, the following Items were recommended:

1. Engineers should be encourage to visit sites more and regularly, than the normal visit.

2. The client have to change habit of paying affordable amount for the purpose of quality work.

3. Engineers should ensure that standard ratios of materials are comply.

4. Students must have adequate knowledge of structures and construction at all levels of technology education.

5. Structural detailing should be emphasized and improved upon in the schools of technology.

6. Students should be cognizance of the importance of structural stability and deeper knowledge taught.

5.6 Suggestions for further Study

From the research study, it can be suggested that further research should be carried out on the adoption and implementation of sustainable construction at the strategic and operational levels by construction firms in Nigeria. The importance of this is to improve implementation process in the building industries in Nigeria in order to reduce the effect of reinforced concrete in the country.

Research should be done accordingly on evaluation of the effectiveness of development control of the effect of reinforced concrete in Nigeria to comb the negative attitude of the stakeholders in the building industry towards trick adherence to structural detailing and improved upon in the schools of technology.

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FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION

QUESTIONNAIRE FOR

THE EFFECT OF REINFORCED CONCRETE ON SAFETY OF RESIDENTIAL BUILDINGS IN KATSINA STATE

SECTION A: PERSONAL INFORMATION

Please kindly complete this questionnaire items by the column that represents based on your perception. Because all the information provided will be strictly used for research purpose and highly confidential.

A four (4) points rate scale is used to indicate your perception as stated bellow:

SA = Strong Agree. =4

A = Agree. =3

DA = Disagree. =2

SD = Strong Disagree=1

The acceptance level for the four points rating Items are;

MEAN (X)={X/N

Where £= Sum of normal value option

X= Mean

N= Number of items

4+3+2+1/4=10/4= 2.50 and above as Agreed

2.49 and below as Disagreed

Decision rule

To determine the acceptance, a mean score of 2.50 is cut 0 point, in other word any response with a mean score of 2.50 and above is considered Agreed, while response from 2.49 and below is considered as Disagreed. Four rating scale was use to analyzed the response as seen above.

SECTION B:

List of Questionnaires.

Please read the questions carefully and tick the appropriate option base on your knowledge.

Research Question 1: what are the causes of reinforced concrete failure in katsina state.

S/N	Questionnaire Items	S D	D	A	S A
1	Improper structural design like foundation				
2	over loading the structure				
3	Lack of using the standard ratio of materials				
4	concrete uncovered areas of the reinforcement				
5	Negligence from building operators				
6	Weather condition in the environment				
7	Substitute of the real steel to be use				
8	Lack of bearing capacity of the soil				
9	Errors during setting out of the structure				
10	Incorrect placement of a steel				
11	Incorrect selection of concrete materials				
12	Chemicals attack on concrete structure				

Research Question 2:what are the effects of reinforced concrete on safety in katsina state.

S/N	Questionnaire Items	S D	D	A	S A
1	crack on plaster due to corrosion on reinforced bars				
2	High level of salty underground water be consider				
3	Collapse of building structure sometimes				
4	Increase in maintenance budget				
5	Maintenance frequency should be increase				
6	There should be increase in maintenance quality				
7	There should be bending of lintel				
8	It should be threatens to the failure of the structure				

9	Effect will delaying the ongoing project				
10	Material wastage and money				
11	Over time working on the site				
12	Inadequate support for foundation				

Research Question 3:what are the remedial measures of the effect of reinforced concrete in katsina state.

S/N	Questionnaire Items	S D	D	A	S A
1	Selection of reinforcement for resistant to corrosion				
2	Protective concrete layer according to Euro code 2				
3	Proper design and construction of the foundation				
4	Application of bitumen and of polymer emulsion				
5	Choice of the good sound concrete materials				
6	supervision from the early stage of a construction				
7	Testing the bearing capacity of the soil early				
8	choosing the appropriate type of foundation				
9	Enough deep of excavation area of the foundation				
10	Reinforcements are placed in right position				
11	Standard ratio of concrete materials should be used				
12	Using enough size of steel should be consider				