PERFORMANCE EVALUATION OF THE BUILDING FABRIC AND SOME SERVICES OF PUBLIC RESIDENTIAL BUILDINGS IN ABUJA

BY

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Being a thesis submitted to the postgraduate School, Ahmadu Bello University, Zaria, Nigeria, in partial fulfillment of the Requirements for the award of the degree of Master of Science in Construction Management, in the Department of Building, Faculty of Environmental Design, Ahmadu Bello University, Zaria, Nigeria.

DECEMBER, 1989

DECLARATION

I hereby declare that this THESIS has been preparted by me and that it is a record of my research work.

That to the best of my knowledge, it has neither been undertaken nor presented in any previous application for a higher degree.

All quotations are indicated and the sources of informations are specifically acknowledge by means of reference.

Signed: _____
SANI ABBA . ALMU

AUGUST, 1989

CERTIFICATION

This THESIS entitle "Performance Evaluation of Building " constructed in Abuja by Sani Abba Almu meets the regulations governing the award of the degree of Master of Science (Construction Management) of Ahmadu Bello University, and is approved for its contributioin to knowledge and literary presentation.

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DEDICATION

This piece of work is dedicated

to the entire ABBA Family and well WISHERS

ACKNOWLEDGEMENT

I am grateful to Dr. A. A. Hussein the Head, Department of Building (my Supervisor) and Jibril Ado Jibril who helped greatly towards the success of the work.

My thank s goes also to the following people, who in one way or the other contributed to preparatic n of this work:

ALHAJI ABUBAKAR GAMBO (JALLI)

ALHAJI ABUBAKAR WAKILI

ABDUL-GHANNI L. ADIGUN

and the entire staff of Department of Building, Faculty of Environmental Design, Ahmadu Bello University, Zaria, Nigeria.

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ABSTRACT

This is a study of performance evaluation of the building fabric and some services of public residential buildings in Abuja; the new Federal Capital of Nigeria.

Different types of defects, the frequency they occured and the subsequent maintenance problems were studied for residential buildings under used.

Four different development districts, Gwagwalada, Nyanyan, Garki and Wuse of the new Federal Capital were taken as the area of study. In each case the type and the cause of the defect recorded and the probable maintenance problem noted.

The analysis of faults observed indicated that those defects related to door, mechanical services, roof and wall occured in that order of frequency.

The causes of these defects were observed to be from low quality materials, poor construction or even mis-use in the case of pipe blockages.

In each case recommendations and suggestions were appropriately made.

Recommendations made included:

12 The improvement of water supply to Nyanyan and Gwaqwalada Districts and more enlightenment on the use of proper materials in the toilets.

2) The Provision of r.c. roof beams and hook bolts to secure rafters firmly to buildings.

3) The Department of Public works at the F.C.D.A. should provide adequate supervision and, or inspection on their current and future building sites to ensure that contractors adhere to specifications and quality procedures in construction.

1.0 INTRODUCTION

Abuja, the Federal Capital City of Nigeria, in the making, is one of the most significant development project being undertaken by the Federal Government (The Federal Capital Development Authority, 1985).[3] The thought for a new capital arose because Lagos had become a 'seamless Web" (with interactable traffic, housing and sanitation problems) due to its dual role as a state and federal Capital. Thus, the Federal Capital Development Authority (FCDA), a body charged with the responsibility of the planning and development of Abuja, was established by Decree No. 6 of 1976.

The New Capital has been planned and designed to achieve a target population of 1.6 million people by the year 2000 and will grow to an ultimate size of 3.2 million when fully developed (the Federal Capital Development Authority, 1985).[3] The main aim of Abuja project.

Figure 1: Map of Nigeria, showing the Federal capital territory (shaded) with other State capitals.

is to provide decent and healthy living condition for all the new capital residents. The greater number of the key projects in the programme involve the construction of different types of buildings for various purposes. These include office and residential accommodations for workers, schools, hospitals and many other services and social facilities. The Abuja Master Plan has defind the broad strategy for the different sectors of the development of the project. The first phase to be developed covers the Central Area which (together with four residential districts) when developed will accommodate a population of ₦230,000 (the Federal Capital Development Authority, 1985).[3] Of the four districts, Garki I and Wuse I districts are, at the moment, the built-up areas where most of the housing, infrastructure and other services are available.

They accommodate the civil servants involved in the initial movements of the seat of the Federal Government from Lagos. (See Fig.2)

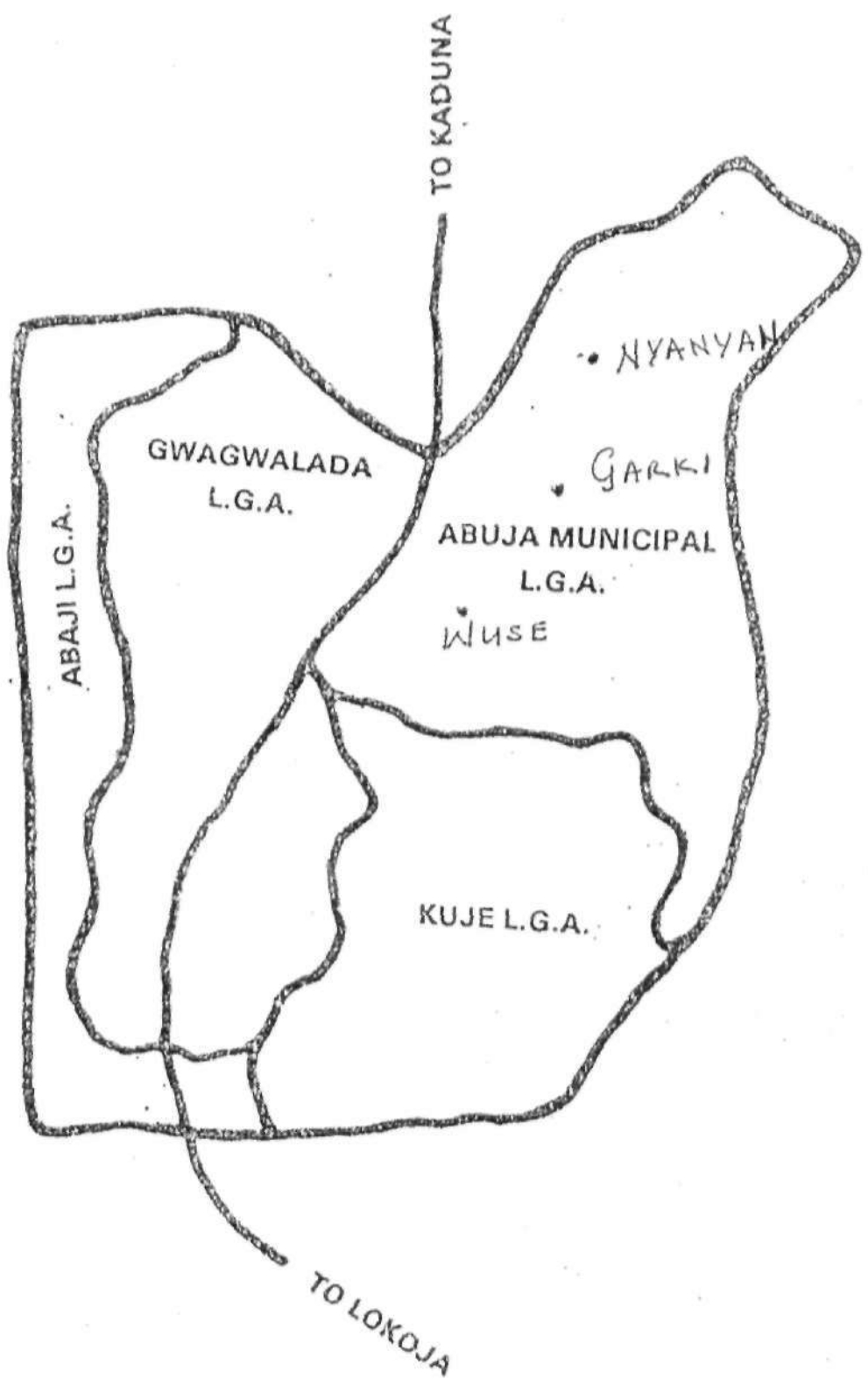


Figure 2: Map of the Federal Capital Territory showing th approximate locations of the districts.

In accordance with the set target for the movement to Abuja, which would have lasted from 1982 - 1986, a target of 25,000 housing units were to be made available for the inhabitants of Phase I of the City by the end of 1986 (the Federal Capital Development Authority,1985). The number of housing units already committed to construction in the Garki I and Wuse I districts are 8,322. Out of this figure 3,524 units were completed by 1982 and are now occupied. The remaining are at various stages of construction. Other housing units are also available in the rest of the residential districts.

Communal facilities to service the residents of the districts of the new Federal Capital have either been constructed or under construction (the Federal Capital Development Authority, 1985). Some of the facilities at each district include: office complexes, health centre, post office, Police station, fire station, shopping centre, primary and secondary schools.

Government planned to commence movement from Lagos to Abuja from 1982. When it became clear that permanent offices could not be ready to meet the demand of the six ministries scheduled in the first phase of the movement, it was decided to provide 8 blocks of 2 storey office buildings to be used as transit facilities. These blocks have been constructed and provide a total of 68,180m2 of office floor area (the Federal Capital Development Authority, 1985).[3] In addition, there are other blocks of offices under construction at the Garki and Wuse districts which, when completed, will provide an additional 28,180m2 of office floor area.

As of now, efforts are being made to provide the entire phase I area with basic infrastructural facilities such as roads, water, electricity, etc. The Abuja Master Plan has also set aside areas (both within and outside the capital city) which would be used for the development of industries, banks and other commercial ventures.

Most of the gigantic projects which are not of utmost importance towards the achievement of the first phase movement of the seat of government have been suspended. The design of the city centre is also being reviewed (the Federal Capital Development Authority, 1985).[3] The movement has now been planned to take place in three phases. The first phase took place in 1986 and the second phase would cover the period between January and December, 1988. The Third and the final phase is to be in 1991.

All buildings are constructed with the aim to serve a certain purpose, or purposes. Before a building could be functional, it should have some objectives in its design and construction phases. While the objectives in design is instilling a certain quality or standard through specifications, the aim in construction is to maintain this quality in the building using the proper materials and means. The Chambers Dictionary defines "performance" as a noble action, or achievement. Therefore performance evaluation in buildings is the determining of the extent or degree to which the buildings have achieved the purposes of which they have been constructed.

1.1.0 NEED FOR THE STUDY

The study was prompted by the amount of money being spent on repairs, and or alterations to completed buildings. For instance, over ₦4.0 million was allocated for repairs to blown-off roofs and walls of some buildings in the area 1, section 2, of the Garki District (Building Department Records, Federal Capital Development Authority). The buildings in this section are among those completed in 1982. Apart from increasing the final costs of the buildings, repairs of this nature inconveniences the occupants of the affected buildings. For example, household items have to be moved to give way for the works to be undertaken. This subsequently, obstructs government assignments in the office. Due to these reasons, and viewing the proportion of the Abuja project that consist perform as expected to keep them within reasonable limit of maintenance.

1.2.0 OBJECTIVES OF THE STUDY

The main objectives of this study are:-

(a) to assess how far the constructed buildings have performed by determining the nature and frequency of repairs on them;

(b) to identify the most frequent (or common) maintenance problems and their causes;

(c) to determine the extent to which contractors have adhered, or (still) adhere to specifications and and standards on building construction sites;

(d) and to determine how buildings currently under construction are likely to perform.

1.3.0 SCOPE AND LIMITATION

The Federal Capital project at Abuja began in 1979 and from that period to date, there have been three governments at the Federal level. This caused corresponding changes in the administration of the Federal Capital Development Authority. For this reason policies towards contracts, their award and supervision have been varying with changes in the administration.

It is assumed in this study that the buildings constructed and those still under construction have an optimum design quality. This assumption is based on the fact that the design and construction stages of a building can be clearly distinguished, and executed by separate parties. Additionally, all the buildings were design by qualified professionals to standard specification. While it would be easy to observe operations and collect information on "active" building sites, the chances of obtaining the desired information after the buildings have been completed may be limited because the readrds may either beincomplete due to poor recording system or entirely missing. Where full records exist, the relevant department ,ay refuse to supply the desired information.

The study has been limited to the Garki, Gwagwalada, Nyanya and Wuse Districts, (see figure 2) because they are representative of the other zones of the Federal Capital Territory.

1.4.0 METHODOLOGY

The study focuses on the performance buildings in the new Federal Capital, Abuja. The concept of performance in buildings was first discussed from literature view paint. A number of buildings in the Garki, Gwagwalada, Nyanya and Wuse Districts of Abuja were administered with questionaires. On-the-spot observations and reports collected from the department of Public works (FCDA) Abuja supplemented these in identifying the nature and frequency of repairs and, or replacements required by the buildings. The response were analysed and observations drawn from these and some recommendations made.

CHAPTER TWO

2.0.0 LITERATURE REVIEW

This chapter discusses performance as it relates to buildings. How it is ensured in buildings after construction and the relationship of building construction materials to the performance of the building in use.

2.1.0 THE CONCEPT OF PERFORMANCE IN BUILDINGS

The term "performance" has different meanings for different situations. With respects to buildings, performance may be defined as the way or extent to which they have achieved their functional requirements (as buildings - or have been servicable. The Dictionary defines performance as "a notable action or achievement; manner or success in working" (Chambers, 1979).[12] A "Successful" building, therefore, is one which stands wear and tear from ordinary use and does not require excessive attention (i.e serviceable) the goal should cover both the design and the construction stages.[13]

While the main objective in building design it to install some degree of quality or standard through performance specifications,

Where ₦100,000 may, for instance, be adequate for the construction of the warehouse, ₦500,000 (or more) would be required for the hospital or bank.

Maintenance starts the day the builder leaves the work site even in the case of a well designed and constructed building. Design, materials, workmanship, function and their relationship in use will largely determine the amount of maintenance required during the building's life span. It is the duty of the performance specification and quality control, during design and construction, to harmonize the technical and other factors to produce a serviceable building.

The general object in building performance is the reduction of maintenance work and improving building operating efficiency. This can only be said to have been achieved, if the building has been functionally reliable and durable. Quality in a building is the assurance of a performance at the price the client has paid (i.e. for the construction). Unsatisfactory quality occures when a client pays a price which should provide a corresponding performance but gets an inferior building which breaks down immediately after completion or rapidly deteriorates in use. Thus, the objectives of performance in buildings are:

(a) satisfying the owner in terms of their functionality and aesthetics;

(b) realiability in terms of strength and durability.

2.2.0 QUALITY CONTROL IN BUILDING CONSTRUCTION

Quality control in building construction has been defined as those measures necessary to produce the results desired by the owner for the desired life of the structure. These measures start right from the initial or excavation stages through to its commissioning. Quality is not just "inspected into" a building during construction. It must be designed and built into it, and quality control assures that this has been done.

The choice of materials, components and construction method will affect the quality of the building. This (quality) will subsequently determine how the building would perform under different conditions of use. Therefore, those characteristics that affect maintenance, operating efficiency and appearance (or aesthetics) would be of primary importance during construction. Taking a quality design, failures from the site can still arise from a long list of causes. Principal among these causes are the following:-

(i) defective raw materials (e.g. cement);

(ii) poor handling of materials and components;

(iii) Inadequate field tests (e.g. on concrete or soil),

(iv) wrong application of materials or components;

(v) construction mistakes (e.g. from poor interpretation of design drawings;

(vi) indequate construction planning.

Implementation and control of quality during construction can be achieved through different and yet related ways. For example, a good control system should include the following quality assurance activities or more, as the case may be:-

(a) in-coming materials and components control;

(b) plant (or equipment) and tool control;

(c) (the) construction process control.

In-coming materials and components control ensures that only the right or specified ones are used in the construction. The application of the correct tool or equipments allows the desired effect to be obtained, e.g., a change in the type of trowel or painting brush will affect the surface texture of the wall in question. Supervision and inspection jointly ensure that the right materials (or components) and tools are used for the job. These quality activities are fully discussed in the following sections.

2.2.1 BUILDING CONSTRUCTION MATERIAL AND QUALITY

To accomplish the work on a building construction site, materials and components of different nature have to be brought to the site and used. Building construction materials range from timber and its derivatives or products to stone, sandcrete, clay bricks, cement, sand aggregates, iron, asbestos, electrical and mechanical fittings. Others include metals, glass, plastics and their related products, concrete and so on. In fact, the construction of a building is normally a fragmented affairs in that on any one site, one finds many distinct, but highly related trades.

Each material or component tends to belong to a distinct trade speciality. The jobs of an Iron Bender and form-work carpenter are distinct on a building site, and yet complement one another when (for example) a beam or column is to be cast. Whatever the nature of the available material or component its properties must be in conformity with the design specification if a durable (and subsequently economic) building is to be achieved. Concrete is one of the few building materials that are made (or prepared) on the building construction site. Areas of concrete application in the construction of a building range from the foundation fotting to the roof structure. Thus, it is the most widely used of building materials. In fact, concrete is the main material that is used in those structural parts of the building (e.g. foundations, beams, columns, and floors) that are expected to have long life and low up-keep. A general requirement of concrete in such positions is high resistance to anticipated exposure conditions. For a concrete to be durable, it has to be strong and water water-tight. The strength of a concrete of some given mix proportion is very seriously affected by the degree of its compaction (Neville, 1975).[6] For this reasons, fresh concrete should be easily workable, consistent and cohesive (i.e, should not segregate). In practice, the quality of concrete varies considerably and it is important to understand those factors which make for good and consistent quality.

Those factors are diverse and range from the basic constituent materials used in the concrete, to the concrete,manufacturing operations on the site. Main

Main constituents of concrete are cement, sand aggregates and water. The most commonly used cement is Portland (complying with BS 12). Several other cements can produce concretes with specialised properties. Aggregates form the bulk of hardened concrete. Gravels, crushed stones and sand constitute the aggregates and are classified as either fine or course. Fine aggregate consist of natural sand or crushed stone that can pass through a 4.77mm BS sieve. Course aggregates are primarily natural gravel or crushed stone that are retained on a 4.77mm BS sieve (BS specifications 882). In general, miximum aggregate size is determine by the type of work and nature of the concrete. Aggregates for concrete should be clean and free from organic impurities. Silt or organic test is used to determine their suitability. Some building construction materials e,g. cement have passed through initial method of production, yet it is necessary to carry out site tests on them to determine their suitability or quality for use. Cement is examined to xxx assess its soundness, a hand is also placed in a sample to feel it it is "blood hot". These two quick tests can determine the suitability of cement on even the smallest of sites. Water for concrete should be adequately free from impurities like suspended solids, organic matter and salts.

These could adversely affected the setting and hardening times, and ultimately the durability of th concrete. In preparing for a quality concrete, these major factors have to be assessed in terms of each concrete 'ingredient' or contituent.

Additionally, in-coming materials control should include all of the quality control activities associated with the receiving and stocking of materials and components from sources outside the construction site concerned. Thus the material on supply should be examined for conformity to the general specification of the design and standards. Other factors which affect the quality of a concrete are to do with the progess for its manufacture. Concreting (i.e. the manufacturing) operation involves batching, mixing, formwork, transport to formwork and placing, compacting and finally curing.

Batching is the acurate determination of the quantities of materials to be used in mixing the concrete. It is either done by volume or by weight but owing to the ability of sand to bulk when moist, volume batching in this condition causes concrete mixes to be inaccurate (Neville, 1975)[6]. Weight batching gives much more accurate results. It also makes for saving in the cost of designed mixes by enabling a lower control factor, to be employed. The lower the control factor, the higher the concrete strength and durability.

Concrete can be mixed manually or mechanically. The essence of mixing is to ensure even distribution of all the component parts of the concrete, uniformity in colour, and consistency. Unless for very small concretes on small jobs, mixing should be done in concrete mixers (which vary un both size and form). Mixers should be washed out thoroughly daily after use, and especially with a change in type of cement.

Formwork provides the shape and texture of concrete members. It supports them during the setting and hardening of the concrete in the members. Timbers, steel and metal faced plywood are used for formwork. Steel formwork comes in standardized but adjustable sizes but timber formwork requires cutting to sizes on site. It is important that timber formwork have the following properties:-

(a) they should have the strength to withstand working loads and the weight of the wet concrete;

(b) they should be rigid enough to prevent undue movement during placing of concrete;

(c) they should have tight joints to prevent loss of fine materials from the wet concrete.

Figures 3 A & B shows poor and good methods of formwork construction.

The method used in transporting concrete to formwork depends on factors like job size and the height (above the ground) to which it would be placed. Whether the concrete is moved from the place of mixing by lorries, barrows, dampers or pum, it is important that the composition of the mix is not altered and that

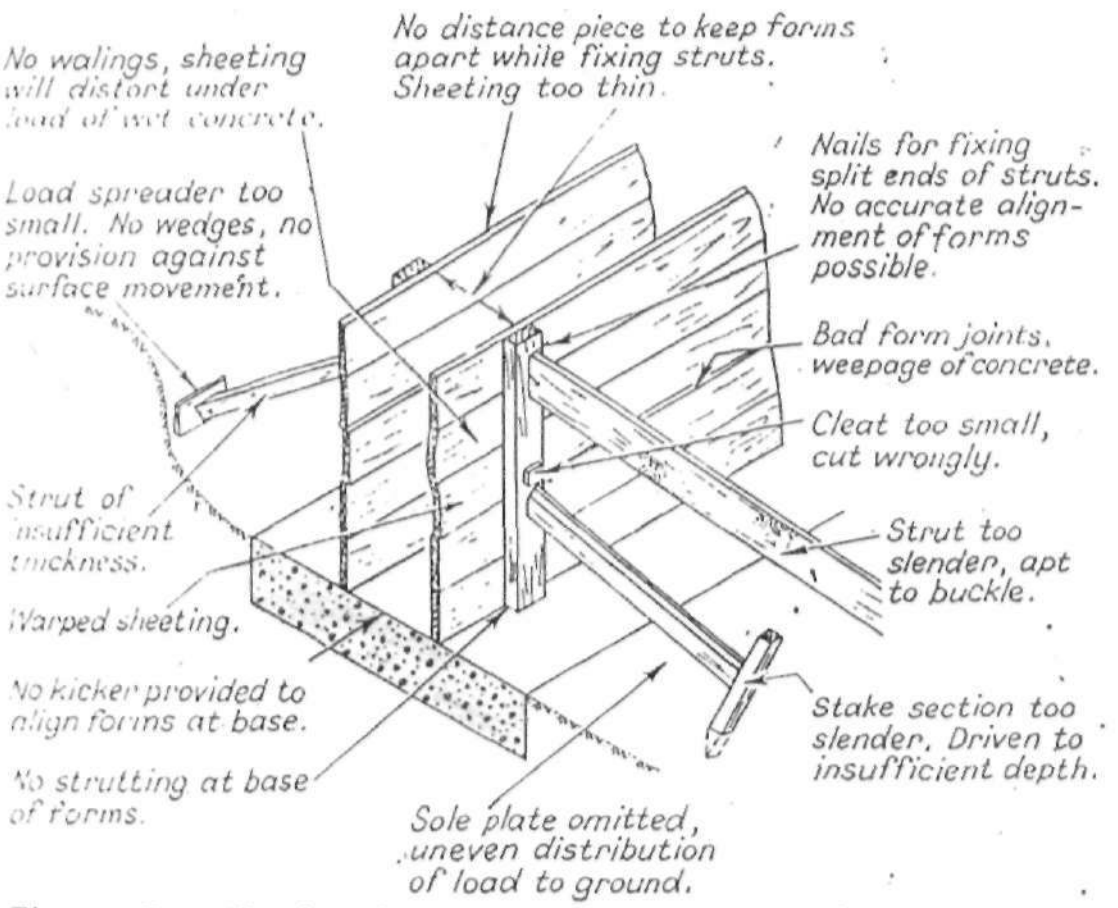


Figure 3a: Showing incorrect way of formwork construction.

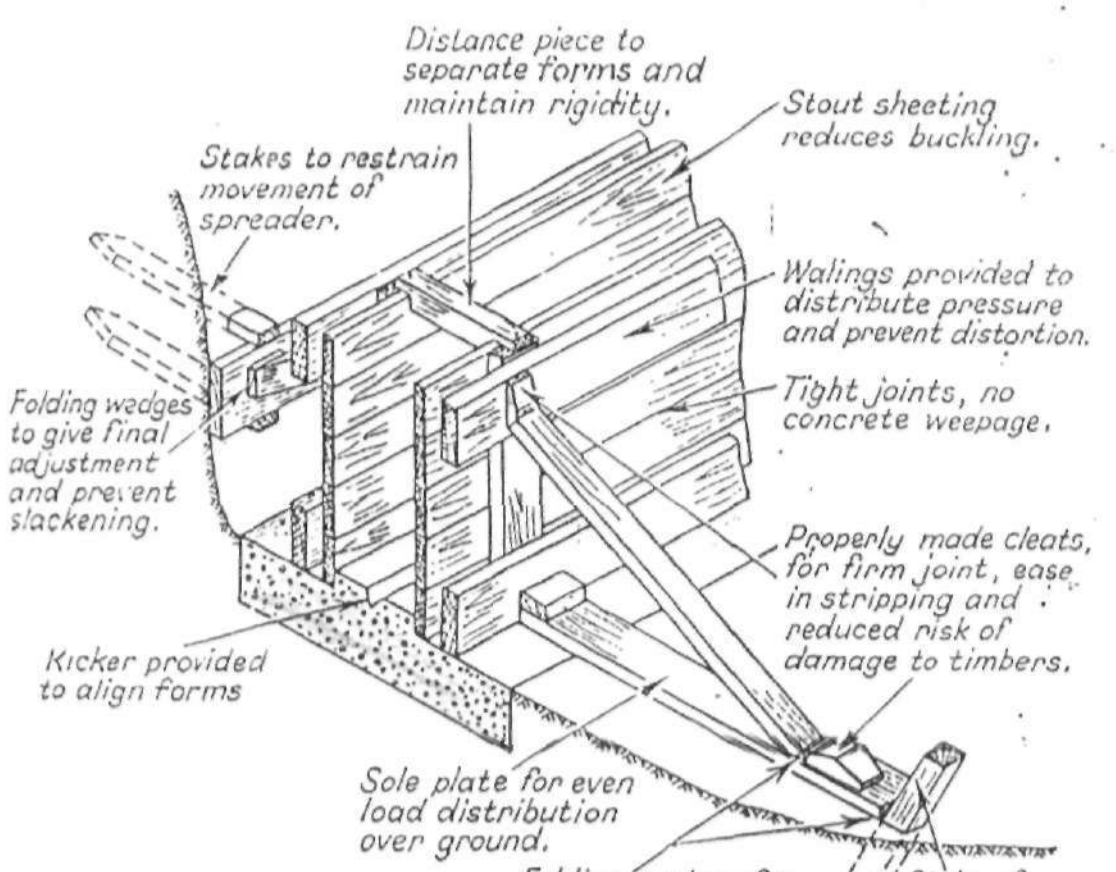


Figure 3b: Showing correct way of formwork construction.

segregation of contituent materials does not occur, as any of these would affect the quality of a concrete. To prevent these happening and to enhance its quality the following points should be noted:

(a) before concrete is placed (preferably at the last minute) formwork should be well cleaned and reinforcement re-checked;

(b) concrete should never be permited to fall freely from a height of more than one metre;

(c) flowing of concrete in the formwork should be avoided by placing it in layers of uniform thickness.

Compacting of concrete is done either manurally or by the use of vibrators. When using vibrators, care must be taken to ensure that concrete is well compacted against formwork and at corners and joints. Vibrators should be withdrawn very slowly so that a hole is not left in the concrete. The chemical reaction accompanying cement setting and subsequently, hardening of the concrete is dependent on water. It is required, therefore, that water is retained in exposed concrete and its (concrete) temperature must be controlled. To achieve this, the concrete is covered in plastic sheeting or water-proof paper. Damp sacks or clean sand is also used to cover the horizontal surfaces of mass concretes. The concrete is left in any of these ways for 7 - 10 days depending on the environmental conditions.

2.3.0 QUALITY CONTROL AT STAGES OF BUILDING CONSTRUCTION

The stages of building construction that will be considered here are not microscopic, but just broad enough to identify some major areas of quality control. The following stages are established to suit the types of buildings considered in this study. Therefore, these stages are not standard in any way.

2.3.1 *INITIAL STAGE.*

This stage marks the beginning of the building construction works. The operations involved here include site survey, setting out, excavation and substructure work. The quality control system in building construction would produce the desired structure only if operated from the initial stages. "start right, finish right". Before building work can realy begin, it is essential to carry out a comprehensive survey of the work on site and set out the construction work. Precision surveying instruments are used to achieve the necessary accuracy. Setting out is of prime importance to the structural and physical success of the building. It is vital therefore, that the setting out engineer should have a clear idea in his mind of the task. Proper attention should also be paid to the instruments to ensure maximum accuracy.

Setting out for a building consist of the consideration of the following (Smith, 1986) [9]:-

(a) plan (or absolute) position of the building;

(b) its relative position;

(c) Size;

(d) level (in relation to mean sea level)

(e) its shape and

(f) verticality

On a small site, the setting out drawing will often provide all the dimentional data needed to locate the corners from existing ground detail or regional survey mark. On a large site, one of these two conditions would exist; either there is planning or setting out grid, or the layout is such that it will be economical of time and more accurate to super-impose setting out base lines on the building plan. They may, or may not, cross at right angles according to the layout. In any case, the main aim is to establish marks which relate the grid, or base lines to the building site.

The Building must be controlled during construction for:-

(a) position;

(b) size and shape;

(c) level, and

(d) verticality

This is important to both low level and high rise buildings. The quality of lines in the setting out must be good because mistakes from this cannot be corrected and will be a high risk to lives, once the building has been constructed.

Setting out is followed by excavation for foundation footing and supports for the building. The type and depth of the foundation footing depends on the building and soil nature (and this has been taken care of by the structural designers, or engineers). Concrete it the principal materials used in foundation footings and the operations ensuring the quality of this materials have already been enumerated. Whichever, is the type of the foundation, it should be of good quality to, appreciably, be able to carry the entire weight of the building and to transmit this weight evenly to the ground - a factor on which the stability of the building depends.

2.3.2 INTERMEDIATE STAGE

This stage consists of the superstructural work. The super-structure may be in any one, or a combination of the following forms:-

(a) load bearing;

(b) monolithic, and

(c) frame construction

Where load bearing or masonry construction is used, the walls are built of small units, e.g. sandcrete blocks or bricks, If monilithic construction is used, the walls are made from solid, reinforced (or un - reinforced) concrete poured between shutterings. The third case is to construct a structural frame-work of structural steel, reinforced concrete or timber, using columns and beams. The soaces between these are then filled with sandcrete blocks or clay bricks.

Walls may be different, but they all perform a number of similar functions, e.g. suporting upper floors and roofs together with their super-imposed loads; providing means of insulation from the weather; resisting damp penetration, etc. Wall must therefore be constructed according to specifications before they can be able to perform these functions successfully.

Sandcrete blocks are the most commonly used walling materials in Nigeria and are produced in sizes depending on the structural importance of the wall they will be used in. Compared to blocks, burnt clay bricks are relatively "new" to the Nigerian building construction sites. To form walls, blocks or bricks are laid in courses and joined (or bonded) with mortar, a paste which spreads readily, remains plastic while the blocks or bricks are laid and acquires early strength. Generally factors affecting the quality of concrete are equally applicable to cement-sand mortar. Even with good quality blocks or bricks, the mortar has to be good before the desired quality is imparted to the wall construction.

Figures 7 and 8 illustrate some of the work in the Intermediate stage.

.3.3 FINAL STAGE

Roofing, fittings, installations, claddings, finishings, drains, clearing and other aspects come under this stage. By all means, this stage involves most of the trades (craftmen).

Figure 4a: Harddore filling completed with uneven spread of wire mesh

Figure 4b: Formwork ready for casting but not well braced

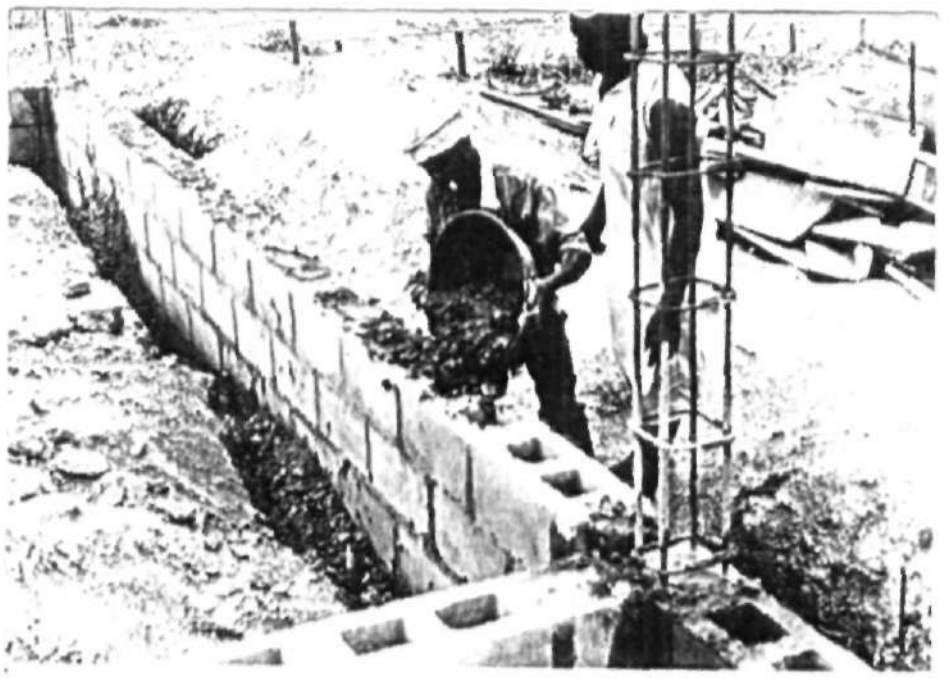


Figure 5: Filling in block holes with concrete to make it solid

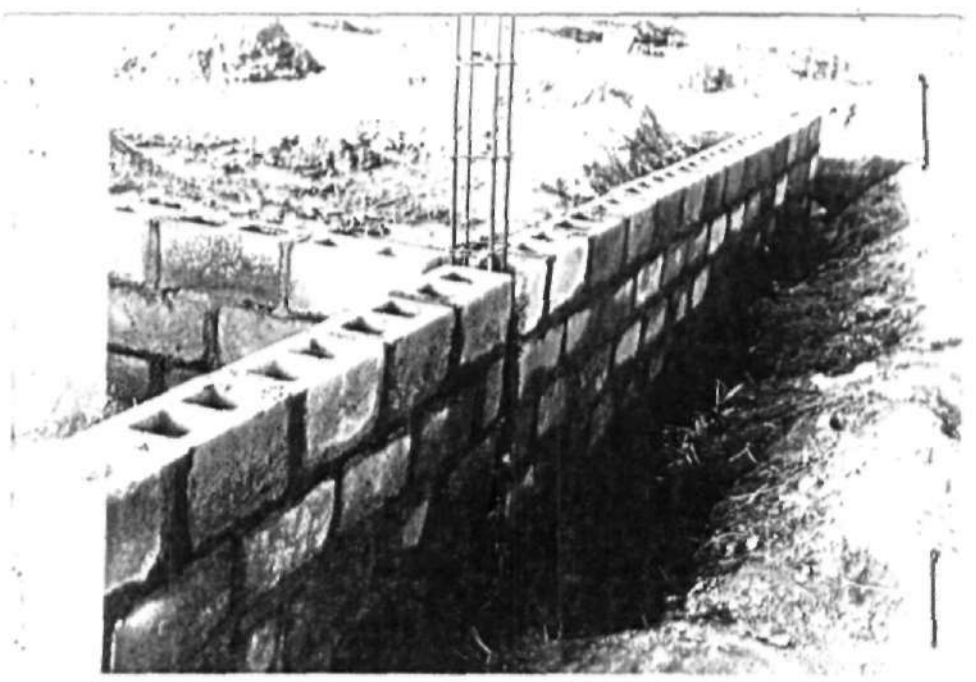
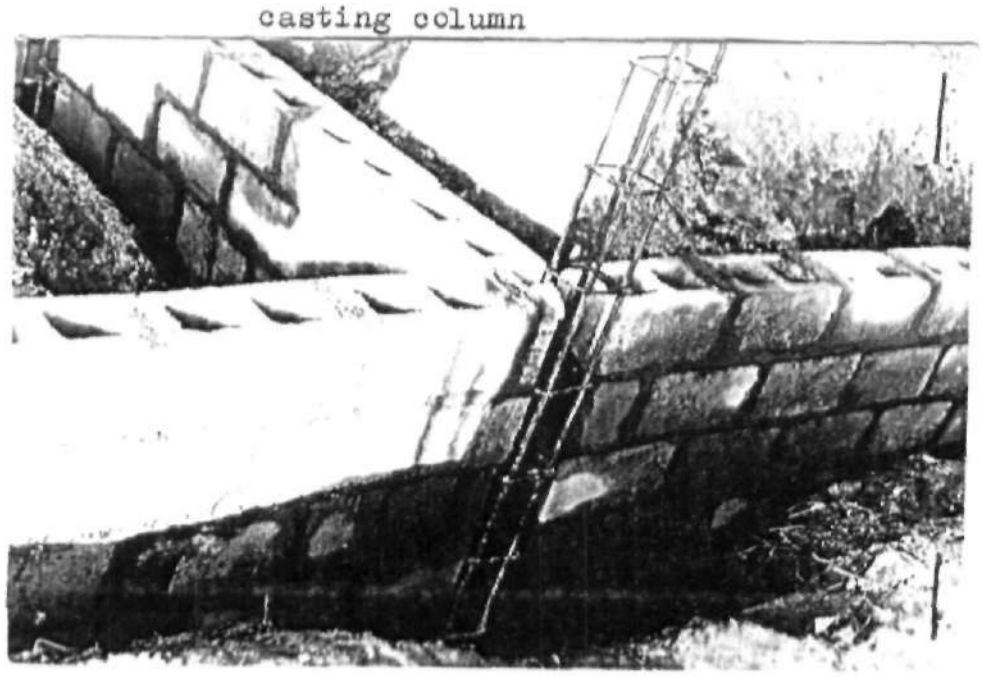


Figure 6: Substructure block work done before casting column



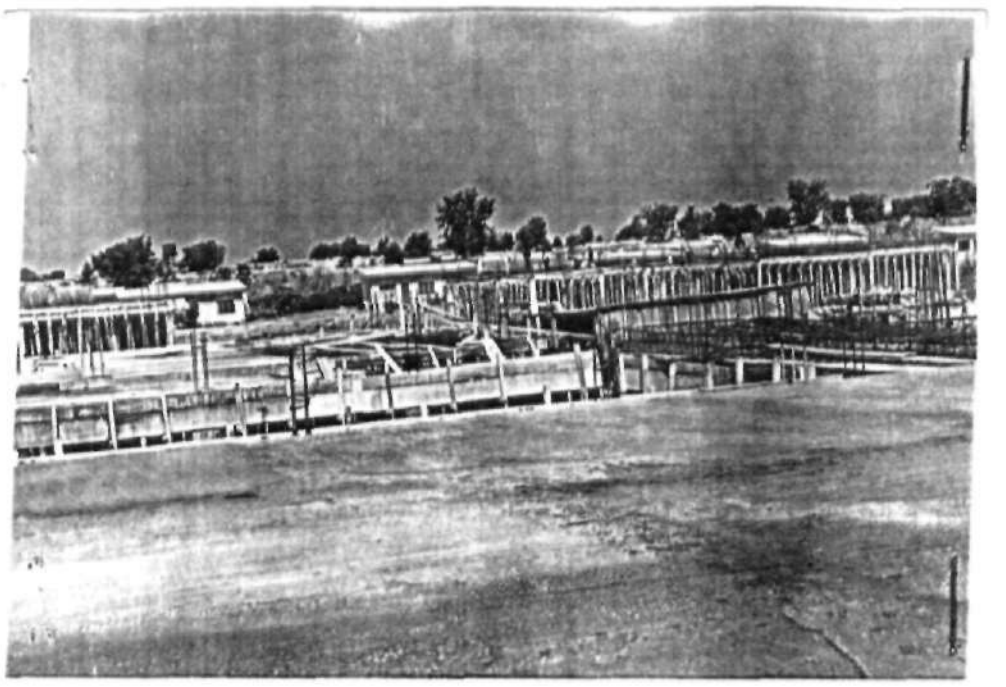


Figure 7: Already cast concrete and formwork construction

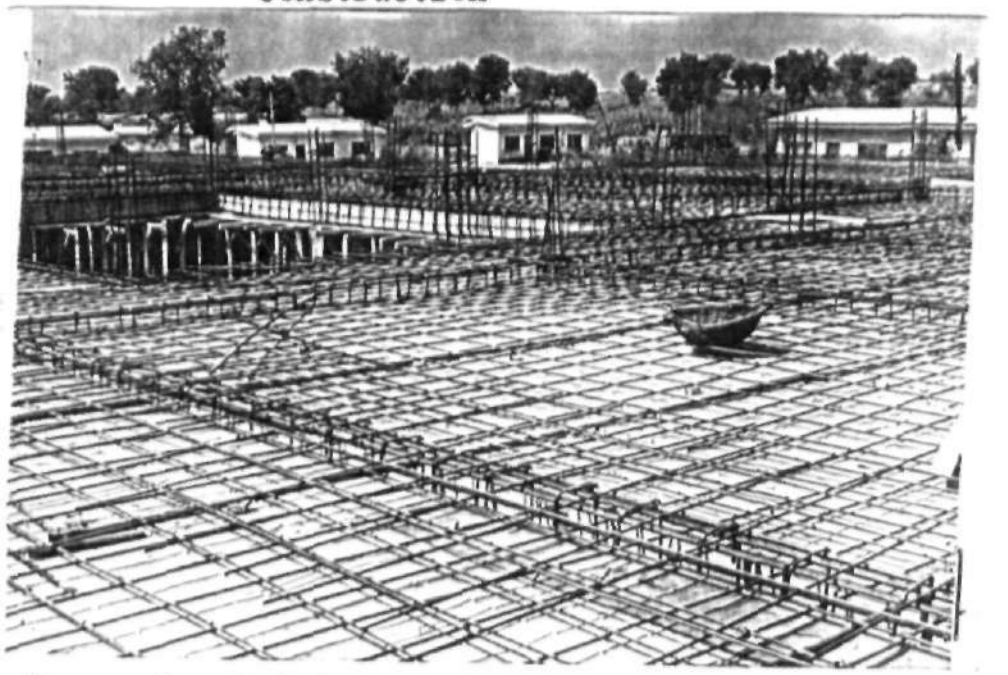
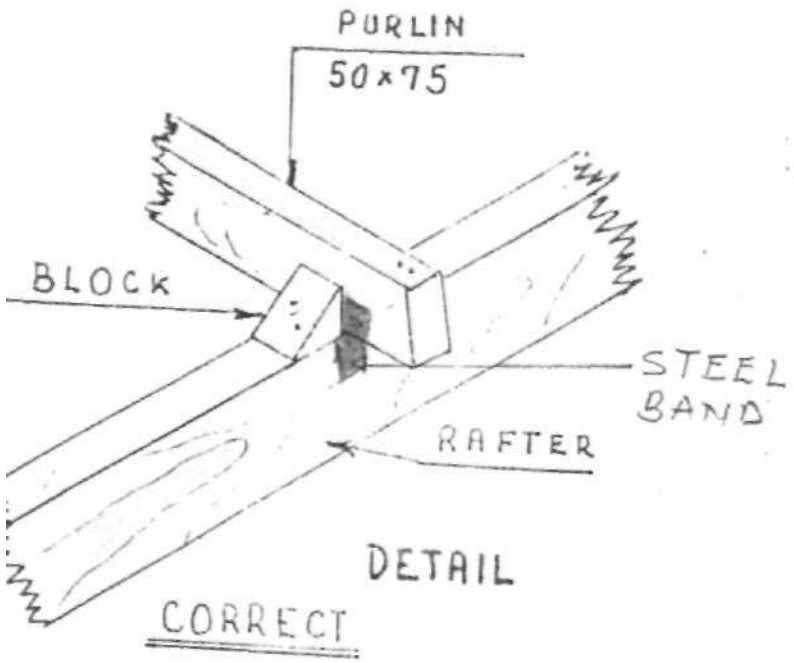
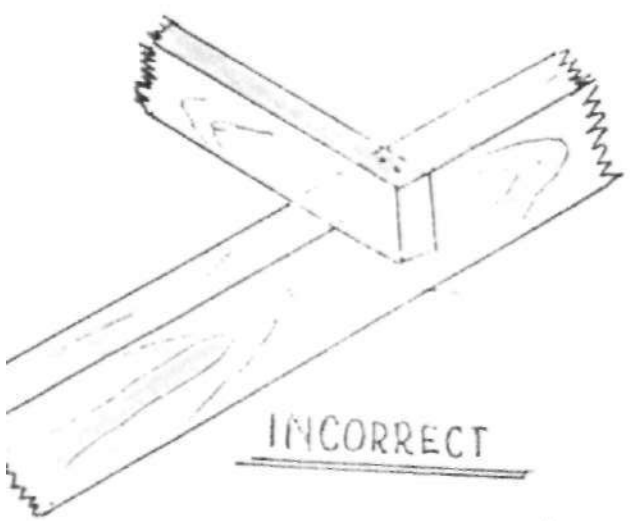


Figure 8: Feinforcement almost ready for casting.

The carpenters take care of the roofing, electricians and plumbers the fittings, and so on, each craftman depends on his tools and skill to produce an affect on the building. This illustrates the point that "quality in building construction is everybody's business".

Roofs are designed and made in different forms. They could be made of reinforced concrete, ti,ber or steel and covered with corrugated zinc or aluminium sheets, asbestos cement sheetings and others. The designed roof has functions (e.g. insulating the building from rains and other weather effects) to perform and is has to comply with the design quality to be able to perform these functions (Figures 9 and 10 show correct method of constructing timber roof). It the roof is to be made of reinforced concrete, its quality will, obviously, be determined by that of the concrete (which have already been discussed). Timber and steel roofs are covered with aluminium or asbestos cement sheets whose various manufactueers specify standard ways of fixing. Therefore, the craftman's tool and skill, in this case, and those of fittings, installations and finishings, basically determine the quality of the work.





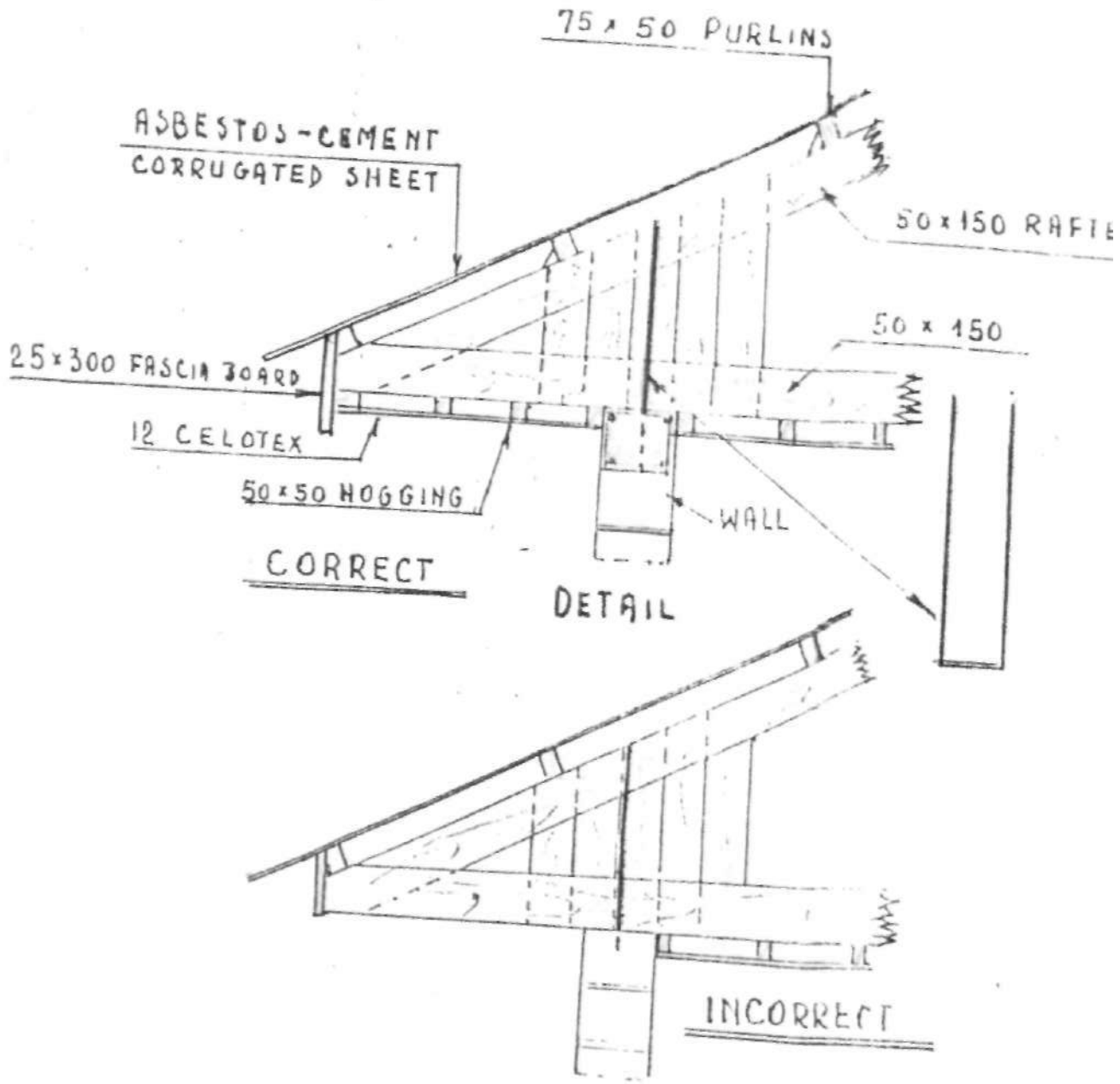
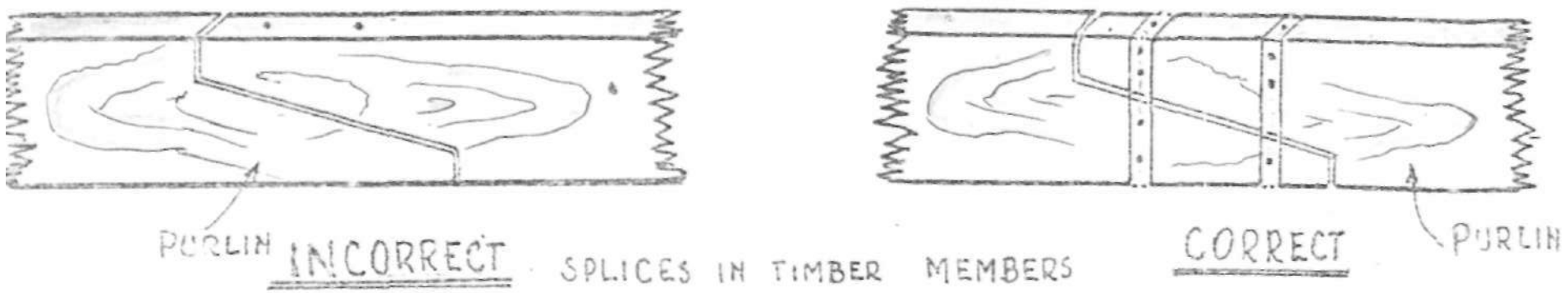
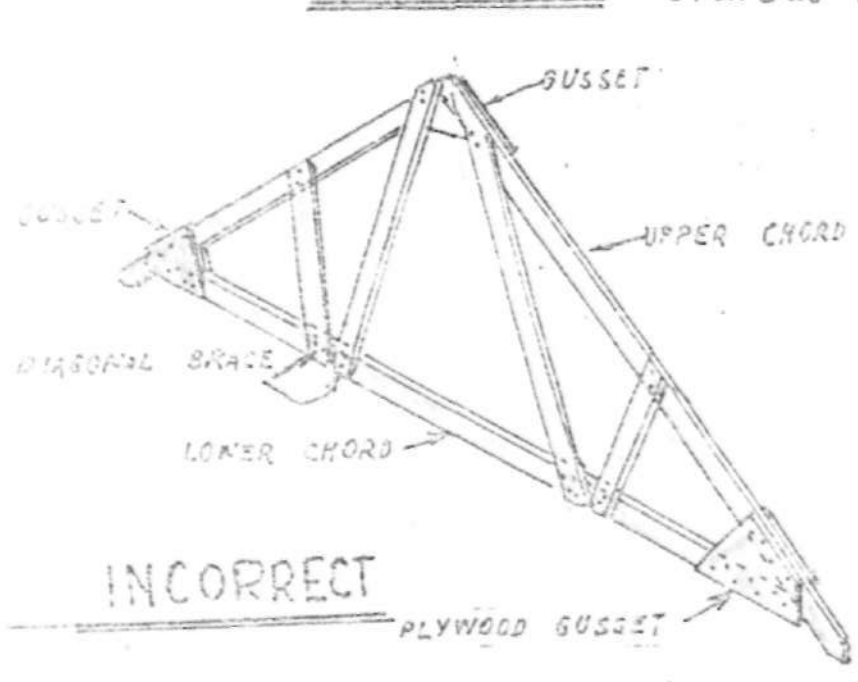


Figure 9 : Showing correct and incorrect way of constructing timber roof.





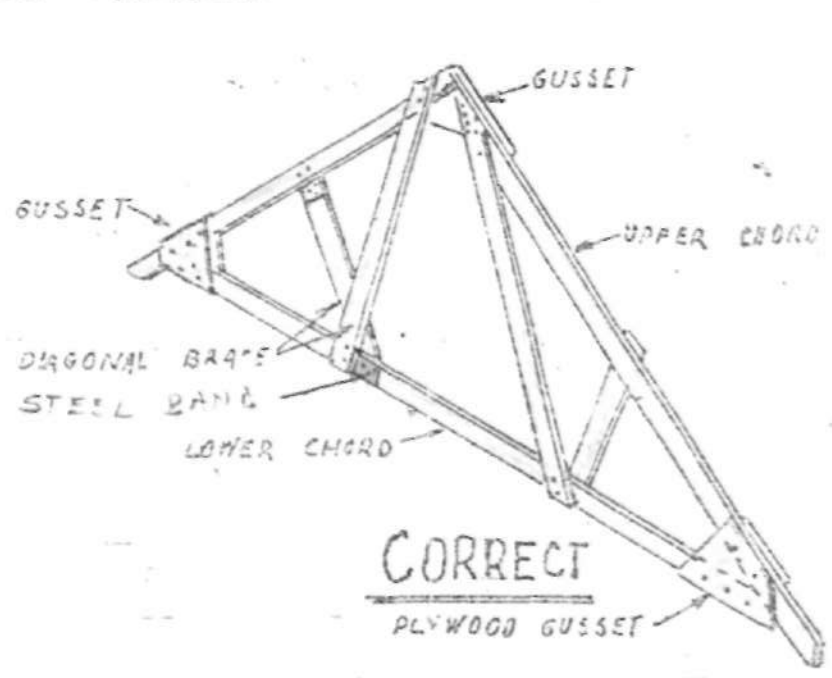


Figure 10 : Showing correct and incorrect way of constructing timber roof.

CHAPTER THREE

3.0.0 INVESTIGATION OF SOME SELECTED DISTRICTS

Four of the districts of the new Federal Capital Territory were investigated. Repair, renovation and replacement records in respect of some affected buildings in each of the four districts were used to determine the nature and frequency of the repairs of replacements in the district. Two hundred (200) different types of buildings were considered in all. A description of the buildings and the procedure adopted are presented in the following sections.

3.10 GENERAL DESCRIPTION OF THE BUILDINGS IN THE DISTRICTS

3.1.1 NYANYA DISTRICT

This district is housing the low income civil servants and is located about 15 kilometers from the city centre and consists mainly of 1-bedroom blocks of 40 units and 2 Bedroom blocks of 8 Units, built in rows. The type and nature of building materials used in this area are as follows:-

i) the roof structure is made of timbers;

ii) roof covering is corrugated iron roofing sheets;

iii) Ceiling is hardboard and asbestos flat sheets;

iv) electricity supply is constant;

v) soak-away and septic tank are the disposal system available.

a) roof structures made of timber and steel roof truss;

b) roof covering of asbestos and aluminium sheets;

c) ceiling with asbestos and hardboard sheets;

d) constant supply of water and electricity available;

e) Central sewer disposal system available

Type of houses:-

i) 2-bedroom bungalow (detached)

ii) 2 Bedroom semi-detached

iii) 3 Bedroom semi-detached

iv) 3 Bedroom detached

v) 4 Bedroom detached and semi detached.

GARKI:

This is the heart of the city housing mostly medium and high income civil servants. The type of houses here range from 1-bedroom to 4 bedroom.

Type of building materials used are:-

a) roof structure made of steel or timber;

b) roof covering with asbestos or aluminium;

c) Ceiling with hardboard or flat asbestos sheets;

d) first occupied beginning of 1982 besides Nyanya district served as a labour camp,

e) Constant supply of water and electricity;

f) central sewer disposal system available.

The type of houses

i) 1 Bedroom rwo type

ii) 1 Bedroom high rise (block of flats)

iii) 2 Bedroom high rise (block of flats)

iv) 2 Bedroom duplex

v) 3 Bedroom high rise (Block of flats)

vi) 3 Bedroom duplex;

vii) 4 Bedroom duplex;

viii) 4 Bedroom high rise (block of flats)

3.2.0 NALYSIS OF QUESTIONAIRES

The questionaire aimed at identifying the nature of repair or renovation works carried out on some of the buildings in the four districts under consideration (Nyanya, Gwagwalada, Wuse and Garki). The data obtained the following records:-

i) job order forms;

ii) repair requisition forms, and

iii) contractors bills of quantities.

The repair or renovation works that affected the buildings in all the four districts were classified under the following:-

(a) Roof

Works under this group involved the roof covering materials (i.e. asbestos, iron, etc) the roof structure itself and the roof finishing (i.e. ceiling boards and cover strips).

(b) Wall

Any form of repair works to walls (e.g. patching of cracks replastering or repainting) fall under this group.

(c) Floor

This group covers any work to the floor structure (i.e. screeding) of finishing (involving any of the PVC, ceramic or terrazzo finishings);

(d) Components and Carpentry

Repairs to or replacement of both metal and timber doors/windows, kitchen cabinet and wardrobes have been classified under this group.

(e) Electrical Services

Electrical works involving partial of complete re-wiring of buildings, and repairs or replacement of fittings, (e.g., wall bracket, sockets, switches, etc) fall in this group.

(f) Mechanical Services

All works involving repair or replacement of:-

i) water supply system, (e.g. plumbing) within the building

ii) water and waste disposal systems

iii) water closet fittings and

iv) all other fittings are grouped here.

Based on these criteria, the observations on the various areas are presented in the following sections:-

3.2.1 NYANYA DISTRICT

A total of 50 blocks of 800 units were observed in this district. Repair works, and or replacements were made to the following parts of the buildings:-

COMPONENT PARTS	No. of repairs undertaken	Percentage
(a) Roof		
- Coverings	40	80.0
- structure	29	58.0
- finishings	40	80.0
(b) Wall		
- crack	18	36.0
- plastering	15	30.0
- painting	44	88.0
(c) - Floor		
- structure	38	76.0
- finishings	5	10.0
(d) Doors and Windows		
- timber	45	90.0
- metal	3	6.0
- ironmongery	35	70.0
- glazing	10	20.0
(e) Carpentry and Joinery		
- Kitchen cupboard	7	14.0
- wardrobe	-	-
(f) Electrical Services		
- wiring	24	48.0
- fittings	19	38.0
(g) Mechanical Services		
- water supply	27	54.0
- waste disposal system	34	68.0
- water closet	22	44.0
- other fittings	19	38.0

Table 1a: Extent of defects observed at Nyanya District.

Table 1b: Observations on the repairs at Nyanya District

Component Parts	Observations	Remakrs
(a) Roof	A large number of the 50 blocks of houses needed repairs to their roof coverings and ceilings. Each of these parts counted for 80% of the repairs to the roof. However, 58% of the total work on roof involved the entire roof structure.	Repairs to roof covering were caused as a results of the effect of wind, which tore them off. The ceilings subsequently got damaged by rain. On inspection, it was observed that the roof coverings were low guage, therefore too thin to stand the effect of wind. The trusses in the roof structure not adequately secured to the buildings.
(b) Wall	Majority of the houses (88%) needed repainting. 36% of them had cracks in their walls that were sealed up. A mere 30% required replastering.	Paint peeling is caused as a result of poor adhensive to wall surfaces. Poor plastering and low quality of paint are the main causes of paint peeling. Cracks in walls are caused by a poor workmanship, weak mortar mix.
(c) Floor	Of the 50 blocks observed, 38 (or 76%) had broken floor screed. Only 10% of the houses had any problem with their floor top finish (this was the PVC type of floor finish in all the case)	Wrong proportioning and choice of concrete materials by the contractor will cause even a well made concrete floor to crack under normal loading conditions. Even a well laid PVC floor tiles will come off if the occupants of the building continually expose them to heat.

Componets Parts	Observations	Remarks
(d) Doors and Windows	The bulk of defects reported in the cases of doors involved timber doors. This is represented in 90% of the 50 blocks observed. Repairs related to locks, door handles and hinges occurred in 70% of the houses. 20% of them needed window/door glasses fitted. Only 6% of the metal doors in the houses had problems.	Soft (wood) timber was used in the manufacturer of the door and window components. These do not resist the effect of rain for any long period. Additionally they easily give away to wear and tear from normal use. Furthermore these components do not retain locks and handles in them for long because their soft nature, makes the screws too loose in their holes.
(e) Carpentry and Joinery	Only 14% of the kitchens in the houses had some form of defects in their cupboards.	There were few wardrobes and kitchen carbinet in this district.
(f) Electrical Services	Almost half the number of the houses in the 50 blocks (i.e. 48% required either complete or partial rewiring. 38% of them had sockets, switches or other electrical fittings that were faulty.	All the houses that need complete re-roofing also had to have new wiring in the roof. Sockets and switches were changed either they got damaged from use or were burnt. Sub-standard electrical fittings normally get burnt. Replacements of fittings like bulbs and flourescent tubes are normal with every day use.

Components Parts	Observations	Remarks
(g) Mechanical Services	Defects in waste disposal system were reported in 68% of the houses. these were either in the form of broken or blocked pipes. 54% of the houses had faulty taps. Defects in water closets were reported in 44% of the houses. Only 38% of the houses had problem with their wash Hand basins, bath or shower traps	Inadequate supply of water to the buildings makes the occupants to use different means to dispose of their wastes. Newspaper and other hard (and non-dissolving) substances ultimate breakages in the waste disposal systems. The taps have plastic heads (rubber washers) which break easily. The top plastic covers on the WC's were mostly broken from use. The bases of the WC's tend to get dislodged, because of mis-use by the occupants.

Components Parts	Total Number of Reported Defects	Percentage of Total Reported Cases
(a) Roof	109	23.0
(b) Wall	77	16.0
(c) Floor	43	9.0
(d) Doors and windows	93	20.0
(e) Carpentry and Joinery	7	1.5
(f) Electrical Services	43	9.0
(g) Mechanical Services	102	21.5
T o t a l	474	100.00

Table 1c: Total number of Defects Reported in Nyanya District.

GENERAL REMARKS

From the observations the defects in the 50 blocks of houses considered in this district can be listed in decreasing order of magnitude as (1) Roof 23%, (2) Mechanical Services 21.5%, (3) Doors and windows 20% (4) Wall 16% (5) both floor and Electrical Services 9% (6) Carpentry and Joinery 1.5%. In roofs, the defects largely related to roof coverings and ceiling. In 58% of the houses the total structures were also affected and had to be made again. Mechanical services defects mostly manifested in the form of blocked or broken waste pipes. 54% of the houses had faulty water taps. Some houses(44%) needed replacements of at least a water closet.

Defects in doors and windows are in the third place with 20%. In most of the houses one of more of the flush doors were defective. In some cases the doors had to be changed complete with their fittings. In others the doors needed repairs and replacements of handles, locks or hinges. In the case of wall, more than 80% of the houses required repainting. Other significant defects were cracks and peeled-off plaster.

3.2.2 GWAGWALADA

A total number of 50% housing units were observed in this district. Repair works, and or replacements were made to the following parts of the buildings:-

Components Parts	Number of Repairs undertaken	Percentages
(a) Roof		
- Covering	46	92.0
- structure	40	80.0
- finishings	46	92.0
(b) Wall		
- cracks	12	24.0
- plastering	18	36.0
- painting	50	100.0
(c) Floor		
- structure	38	76.0
- finishings	33	66.0
(d) Doors and windows		
- timber	42	84.0
- metal	9	18.0
- ironmongery	37	74.0
- glazing	37	74.0
(e) Carpentry and Joinery		
- kitchens cupboard	37	74.0
- wardrobes	8	16.0
(f) Electrical Services		
- wiring	27	54.0
- fittings	40	80.0
(g) Mechanical Services		
- water supply	29	58.0
- waste disposal	37	74.0
- water closet	37	74.0
- other fittings	33	66.0

Table 2A: Extent of defects observed at Gwagwalada

Table 2b: Observations on the repairs at Gwagwalada

Components Parts	Observations	Remarks
(a) Roof	Roof covering and ceiling in 92% of the houses observed in this district were defective. 80% of the houses needed additional repair works on the main roof structure	Winds were able to remove the roof coverings easily from the roof structures because they (the coverings) were thin. The structures were not constructed rigid enough to withstand the winds. The ceiling subsequently got damaged
(b) Wall	All the houses considered in the district required repainting 36% of them were replasterd and 34% had cracks in the walls that need patching.	Poor workmanship in plastering and the use of low quality paints were the main causes of these defects
(c) Floor	76% of the houses had broken floors, and 66% had defective floor finishing that needed replacing	Wrong proportioning and poor choice of concreting materials by the contractor will cause a well made concrete floor to develop cracks under normal use. Sudden expansion from the use of heater by occupants cause PVC floor tiles to come off.
(d) Doors and Windows	Timber flush doors in 84% of the houses were defective, Repairs and, or replacements are made to door handles, locks and glazing in 76% of the 50 houses observed in the district. Only 18% of the houses reported any defective metal doors	All the door and window components were made from soft timber. These do not resist the effect of rain (especially when directly exposed) for long. They also easily give away to normal wear and tear especially of doors/windows. Furthermore their soft nature does not allow them to retain locks handles in them for long because the screws get too loose in their holes and fall off.

Components Parts	Observations	R e m a r k s
(e) Carpentry and Joinery	Defects were reported and, subsequently, repairs were made to the cupboards in 74% of the kitchens in the district. However only 16% of the wardrobes needed any repairs.	Kitchen and room carpentry work was made from the same quality of material as the doors. The kitchen cupboards are located from the floor level, therefore more people can get access to them than (for example) the wardrobes.
(f) Electrieal Services	A large numbers of the houses (80%) had faulty or defective sockets, switches and other electrical fittings. 54% of the houses required either complete or partial re-wiring.	All those houses that were re-roofed had to be re-wired also. Substandard and wrong sockets get burnt easily, but replacements of other fittings like flourescents tubes are normal occurrences with daily use.
(g) Mechanical Services	Defects in waste disposal system and water closet were reported in 74% of the houses. The former was either in the form of broken or blocked pipes. The water closets needed complete replacement in some cases and partial replacement in others. 66% of the houses had problems with the wash hand basins and other fittings like bath tubs. Only 58% of the houses had faulty taps.	Inadequate erratic supply of water to buildings makes the occupants of such buildings to use other means to dispose off their wastes. News papers, and other hard substances do not dissolve in these systems, but become rock hard causing complete blockage and ultimate leakages of the waste disposal systems. Wash hand basin and WCs get loose from walls or floors because of a combination of mis-use and bad workmanship. Even where the work is good, such fittings would easily come-off if not used properly.

Components Parts	Total Number of Reported Defects	Percentage of Total Reported Cases
(a) Roof	132	20.1
(b) Wall	80	12.1
(c) Floor	71	10.3
(d) Doors and windows	125	19.1
(e) Carpentry and Joinery	45	6.9
(f) Electrical Services	67	10.2
(g) Mechanical Services	136	20.7

Table 2c: Total number of defects reported at Gwagwalada

GENERAL REMAKRS

The defects observed in the 50 housing units in Gwagwalada District can be arranged in this order:-

1st Mechanical services 20.7%
2nd Roof 20.1%
3rd Doors and windows 19.1%
4th Wall 12.0%
5th Floor 10.8%
6th Electrical Services 10.2%
7th Carpentry/Joinery 6.9%

Mechanical services problems in 74% of the houses were mostly of blocked waste disposal pipes and water closets. The roof coverings and ceiling in almost all the 50% houses were defective. A large proportiong (i.e 80%) of roof structures also had to be reconstructed.(see figure 11-14)

Door and Windows defects were mostly to do with replacement of broken glasses and parts of the ironmongery. All the houses needed repainting and a few (36%) had defective plaster work.

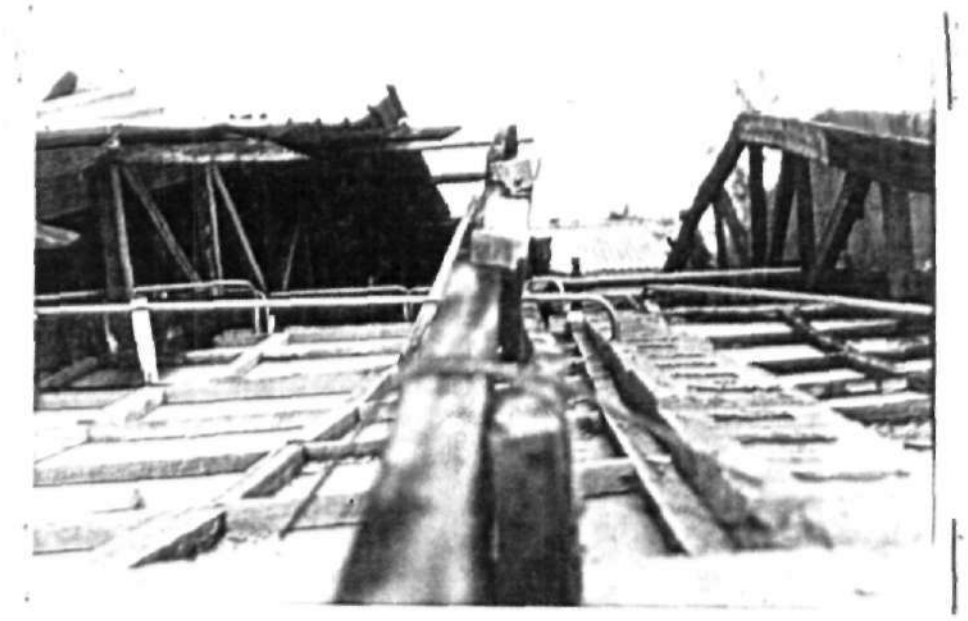


Figure 11: Roof blown off by wind - ceiling and electrical works affected

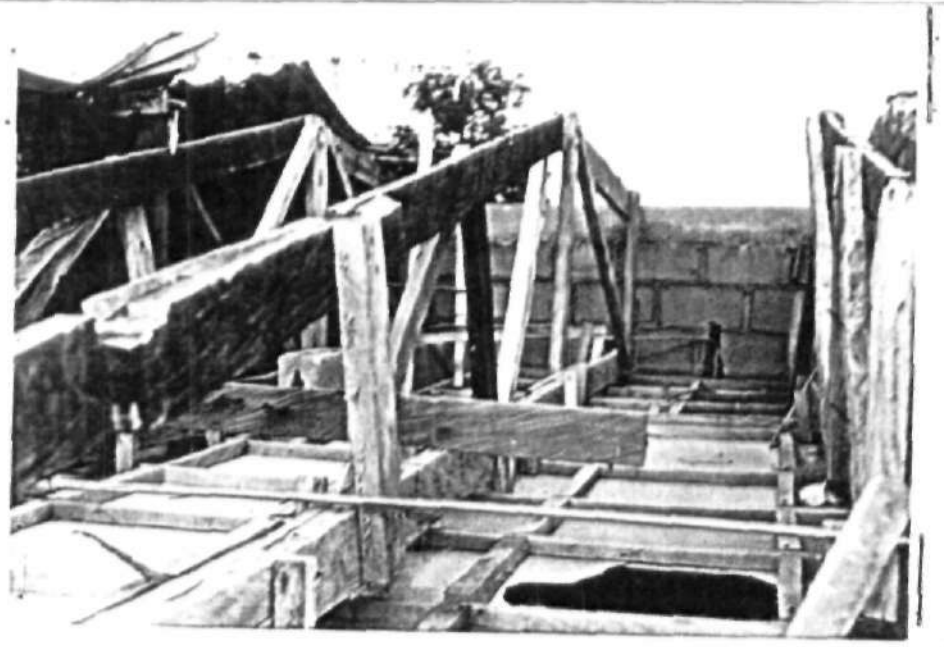


Figure 12: Uneven treatment roof with antitermite chemical also shows white soft wood

Figure 13: Aluminium sheets and purlins blown off living the rafter in position

Figure 14: A four bedroom duplex with roof structure blown - off at wuse

3.2.3 GARKI DISTRICT

Fifty (50) various types of housing units were observed in this district. Repairs works, and or replacements were made to the following parts of the buildings:-

Components Parts	Number of Repairs Undertaken	Percentage
(a) Roof		
- Coverings	30	60.0
- structure	7	14.0
- finishings	30	60.0
(b) Wall		
- cracks	16	32.0
- Plastering	19	38.0
- painting	45	90.0
(c) Floor		
- structure	22	44.0
- finishings	3	16.0
(d) Doors and windows		
- timber	36	72.0
- metal	13	26.0
- ironmongery	35	70.0
- glazzing	26	52.0
(e) Carpentry and Joinery		
- kitchens cupboards	28	56.0
- wardrobes	20	40.0
(f) Electrical Services		
- wiring	17	34.0
- fittings	32	64.0
(g) Mechanical Services		
- water supply	21	42.0
- waste disposal system	12	24.0
- water sloset	22	44.0
other fittings	20	60.0

Table 3A: Extent of defects observed at Garki

Table 3b: Observations on the Repairs at Garki

Components Parts	Observations	R e m a r k s
(a) Roof	More than half the number of houses considered in this district had faults in their roof coverings and ceiling. Exactly 60% of the houses needed repairs to both their roof covering and ceilings, only 14% had problems with the actual roof structural members.	Low gauge (i.e. thin) roofing materials were used. These coverings can easily be holed or broken. Whenever any of these occurs rain tends to affect the ceiling. Most of the roof structure was steel, therefore the only damaged was done to the few soft timber roof structures and in some cases the length of nail used to secure the purlin to the rafter was not long enough, eventually pulled out.
(b) Wall	Most (i.e. 90%) of the 50% houses needed repainting. 38% of them had some defective, plaster work that required - re-doing. In 32% of the houses the walls had cracks which were repaired.	Poor workmanship in plastering and the use of low quality paints. Poor mortar mix by contractors were the main cause of these defects.
(c) Floor	Defects were reported in some floors of 44% of the houses. Only 16% of the houses had problems with the floor top finishings.	Wrong proportioning and poor choice of concreting materials by the contractors were the main cause of cracks in the floors. Low quality adhensive used in lating the PVC tiles by the contractors caused some defects.
(d) Doors and Windows	72% of the houses had timber flush doors that were defective. These were either changed in whole or just repriared. Locks door handles, or hinges were either repaired or replaced in 70% of the houses. Door and, or window glasses were replaced in 52% of the houses. Only 26% of the houses had problems with their metal doors.	All the flush doors had no hand core and were made from soft wood. These do not resist the effect of rain (in the case of external doors) and hardly stand the wear and tear of normal use required of doors.

Components Parts	Observations	Remarks
(e) Carpentry & Joinery	More than half (i.e 56%) of the kitchens in the houses had defects in their cupboards. 40% needed repairs made to their ward robes.	Carpentry work in kitchens and rooms were made from soft timber which does not allow these components to resist normal wear and tear for long.
(f) Electrical Services	About 64% of the houses in the district had fault or defective sockets, switches and other electrical fittings less than half (i.e 34%) of the member of the houses requires either part or complete re-wiring.	Sub-standard and wroung sockets/switches get burnt easily. Other replacements (for example bulbs) are expected from normal use.
(g) Mechanical Services	Faults in wash hand basins, bath tubes and related fittings were repaired in 60% of the houses. Water closets were changed or repaired in 44% of the houses. 42% of them had partly taps. Defects in waste disposal system were reported in 24% of the houses. These largely manifested in the form of broken and blocked waste pipes.	Wash hand basins and WCs get dislodged from walls or floors as a result of poor workmanships. Even where the quality of work is good, mis-use by the occupants will cause these fixtures to remove from position.

Components Parts	Total Number of Reported Defects	Percentage of Total Reported Cases.
(a) Roof	67	14.3
(b) Wall	80	17.1
(c) Floor	30	6.4
(d) Doors and windows	110	23.5
(e) Carpentry/Joinery	48	10.2
(f) Electrical services	49	10.4
(g) Mechanical services	85	18.1
T o t a l	469	100.0%

Table 3c: Total number of defects reported at Garki

GENERAL REMARKS

From the observations in table 3c the defects can be ranked in decreasing order as follows:-

1st doors and windows	-	23.5%
2nd mechanical services	-	18.1%
3rd wall	-	17.1%
4th roof	-	14.3%
5th electrical services	-	10.2%
6th Carpentry and joinery	-	10.2%
7th floor	-	6.4%

Im most of the houses (72%) the flush doors were defective. It was observed that in 70% of these cases the doors had to be changed completely with locks and handles. It was only in a few cases that they needed minor repairs.

Mechanical services defects related to replacements of wash hand basins and other fittings in 60% of the houses. While blocked waste pipes and broken water closets were reported in more than 40% of the houses.

Exactly 90% of the houses needed repainting and more than 30% of them had cracks in their walls, and defective plaster work. (See Figure 15-17).

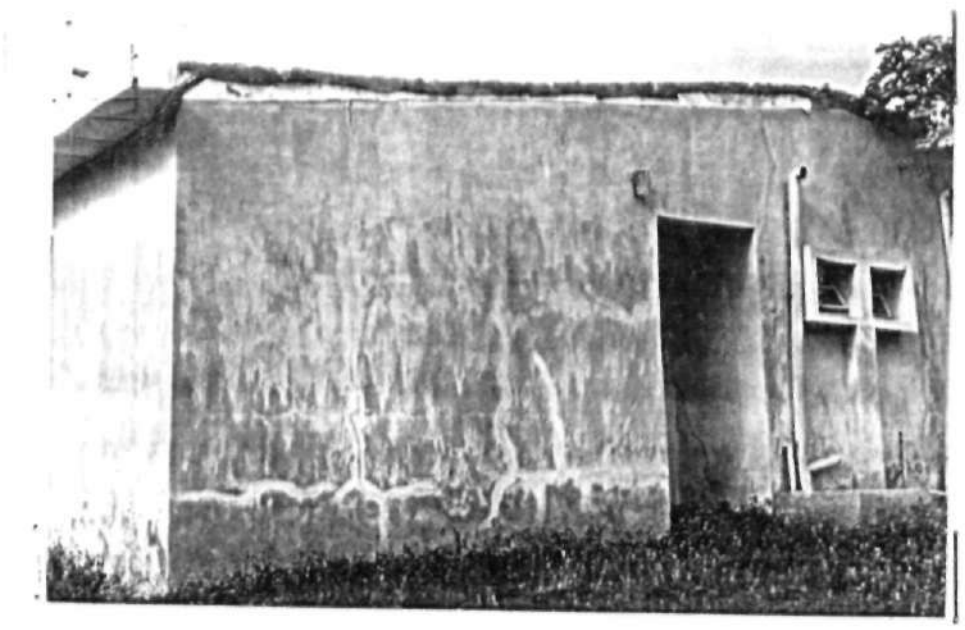


Figure 15: Roof removed completely with members, and cracked and peeled off plaster on walls

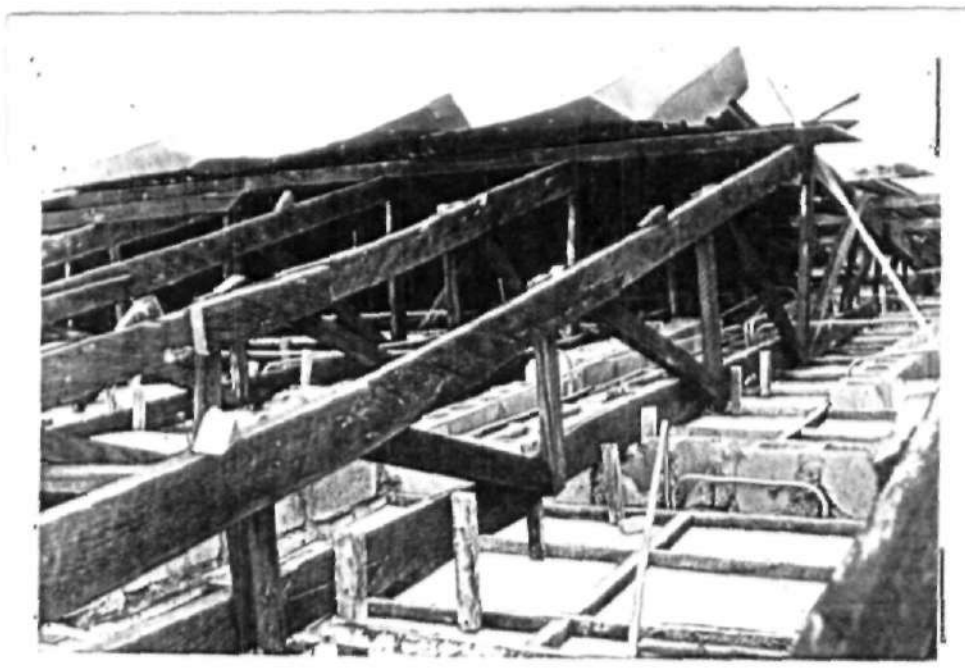


Figure 16: Purlins and Aluminium sheets blown off from rafter due to inadquate fixing to rafter

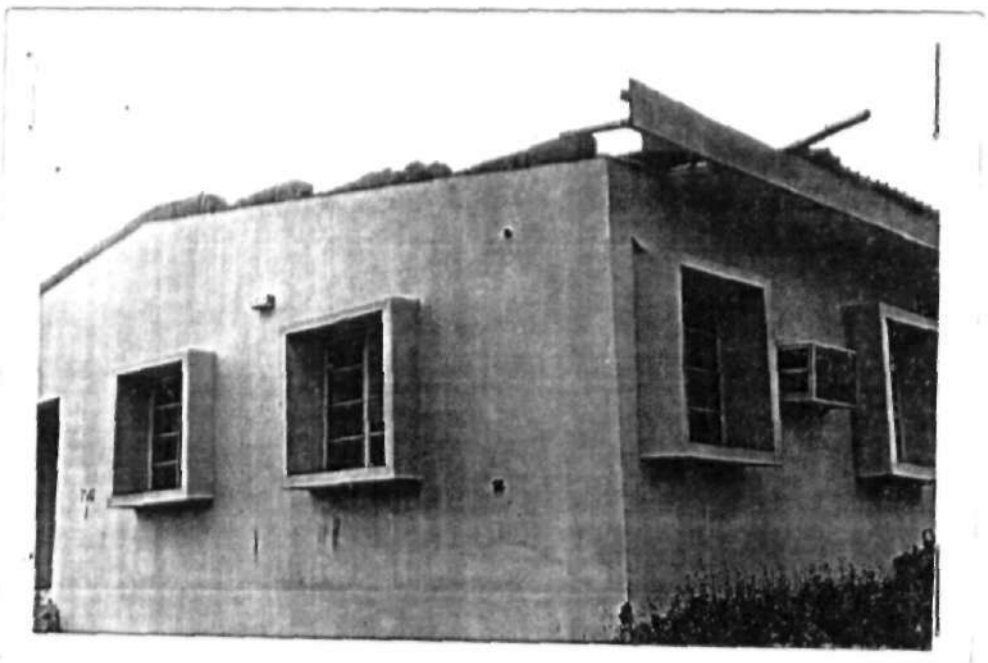


Figure 17: Rafter, purlins and roofing sheets blown - off from wall due to non provision of roof beam

Defective roof covering and ceiling were observed in 60% of the houses. Only a few (14%) had problems with their roof structure.

3.2.4 WUSE DISTRICT

A total of 50 houses were observed in this district. Repair works, and or replacements were made to the following parts of the buildings:-

Components Parts	No. of repairs Undertaken	Percentage
(a) Roof		
- covering	27	54.0
- structures	11	22.0
- finishings	27	54.0
(b) Wall		
- crakcs	9	19.0
- plasterings	18	36.0
- painting	42	84.0
(c) Floor		
- structure	17	34.0
- finishings	12	24.0
(d) Doors and windows		
- timber	34	68.0
- metal	7	14.0
- ironmongery	18	36.0
- glazing	14	28.0
(e) Carpentry/Joinery		
- kitchen cupboard	11	22.0
- wardrobe	9	18.0
(f) Electrical services		
- wiring	11	22.0
- fittings	29	58.0
(g) Mechanical services		
- water supply	14	28.0
- waste disposal system	10	20.0
- water closet	13	26.0
other fittings	19	38.0

Table 4A: Extent of defects observed at Wuse

Table 4b: Observations on the repairs at Wuse

Components Parts	Observations	Remarks
(a) Roof	Roof coverings and ceiling in more than half (i.e 54%) of the houses considered in this district were defective. Only 22% of the houses needed repairs to the main roof structural members.	Low gauge (i.e thin) roofing materials were used. These covering can easily be hold or broken (in the case of thin asbestos). Whenever any of these occurs, rain gets in and damage the ceilings. Most of the roof structure was steel therefore the only damage was done to the few soft timber roof structure.
(b) Wall	A large proportion (84%) of the 50% houses observed in the district nedded repainting. 36% had some defects in their plaster-work and required replastering. A small proportion (18%) of the houses had cracks in some parts of their walls	Poor workmanship in plastering and the use of low quality paints by contractor were the major cause of these defects
(c) Floor	Only 34% of the houses had defective floor screeds, and 24% had problems with their finishings.	Wrong proportioning and poor choice of concreting materials by contractors can cause defects in floor screeds even under normal use.
(d) Doors and Windows	Timber flush doors in 68% of the houses were defective. Repairs and, or replacements were made to doors handles, locks, and hinges in 38% of the 50 houses observed ir the district. 28% of them needed glass replacement to metal doors and windows. only 14% of the houses reported any defective metal doors.	The flush doors had no handcore and were made from soft wood timber. These do not resist the effect of rain ((especially with respect to external doors) and hardly stand the wear and tear of normal use required of doors.

Components Parts	Observations	Remarks
(e) Carpentry/ Joinery	22% of the houses had defects kitchen cupboards, and only 18% of them had problems with their wardrobes	Carpentry work was also done from soft timber which hardly stands continous opening and closing
(f) Electrical Services	More than half the number of houses (i.e. 58%) had faulty or defective electrical fittings (e.g. sockets, switches etc). 22% of the houses requires either complete or partial re-wiring.	Substandard electrical fittings get burnt easily and have to be changed. The new houses that required re-roofing also had to have the wiring done up again.
(g) Mechanical Services	Defects in wash hand basins, bath tubs and shower trays were reported in 38% of the houses. 14 houses (accounting for 28% had faulty water taps that were repaired. 26% of the houses had problems with their water closets. Only 20% of the 50 houses had defects in their waste disposal system.	Wash hand basin (and WCs) get dislodged easily from their positons in walls and floors as a result of poor workmanship. Even where the quality of the work is good, mis-use by the occupants will cause these fixtures to remove away from position.

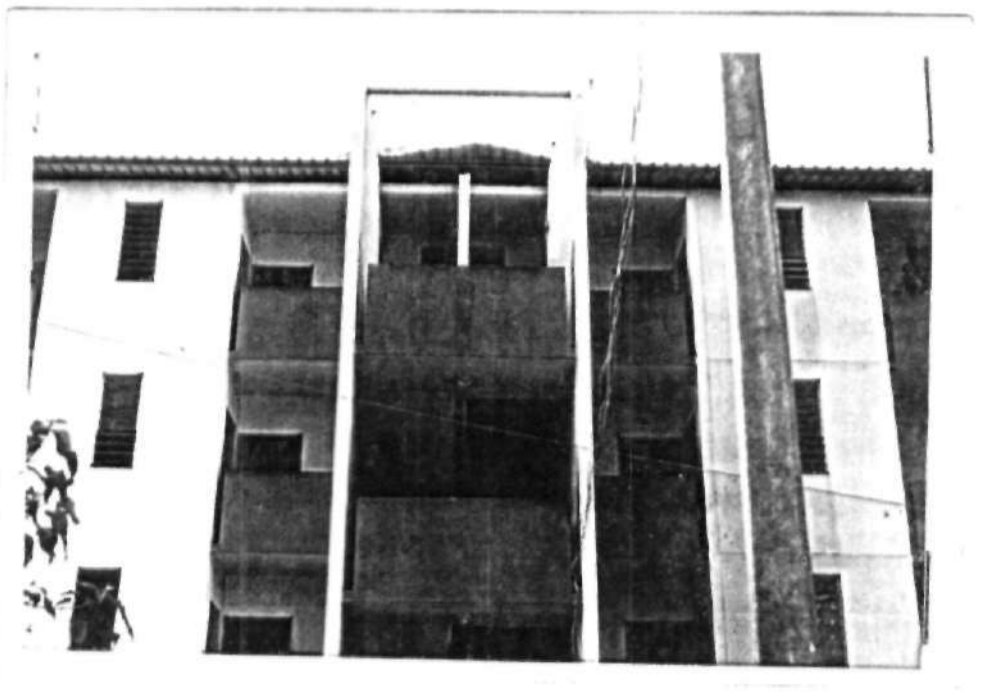


Figure 18: Steel purlin not well - secured to the roof beam being blown off

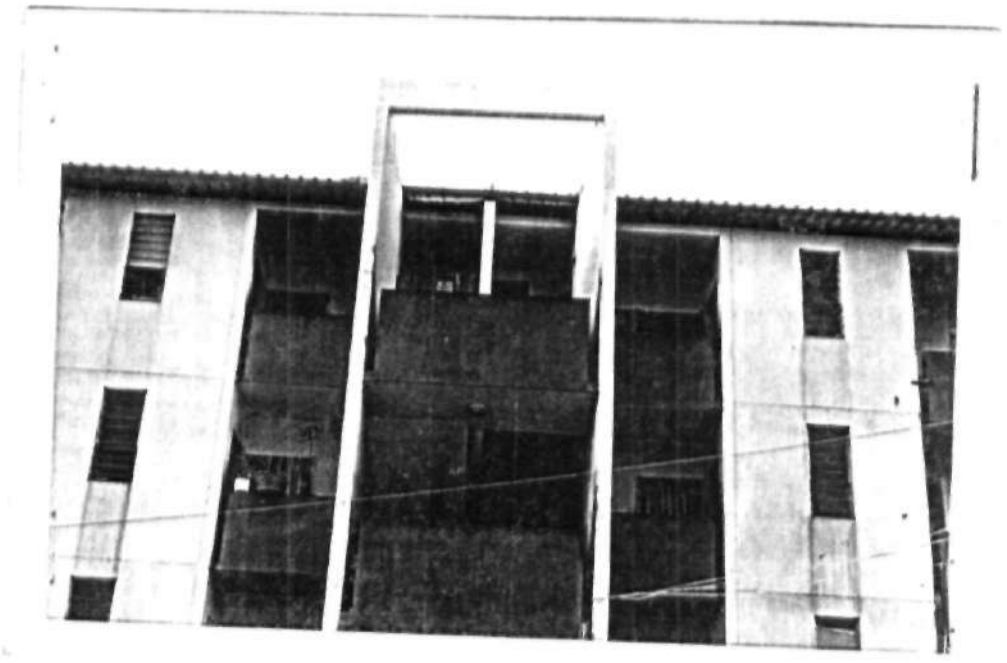


Figure 19: Aluminium sheets removed from purlin due to low thickness,living the hook bolt with purlin

CHAPTER FOUR

4.0.0 SUMMARY

The need for a new Federal Capital arose becuase Lagos has become inadequate in playing the dual role of a state and federal capital. The new capital was designed for an ultimate population of 3.2 million, and the project is expected to provide decent and healthy living conditions for all the residents of Abuja. Movement from Lagos to the new capital, Abuja was planned in phases. About 3,524 housing units alone were completed by 1982 ready for the first phase of the movement expected as well as the movement calender have now been reviewed. The first movement was in 1986 the second ended by December, 1988 and the final is expected to last till 1991.

A building is deemed to be formorming well it is stands the wear and tear of every day use; requiring very little and infrequent maintenance. The aim in building design is to specify a certain level of quality. Constructional procedures on site assure that the building attains the desired quality on completion. This responsibility has been seen to lie with the contractor. The degree to which the building comtractor produces the desired quality in the building depends on how faithfully he has adhered to quality control procedures and supervision in the various stages of contructing the building.

From the investigations carried out in four districts (Nyanya, Gwagwalada, Garki and Wuse) various defects have been identified in a number of buildings already completed. These ranged from minor maintenance repairs to partial and (in some cases) complete change of some

Table 5 below shows the total number of defects reported in the districts:-

S/No.	Affected Parts	Total Number of Reported Cases	% of Total Number of Reported Cases
1.	Roof	373	19.1
2.	Wall	306	15.7
3.	Floor	173	8.9
4.	Doors & Windows	401	20.6
5.	Carpentry/Joinery	120	6.2
6.	Electrical services	199	10.2
7.	Mechanical services	379	19.4
	Total	1,951	100.0

From observation, the defects can be ranked in decfeasing order as follows:-

First	Doors and windows	20.6 percent
Second	-Mechanical services	19.4 percent
Third	Roof	19.1 "
Fourth	Wall	15.7 "
Fifth	Electrical services	10.2 "
Sixth	Floor	8.9 "
Seventh	-Carpentrh/Joinery	6.2 "

4.1.0 CONCLUSIONS

It was observed from the analysis of the questionaire administered and records obtained on the buildings in these districts that:-

(a) The highest group of reported defects are those repated to doors/windows mechanical services and roof (i.e 20.6 percent, 19.4 percent and 19.1 percent respectively);

(b) Wall defects are also serious (15.7 percent).

Low quality timber is used for the doors and windows. This is why almost 100 cases of this defects was reported in each of the four districts. Mechnical services defects mostly manifested in the form of blocked or broken waste disposal systems. This generally caused by the use of semi solid materials(e.g. paper) and infrequent flushing of toilets due to lack of water. This was rampant in Nyanya and Gwagwalada districts where there is no proper water distribution system. These districts accommodate the low and medium level civil servants. Blown-off and leaking roofs were also mostly in Nyanyan and Gwagwalada districts, where there are apparently higher winds associated with the rainfall pattern. In most cases, soft structures, and covered with low gauge roofing sheet (galvanised from zinc) in the two districts.

The presence of these defects may be attributed to the non-conformance (by the building contractors) to specifications and standards in the cause of executing these projects. This trend, if left unchecked, would also spread to those buildings still under construction.

4.2.0 RECOMMENDATIONS

The following would be recommended:-

1) Tropical metal and/or steel casement doors and windows should be used, or provided to replace the existing ones in the low and medium group houses at Nyanya and Gwagwalada where they are highly exposed to weather conditions from the outside;

2. Improvement in water supply to Nyanya and Gwagwalada districts and more enlightenment on the use of proper materials in the toilets, would go along way to reducing the frequency of blockages in their waste disposal;

3. (a) Provision of reinforced concrete roof beams round buildings and hook bolts to secure the rafters to it;

   (b) Parapet walls should be provided in storey buildings to protect their roofs against strong wind;

   (c) hardwood (timber) should be used for the roof structure;

   (d) Longer nails and metal strips should also be used to properly anchor the roof members;

   (e) thicker metal and asbestos roof coverings should used.

4. The department of Public Works of the Federal Capital Development Authority should provide adequate supervision on all their building construction sites. This would ensure that contractors strictly adhere to specifications and standards of quality in their works.

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