

Original Research Article**A STUDY OF ROOF FAILURES IN AND AROUND IBADAN, NIGERIA: CAUSES, EFFECTS AND REMEDY****ABSTRACT**

A random survey was carried out on the collapsed and ripped off roofing systems in the South-Western Nigeria. The survey revealed that perennial roofing problems were not limited to old roofs. Newly constructed ones, in both rural and urban areas are equally affected. Poor workmanship, design error, age and environmental forces, materials inadequacy, roof geometry and topographical location have been identified as the major causes of roof failures with relative frequency of occurrence of 30.48 %, 14.76 %, 10.28 %, 18.64 %, 14.08 %, and 11.76 % respectively. Measures for minimizing incidences of roof failures were therefore suggested

Key words: Roof; Failure; Causes; Effects; Remedy

1.0 Introduction

Roof failure is a common occurrence in several parts of Nigeria, and all categories of buildings in the different regions are affected. Roof failure is not peculiar to Nigeria as several countries of the world including the developed nations experience roof failure. In Britain, current statistics suggest that about 70% of the insured loss costs of storm relate to domestic property includes roof failure (Ajagajigiegbirrin, 2011). The roof is an important component

of any building and its total failure invariably renders the structure over which it is built unsuitable for habitation. Whenever there is total failure of roofing system, it is often associated with dangers to other buildings and passersby. It also affects facilities such as electric lines. The problems arising from roof failures are crucial in the development of any community and efforts must be made to minimize or where possible eliminate them. An understanding of the causes and patterns of failures of roof is necessary.

The World Health Organization (WHO) recognizes that the roof is one of the important requirements for a house to be considered suitable for healthy habitation (WHO, 2005). This is because while a house may be inhabited without some elements of buildings such as partition walls, beams or columns, a house without a roof is not conducive for human and even animal accommodation.

The protection and comfort which building roofs should provide to occupants, the contents of buildings and external walls are frequently threatened by failures in the roofing system. The cost of repairs or a complete replacement of a failed roof could be enormous. These include cost of repair in terms of material and labour; the cost of alternative accommodation pending the repair of the roof; the cost of treatment for injuries sustained by persons that the roof has fallen on; the cost of treating ailments such as pneumonia to persons directly affected by roof failures; the cost of replacing property loss in the affected building, and the trauma and psychological disorientation for those living within any building whose roof has failed. Investment in building maintenance is huge all over the world. In most countries, it represents almost 50 per cent of the total turnover of the construction industry (Olanrewaju, 2009).

As in most of West Africa, Nigeria's climate is characterized by strong latitudinal zones, becoming progressively drier as one moves north from the coast. Rainfall is the key climatic

variable, and there is a marked alternation of wet and dry seasons in most areas. Two air masses control rainfall--moist northward-moving maritime air coming from the Atlantic Ocean and dry continental air coming south from the African landmass. In the coastal and southeastern portions of Nigeria, the rainy season usually begins in February or March as moist Atlantic air, known as the southwest monsoon, invades the country. The beginning of the rains is usually marked by the incidence of high winds and heavy but scattered squalls. Temperatures throughout Nigeria are generally high; diurnal variations are more pronounced than seasonal ones. Highest temperatures occur during the dry season; rains moderate afternoon highs during the wet season. Average highs and lows for Ibadan and environs are 31° C and 23° C in January and 28° C and 23° C in June. Although average temperatures vary little from coastal to inland areas, inland areas, especially in the northeast, have greater extremes. There, temperatures reach as high as 44° C before the onset of the rains or drop as low as 6° C during an intrusion of cool air from the north from December to February. All these environmental forces contribute to the factors resulting to damages to the building especially the roof.

In the past, many attempts have been made to solve the problem of roof failures. These included the use of various roofing materials, the different construction methods; construction of block wall on the roof, the use of roofs of different shapes and planting of wind breakers. These methods are not full proof as there are still records of damages even with these in place. The construction of wall on the roof makes roof to be susceptible to leakage because the roof/wall interface may not be adequately taken care of. Wind breakers, if too close to the house can be broken during wind storm and cause damage to the roof. An understanding of the effects of environmental factors and performance potential of materials of construction would be useful in the design and construction of appropriate roof structures. Despite the antecedents

of roof failure, its scourge and havoc it promises to wreck in future going by its trend, individuals and governments had for long-time not paid adequate attention to roof failure disaster. An improvement on roofing quality and durability in the zone therefore will mean the understanding of the environment, economy, design, construction practices as well as maintenance culture of the people. It is the incessant cases of roof failure and the exacerbating damages associated with it that has necessitated this research.

The objectives of this work are:

- i) to identify the causes of roof failures commonly experienced in South-western Nigeria,
- ii) to identify the effects of roof failures, and,
- iii) to work out ameliorating measures to minimize the incidences of roof failures

2.0 Literature review

2.1 Roof Failures

Mijinyawa et al (2007) identified eleven major types of roof failure, these include rust, leakage, tearing-off, open lap, truss damage, nail withdrawal, wood decay, sagging, ponding, discolouration and blown-off. The four prominent types of failure are rust; leakage; nail withdrawal and wood decay. Although blow-off is the least failure in occurrence of the eleven identified roof failures, its effect is more severe than any of the other failures (Mijniyawa et al, 2007).

Failure can be defined as any form of behaviour in the roof that seems to threaten the safety of the roof in terms of serviceability or which could lead to total collapse. There are three broad categories of failures, (1) Ultimate limit state generally connected with collapse, (2) Serviceability limit state connected with deflection and vibration, (3) All other limit state

connected with special requirements, for instance, aesthetics, fatigue, fire resistance, and water tightness (Chukwuneke,2000).

2.2 Ultimate Failure

This type of failure is the structural collapse of the roof, it may be slow structural collapse known as plastic failure or sudden failure. These types of failures are usually disastrous in nature and more widely publicized than the serviceable failures. An example of ultimate limit state failure is roof blown-off (Blake, 2001)

2.3 Serviceability Failure

These are fairly frequent form of structural failures observed in roofs. They appear in form of deflection and cracks on a structural member, or a breakdown of waterproofing cover which could result into water penetrating the roof, in case of concrete, initiating corrosion of reinforcements and in wood structure, causing decay and eventual deterioration. They could lead to disruption of services and interruption of business activities (Blake, 2001)

2.4 Special Requirement Failure

This is a functional purpose requirement that has to do with special requirements other than the limit states considered for some special functions other than that of the normal roof functions. For example, in studio design, special precautions are built in the roof to reduce the noise penetration and the acoustics of the roof. The requirement in radiation protection building is to prevent leakage of radio-active elements; here the special requirement is to prevent porosity (Ayoade, 1980)

116 **3.0 Methodology**

117 Survey was carried out using structured questionnaire, interview schedule; focus group
 118 discussion (FGD) and personal observations. The instruments were validated by experts in the
 119 building industry and pre-tested at Apete area in Ibadan, using respondents who did not form
 120 part of the final sample for the study. The pre-testing was very useful as it enabled the
 121 instruments to be revised eliminating redundant questions and including vital questions that
 122 were previously omitted. Altogether, the roofs of randomly selected 1,894 buildings were
 123 examined during the survey carried out in Ibadan metropolis, Abeokuta, Ikeja, Ado-Ekiti, Akure
 124 and Oshogbo in Southwestern Nigeria. Also about 200 people that were affected were
 125 interviewed to know the effects of roof failures on the affected people.

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127 **4.0 RESULTS AND DISCUSSIONS**

128 **4.1 Reliability of the Survey Instrument**

129 To test for the reliability, the test-retest method was used. 40 contractors/suppliers from the
 130 University were randomly selected and the questionnaire was administered on them. After one
 131 month, another administration of questionnaire was carried out. When the two sets results were
 132 correlated, the co-efficient of correlation indicated a high relationship between the two sets of
 133 results. A correlation co-efficient 0.84 significant at 0.05 confidence level was obtained. The
 134 Spearman Brown correlation co-efficient was used.

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140 4.2 Indices and Measurement of Roof Failures

141 There are many ways of identifying failed roofs; their indices are shown in Table 1.

142 They include visual observations, measurements, and calculations where necessary.

143 **Table 1 INDICES AND MEASUREMENT OF ROOF FAILURES**

S/N	Failure	Indices	Measurement
1	Blow off	Lifting and carrying away of total or part of roof	Visual observation; determination of overturning and resisting moment; and determination of wind pressure and suction
2	Sheet removal	Detachment of sheet coverings from trusses	Visual observation; finding the trajectory path and distance of travel
3	Nail removal	Gradual withdrawal of nail fasteners from roof members.	When the joint is weakened by the withdrawal of nails as to cause joint failure. Determining the load bearing capacity of the joints
4	Rust and/ or discolouration	Change in colour of sheet covering materials	Visual observation, rust cases bubbles to form under paint
5	Truss Damage	Tearing of or broken truss of a roof	Visual observation
6	Wood Decay	Deterioration of wood quality by water/moisture penetration	The wood texture is softened and disintegrates; measurement of wood density and stress will be carried out.
7	Leakage	When the roof covering can no longer exclude rain water from penetrating into the house	The dripping of water in the house.
8	Open lap	When the sheeting overlap is open to ingress of water	The line of lapping is loose as to cause flapping of sheets.
9	Sagging	When roof cave in such a way as causing an excessive deflection greater than stipulated in the code	The depth of sagging is measured by tape
10	Ponding	Collection of water on roof due to inadequate drainage of the way.	Visual observation and dripping of water when the covering materials are not water-tight.

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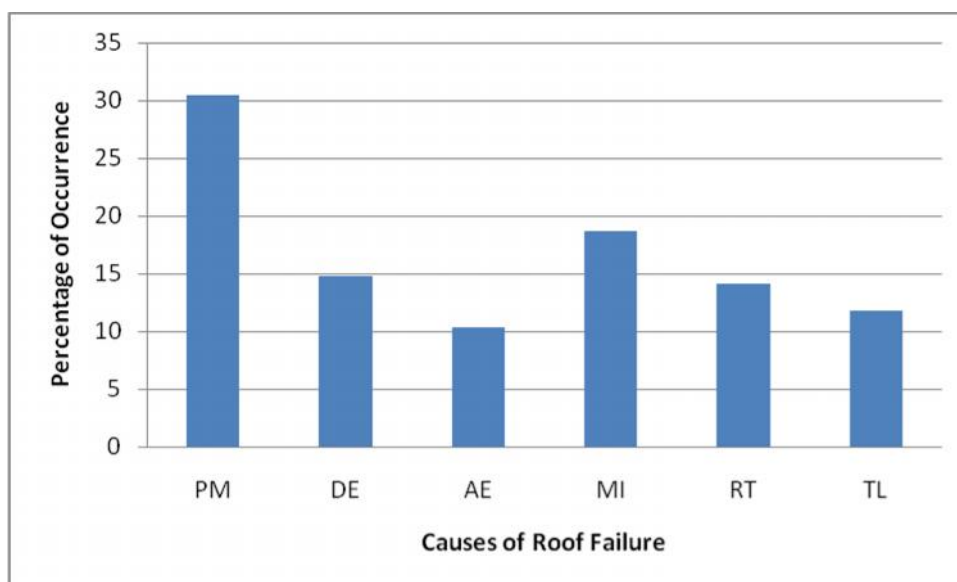
145 4.3 CAUSES OF ROOF FAILURES

146 There are some factors that are primarily the causes of roof failure while others that may
 147 not be primary causes of roof failure can influence roof failure. The primary causes include
 148 design problems, poor construction and installation practices, lack of maintenance, climatic
 149 factors, imposed load on the roof, materials of construction and aging. Factors that can
 150 influence roof failure include poverty of the building owner which in many cases makes

151 building owners to seek for bold-off wood instead of good materials to construct, ignorance,
152 topography of the building location and roof geometry.

153 4.3.1 General Causes of Roof Failures

154 There are six major causes of roof failures that had been identified in the study area.
155 These are poor workmanship, design error, age and environmental forces, materials inadequacy;
156 Roof geometry and topographical Location (Fig 1).
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158 **Fig. 1.0: Causes of Roof Failures**
159 Source: Field survey (2010)

160 Where PW = poor workmanship; DE = Design Error; AE = Age and Environment
161 MI = Material Inadequacy; RT = Roof Type; TL is topographical location

162 4.3.2 Poor Workmanship

163 Much of the damage to roofing system is due to substandard construction, often due to
164 inadequate training or supervision during building, rather than poor design. The random surveys
165 that were carried out revealed that ignorance of some of the carpenters also contributed very
166 greatly to the total collapse of some of the roofing systems that were poorly constructed in some

167 areas. There were situations where the roofing members were structurally adequate, but due to
168 poor construction, the roofing systems became very defective and hence roof failures were
169 experienced. In some situations, it was detected in some cases that either there was no
170 anchorage of the roofing systems to the rest of the building structure or the anchorage provided
171 for the roof was not adequate. Also in situations where rafters are not firmly secured to wall
172 plates, the roofing systems were blown off leaving the wall plates behind. Wrong or inadequate
173 fasteners on the roof covering materials and at the critical stressed areas on roof surface also led
174 to situations where the roof covering materials were ripped off from the roof structure. The
175 random surveys also revealed that nailing was done during construction of the roof structure
176 without detail reference to the end and edge distances. In some cases where the nail does not get
177 good holding in timber roof joints, the timber roof joints were easily distorted under serious
178 windstorm which resulted in the failure of such joints and consequent collapse of some of the
179 roofs. Also the lengths of laps at roof timber joints in some cases were found to be inadequate
180 leading to premature deterioration when the roof is subjected to constant vibrations and that
181 might have caused some of the distortions and failures in some of the laps at some roof joints in
182 some of the collapsed roofs. During roof construction, if the end or side laps are not adequate or
183 when the corrugated roofing sheets are laid in the wrong direction with respect to the direction
184 of the prevailing wind, there will be water back splash resulting in leakages. This leakage if not
185 rectified immediately can lead to the deterioration of the timber roofing members and the
186 rusting of the fasteners in the roofing system. All these can result in the weakening of the entire
187 roofing system and that might also have contributed to the collapse of some of the roofing
188 systems. Non-compliance with design specifications and manufacturers requirements for the
189 use of roof covering materials are the major causes of roof leakages, especially where roof

slopes have been constructed below the manufacturer's recommended minimum level. Failure to stop these leakages immediately resulted in the deterioration members and the loosening and rusts on roofing nails used in the timber joints and when this continues, the roof structure deteriorates and eventually fails. A survey of roof construction practices in general in the country, has revealed that there is complete lack of supervision during roof construction by experts. The general practice has been that the would-be house owners, and even some of the functional roof designers, most of the time rely on the experience of the carpenters during the construction of the roof. In most cases, these artisans are usually not supervised and are allowed to construct the roof the way they think is right. This over reliance on these "so-called" experienced roof artisans is a major cause of the perennial roofing problems facing the housing industry, since most of the roofs constructed by them are usually defective and can easily collapse under any serious rainstorm

4.3.3 Material Inadequacy

Conventional roofing materials suffer from a number of disadvantages. Asphalt and asbestos, for example, are both very heavy and brittle materials with a typical useful life of approximately 15 to 25 years. As these materials approach the end of their useful lives, they deteriorate in both appearance and function. Asbestos has been found to be an environmentally unsafe material, and is rarely used in roofing today. Clay and slate roofing material are also both heavy and brittle, and require a sturdy roof foundation to hold them in position. In addition, damaged clay or slate roofs are very difficult to repair. Wood and thatch roofs suffer a serious disadvantage since neither is fire resistant. The survey revealed that, due to the high cost of the standard structural roofing members, the would-be house owners who usually adopt direct labour techniques in their projects normally go in for off-cuts and undersized structural

213 timber members which are relatively cheaper but structurally inadequate. The roof structures
 214 formed from these timbers are usually prone to various types of failures which include warping,
 215 sagging and decay. The lightweight nature of most of roof structures formed this way from
 216 smaller timber sections makes them highly susceptible to damage from suction caused by
 217 strong winds and that also contributed greatly to the collapse of some of the roofing system.

218 Table 2 Distribution of Roof Designers

Type	No. of Building Roofs	Percentage
Architect/Engineer	918	48.47
Carpenter	880	46.46
Others	96	5.07
Total	1894	100

219 **Source: Field Survey (2010)**

220 4.3.4 Design Error

221 Structural inadequacy was found to be one of the major causes of the collapse and
 222 ripping off of some of the roof structures. The result of the random surveys of roof undertaken
 223 indicates that only 48.47% our roofs are said to be designed, while more than half of the roofs
 224 (51.43%) were left to the discretion of the carpenters and the house owners (Table 2). The
 225 growth design approach that relies basically on experience, intuition, common sense and the
 226 rule-of-thumb were employed in their design. In such a situation, those artisans who possess
 227 these qualities are able to size structural roofing members without having to resort to design
 228 code, theories and rigorous computations since they have the understanding of what the correct
 229 sizes of the roofing members should be. Artisans, who are less experienced, do not have the
 230 requisite sense to size structural roofing members, so they rely mostly on the rule-of-thumb
 231 which unfortunately resulted in very defective roofing systems which in most cases also
 232 contributed to roof failures. Some vital questions to ask while designing are often overlooked;
 233 the questions include what are the criteria to be used in choosing materials? Are the required

234 strength factors and tolerances, the needs for flexibility, fire -resistance, corrosion resistance all
235 valid? Is the system over-engineered? Can material contents be reduced without any loss of
236 performance? Is the design unnecessarily complex? Could changes be made to reduce
237 construction cost or to simplify the assembly?

238 **4.3.5 Roof Type**

239 The most appropriate form of roof structure for a particular building will depend but not
240 limited to such factors as size and plan or shape of the building, appearance or aesthetic
241 considerations, cost of construction, ease of effecting repairs, nature and magnitude of the loads
242 that may be imposed on it, including the suspension of machinery, possibility of future
243 alteration, lighting requirements and accommodation for services. Wind interacting with a flat
244 or low sloped roof will cause outward pressure over the entire roof similar to the top surface of
245 an airplane wing. As the wind flows over the roof, uplift occurs; the faster the wind, the greater
246 the uplift. Wind blowing in a direction perpendicular to the ridge of a high-sloped roof will
247 cause an inward pressure on the windward side of the roof and an outward pressure on the
248 leeward side. Wind blowing parallel to the ridge will result in outward pressures on the roof
249 surfaces. Winds flowing around eaves, ridges and overhangs cause high uplift forces. The roof
250 slope also determines the water shedding capacity of the roof. The shape either in form of gable
251 or hip roof influences roof resistance against wind uplift. The type and shape of the roof can
252 help determine how well it will perform during a severe windstorm. A hipped roof is one that
253 slopes upward from all sides of the building. Because of its aerodynamic properties and
254 construction techniques, most hipped roofs will perform better in windstorms than gabled roof.
255 A gabled roof has two slopes that come together to form a ridge or a peak at the top, each end
256 looks like the letter A. Homes with gabled roofs are more likely to suffer greater damage, such

as collapse of the end wall from high winds because they are often not braced properly during construction.

4.3.6 Topographical Location of Building

The force, direction and moisture content of air flows are strongly influenced by topography. Air could be diverted by mountain ranges. On mountain summit, wind speeds are higher than in free air at corresponding elevations at the plain because of the convergence of the air forced by the mountain barriers. As the air flow is deflected upward, it cools and releases its moisture content. A descending air mass will rarely give any precipitation, therefore rainfall characteristics vary sharply between locations on windward and leeward slopes of mountain ranges. The effects of topography on precipitation, wind, moisture have great influence on roof failure. Table 3 shows the relative occurrence of topographical effects on roof failure. The buildings on slopes and summit of hills do not only enjoy the positive influence of wind flow, they also enjoy better geotechnical characteristics and also the soils from gentle slope are more geo-technically stable than those from flat sites. Soils along slope are better drained and more laterised than those from flat sites. This phenomenon is responsible for the higher amount of gravel-size particles, lower amount of sand-size particles, lower plasticity and higher strength characteristics exhibited by soils along slope than those in flat site (Fullerton, 2005). As a result of this better geotechnical characteristics, dampness or moisture ingress into the roof leading to failures such as decay can be prevented.

Table 3: Roof blow-off pattern based on topography location

LOCATION	FREQUENCY	%
Plain	89	32.00
Valley	44	15.67
Up-Hill crest	146	52.33

Source: Field Survey (2010)

278 4.3.7 Age and Environment

279 The constraints placed upon roof performance are not only confined to the properties of
 280 the roof materials; social, environmental and ecological constraints also exist. They gain
 281 increasing importance as population densities increase, more natural resources are consumed,
 282 and increasing environmental pollution becomes incompatible with the need to have a sound
 283 roofing system. Climate change could affect the quantity of the wind hazard; and the operation
 284 and effect of wind on the building. Over-intense development has effectively covered the
 285 ground with concrete. This has dramatically reduced the capability of the ground to absorb
 286 precipitation, with a consequent escalation in the amount of moisture present in a particular site.
 287 This excess moisture can find its way into the foundation and thereby undermine the integrity
 288 of the foundation; there could also be possible moisture ingress that can lead to roof failure
 289 of failures. Most walls used in building houses in the western part of Nigeria are absorbent
 290 media for water. Underground water within the foundation level, water on bathroom floors and
 291 water linking from poor conditioned drainage pipes are adsorbed and transported to the roof
 292 through walls and forming films of water on wooden roof thereby causing decay.

293 Age equally plays an important role in determining roof failures, when the materials of
 294 construction experiences stress reversal for a long time; there is the likelihood that the material
 295 will fail thereby leading to the eventual failure of the roof.

296 4.4.0 Effects of Roof Failure

297 Roof failures have social, economic and psychological consequences on the affected
 298 people. Owning a house provides social security, as the owner is not subjected to insults or
 299 intimidation by a landlord. This security could be lost when the roof of a building collapse and
 300 rendered the building unfit for habitation. The cost of repairs of damaged roof could be

enormous, because of the daily increase in the prices of roofing materials. The situation is even worse in rural areas where early replacement of damaged roofs become almost impossible due to low level of financial resources available to building owners. Survey showed that numerous Government-owned schools in rural areas have had their roofs blown off and left un-repaired for upwards of three years. Delayed actions to replace collapsed roofs during the rainy season may lead to much greater damage to the wall structures which are mainly earth materials thereby exposing the contents of the house to damage. Worst off, any delayed response to replace these collapsed roofs during the rainy season can lead to total collapse and erosion of the mainly earth wall structures that are supporting the roof. In this case the total house can be left to collapse and may not be replaced even in the distant future, thereby reducing the national housing stock and worsening the housing situation in the country. Further more, the FGD held during the survey revealed that when roof fails especially when it is blown-off and it is not replaced on time, anxieties, pains and adverse emotional reactions from the house owners follow the incidence.

The sheathing membrane of roof structure provides a good protection for a building because of its umbrella action in quickly removing the rain water and shielding it from sunshine and other weather elements. Therefore roof damage could result in loss of fortunes or valuable properties. Delayed actions to replace collapsed roofs may lead to much greater damage to the wall structures thereby exposing the contents of the structure to pilferage. The cost of repairs of damaged roof could be enormous not just because of the daily increase in the prices of roofing materials but the special skill required for roofing. While other artisans such as mason, iron benders and painters are employed at a cost of ₦1, 500.00 for a day's job, carpenters depending on their experience in roof construction are project paid between ₦ 2, 500.00 and ₦ 3, 000.00

per day. Tables 4 and 5 which are the case studies of some selected institutions in Southwestern Nigeria show that the cost of roofing a new building constitute between 12 % and 20 % of the total cost of the project while that of rehabilitation work will take between 21 % and 46 % of the total rehabilitation cost.

Table 4 Roofing Cost as a Percentage of Total Cost of New Building Project

Project Name	Contract sum (₦)	Roofing Cost (₦)	Percentage
Construction of Telephone Operators' Office University of Ibadan	554,516	67,700	12.21
Construction of Estate Office University of Ibadan	16,906,765	2,334,930	13.81
Construction of students Affairs office University of Ibadan	10,625,307	1,777,775	16.73
Construction of C.I.C.S Building University of Ibadan	27,102, 575	4,415,599	16.29
MacArthur/ICT building University of Ibadan	19,603, 752	4,100,730	20.09

Source: Works and Maintenance Department, University of Ibadan (2007)

Table 5: Roofing Cost as a Percentage of Total Cost of Building Rehabilitation Project

Project Name	Contract sum (₦)	Roofing Cost (₦)	Percentage
Renovation of UPE Building Bowen University, Iwo	3,576,613.33	1,104,900.00	30.89
Renovation of Agric Hall Bowen University, Iwo	416,348.87	105,750.00	25.40
Renovation of Maclean Hall Bowen University, Iwo	467,727.27	188,000.00	40.19
Renovation of Science Education Hall Bowen University, Iwo	403, 514.55	87,000.00	21.56
Renovation of Principal's house Bowen University, Iwo	2,500,000.00	1,150,000.00	46.00

Source: Works and Maintenance Department, Bowen University Iwo (2008).

4.5.0 Remedial Measures

Roof failures can be minimized in the zone by taking some precautionary measures which involves some design, construction, provision of some amenities and maintenance practices.

During the survey, eleven types of failures (Roof rust, leakage, nail withdrawal, Blow-off, asbestos discoloration, ponding, wood decay, sagging, tearing-off, Truss damage and Open lap. Although blow-off is the least failure in occurrence of the eleven identified roof failures, its effect is more severe than any of the other failures.

Remedies of rust; leakage; nail withdrawal wood decay and blow-off cases will take care of the rest six. While treating blown-off, sheet removals could be addressed; in the same vein leakage treatment can take care of failures such as sagging, ponding wood decay and open lap. Rust can also be taken to mean discolouration, however asbestos do not rust but changes colour. Generally, in order to forestall roof failure Table 6 below serves as guide.

Table 6 Precautionary Guide against Roof Failures

S/N	Guide Measure	Failures that will be prevented
1	Routine maintenance programme	All types of failure
2	Provision of adequate slope and roof overhang	Wood decay, rust/discolouration, blow-off ponding, leakage, and sagging
3	Construction which include provision of adequate nail density and proper nailing, paying attention to edge distance, proper anchorage of rafters, good joints and use of well seasoned timber	Sheet removal, open lap, sagging and truss damage, blow-off , nail withdrawal and leakage
4	Provision of good roof drainage and drainage of the whole surrounding	Leakage, sagging, wood decay, and rust/discoloration
5	Provision of courtyard and enough and well positioned openings	Blow-off, wood decay, sagging and leakage

Simple visual inspection can reveal obvious signs of problems. Roofs should be checked for debris and sharp items that could damage the roof system. Sharp items should be removed from the roof immediately. Trees that overhang a roof should be trimmed or cut back to reduce the potential for tree debris on the roof. Keep the roof or building area free of floating debris, as this is an excellent source of both borer and mechanical damage. If the roof has gutters and

downspouts, they should be inspected and, if clogged, the debris should be immediately removed. When inspecting gutters, check for sagging, because it will prevent water from draining properly and result in roof failure such as leakage and wood decay

5.0 CONCLUSION

The study revealed that poor workmanship, design error, age and environmental forces, materials inadequacy, roof geometry and topographical location have been identified as the major causes of roof failures. The study revealed further that roof failure has economic, social and emotional effects on the affected people. Routine maintenance programme, proper construction, provision of courtyard, adequate drainage, good slope and roof overhang will minimize incidences of roof failure is therefore recommended.

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