TECHNICAL REPORT

ON

RECOMMENDED ROOF SLOPES FOR RESIDENTIAL BUILDINGS IN AKURE

BY

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ABSTRACT

Many residential buildings in Ondo State and Akure in particular have experienced incidences of roof failures in recent times, as a result of several factors among which are, the effect of prevailing winds on roof, and more importantly varied roof slopes. Survey was undertaken to investigate the pattern of failure, causative agents, consequences and possible remedial measures aimed at curtailing these occurrences. Besides being blown off, which is the popularly acknowledged index of failure. A number of roofs were found to have failed in their primary function of offering protection against rain even when they were not blown off. Wind is a major causative agent of roof failures as it either completely removes the roof or tears it, leading to leakages.

The survey adopted the use of questionnaires, and interview schedules. Information considered of relevance to the study was the type of roof, slope of roof, prevailing winds and rainfall pattern in Akure. As panacea, the design of steeper slopes, adoption of a good maintenance culture, good workmanship and consultation of experts in the selection and construction of roofs are recommended.

Keywords: roof slope, roof failure, roof blown off.
1.0. INTRODUCTION

The roof is the most important component of a building. It is that portion of the building that offers protection against sun and rain, without which the content of the structure would be damaged. As important as it is, the roof is also the component of the building that is most abused and subjected to agents of degradation. Besides its subjection to repeated wetting, it can be equally exposed to wind and as such the extra loads arising from these external sources must be adequately supported by the roof.

The slope of a roof is referred to as its pitch. Roof slopes are normally presented as a ratio of a roof's height versus its length, such as a one-to-four roof having one foot of height for every four feet of length. Although modern architecture has given rise to different methods of roof design and construction, and hence roof types, all roofs can be broadly classified into two types on the basis of slope: flat and pitched roofs. Roofs having pitch angles not exceeding 10° are defined as flat while for higher pitch angles, they are referred to as pitched. While flat roofs may be subjected to ponding, there is an improved drainage system in pitched roofs that accounts for their use in equatorial climates where runoff may be a problem. Pitch roofs are less prone to leakages as even when there are small holes, the water can drain over them. The most popular of the pitch roof types is the gable roof. Economic, aesthetic, size and shape of buildings are some of the factors influencing the choice of roof type.

The desirability for a roof over a building is as old as mankind. Modder (1991) reported that the desirability for a roof to offer protection was possibly responsible for early man's preference to live in caves and hollow trees even when his safety might be threatened. Thus, caves and hollow trees served as natural protective cover for regulating environmental factors in the early ages. Modern man later developed an artificial protective cover. The bamboo roof and thatch roof made of dried straw and reeds were the first set of these artificial roofs that came into existence. Improvement in technology has resulted in the development of assorted materials for roofs construction including wood, concrete, metal, rubber, limestone, clay and ceramics.

The work reported in this paper was undertaken to appraise roof slopes for residential buildings in Akure, and make recommendations that could curtail the aftermath of poorly designed roofs with bad slopes.
1.1 The Study Area

This study was carried out in Ondo state of Nigeria (Figure 1), Akure, a city in the South western region of Nigeria, the capital of Ondo State is located on the intersections of Latitude 7° 17' North of the equator and Longitude 5° 14' East. It stands on the altitude of about 370 meters above the sea level. The land towards Ado-Ekiti is hilly and studded with granite formations believed to be of volcanic origin spreading over an area of 99,287 square kilometers, Akure is situated 210 kilometers east of Ibadan, the capital of city of Oyo state, 168 kilometers west of Benin the capital of Edo state, 311 kilometers north east of Lagos, capital of Lagos, 189 south East of Ilorin the, capital of Kwara state.

In relation to all big towns in state, Akure is centrally located, being surrounded with a 48-kilometer radius by those important towns. It is bounded by Ondo and Idanre to the south, Owo to the east, Iju / Itaogbolu to the north and Ile-oluji to west.

Its location gives a favourable climatic condition while it is known for its dual maxima rainfall periods and a monthly temperature range between 25°C and 29°C. The humidity ranges from 66% in January to 85% in September. Akure is one of the economic nerve centres of Ondo State, a leading producer of mineral resources and cocoa in Nigeria. Akure, with a population of 353,211 in 2006 as against 190,000 in the 1991 census; has expanded over a large area due to varied developmental processes.
2.0. MATERIALS AND METHODS

The type of buildings surveyed were mainly, residential with ages varying from recent construction to as much as 40-year-old roofs. 6 roofs spread across Akure metropolis were appraised.

Structured questionnaires and interviews were used as instruments for data collection. Information of interest and which were included in the instruments were the roof slope, types of roof, materials used in the construction of roof trusses and sheathing, age of roof, and their subsequent consequences.

The experiment for roof slope degree and rainwater runoff through roof top for 6 roofs patterns in the akure were assessed as follows.

Table 1

<table>
<thead>
<tr>
<th>Roofs</th>
<th>Dimension(m)</th>
<th>Surface Area(m²)</th>
<th>Slope</th>
<th>Design Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11.2 x 25.2</td>
<td>282.24</td>
<td>0.24</td>
<td>Rainwater runoff is possible from two sides of the roof catchments</td>
</tr>
<tr>
<td>2</td>
<td>18.9 x 41.47</td>
<td>783.78</td>
<td>0.24</td>
<td>Rainwater runoff is possible from two sides of the roof catchments</td>
</tr>
<tr>
<td>3</td>
<td>10.97 x 10.9</td>
<td>218.30</td>
<td>0.21</td>
<td>Rainwater runoff is possible from three sides of the roof catchments</td>
</tr>
<tr>
<td>4</td>
<td>11.6 x 24.2</td>
<td>280.72</td>
<td>0.24</td>
<td>Rainwater runoff is possible from all sides of the roof catchments</td>
</tr>
<tr>
<td>5</td>
<td>21.85 x 15.2</td>
<td>332.12</td>
<td>0.59</td>
<td>Rainwater runoff is possible from all sides of the roof catchments</td>
</tr>
<tr>
<td>6</td>
<td>19 x 9.1</td>
<td>172.90</td>
<td>0.46</td>
<td>Rainwater runoff is possible from all sides of the roof catchments</td>
</tr>
</tbody>
</table>
Plate 1: Showing a typical hip roof of a residential building at Ijapo Estate.

Source: Researchers archive
3.0 RESULT AND DISCUSSION.

3.1. Roof slopes, roof types and buildings for which they were used

The buildings have high pitched hipped roofs (also referred to Dutch type) with a slope of 20° to 35° to withstand the heavy rainfall. The top ridge of some roofs is parallel to the front elevation while in other cases it is perpendicular. The eaves of the roof are projected beyond the wall around 40cm to 1m. The roof is covered by the corrugated iron roofing sheets which have poor thermal properties. With time the iron also reacts with water and corrodes turning to dark red in colour. Many houses were renovated recently and now they also have a ceiling that is made from asbestos tiles. This improves acoustic and thermal condition. Although all types of roof could be found in the area surveyed, pitched/gable roofs were the most predominant (80 per cent). Although there was no restriction as to the use of roof for a particular type of building, most residential buildings used the gable roof. Ease of construction, and symbolism are some of the factors that influence the choice of roof.
3.2 Materials used for roof construction

Of the roofs surveyed, 60 per cent were made from corrugated iron sheets, 23 per cent were asbestos, 9 per cent concrete and 8 per cent aluminium, while others such as tiles accounted for less than 1 per cent.

The most common material used for roof trusses is wood. It is relatively cheap and readily available, and easily worked. These qualities give wood trusses an edge over iron for small-to medium-sized buildings

3.3 Failures identified as a result of roof slope and possible causes

The types of failures observed during this study is mainly, the roof is still in place but may suffer one problem or the other that inhibits it from maximum performance. Such failures include rusting, leakage, open lap, tearing off, truss damage, nail withdrawal, sagging and discolouration. The results of the study are shown in Figure 2.

Wind was the primary cause of roofs being blown off and could be further aggravated by poor roof slope, poor workmanship, the use of inferior quality materials and poor attachment of the roof to the underlying walls. For example, in many cases it was observed that weak metal straps had been used for attachment and the top of the wall on which the wall plate is
seated was uneven which subjects the straps to stresses such that any additional external load imposed will cause it to fail.

The appearance of holes in roofs due to wearing of the washers under fixing nails, punctures from external loads falling on the roof or rusting, provides an avenue through which water can penetrate a building. In addition, wooden elements are subjected to moisture damage and deterioration sets in.

Poorly secured roofing sheets can tear off even in low winds and subsequently provides an avenue for further damage and in extreme cases the whole roof may be blown off. These results are not surprising since buildings on plains and without wind brakes are directly exposed to the full force of the wind compared to the other topographical areas where some of wind energy is dissipated before hitting the building.

Of the roofs surveyed 80 per cent were of the gable type, 25 per cent of irregular shape and 5 per cent flat roofs. Roofs were blown off most frequently in the evenings, at the onset and end of the rainy season. The result of the study is shown in Figure 3

![Figure 3: Roof Types reported.](image)
3.4 Losses incurred in roofs failures as a result of poor slope angle.

For new projects a roof accounts for between 10 and 20 per cent of the total building cost, while for rehabilitation it is even higher ranging from 20 to 45 per cent of total cost (University of Ibadan Maintenance Department, 2005). When roof failures occur, the first major loss is the roof itself that must be replaced if the building is to be put to further and effective use. In residential buildings damage to essential home appliances can be a significant consequence of roof failure which in turn affects the quality of life of the residents affected. In rare cases where the government has come to the aid of such victims, the amount of compensation is not tied to the extent of losses incurred.

CONCLUSION

Although all types of roof could be found in the area surveyed, pitched/gable roofs were the most predominant accounting for about 80 per cent, while only about 5 per cent were flat roofs. Ease of construction, and symbolism are some of the factors that determine the choice of roof. Wood was the main material for truss construction in small to medium buildings, while for large buildings steel trusses were often used. Roof sheathing included galvanised iron sheets, asbestos and concrete. Roof failures manifested in the forms of leakages, nail withdrawal, sagging, tearing off, Open lap, corrosion, and in extreme situations blown off. Roof slope gradient, and quality of workmanship were found to play major roles in roof failures.
RECOMMENDATIONS

a. Adequate rainwater drainage, high pitched roof to allows quick evacuation of water from the roof top should be considered when designing for roofs in residential buildings in Akure.

b. Good quality workmanship plays an important role in the performance of a roof. It should be ensured that the top of the wall on which the wall plate is seated is level and plumb so as to reduce the stresses induced on the metal straps that binds the roof to the wall.

c. Most roofs, like the entire building below them are constructed without recourse to the engineers or builders who designed them, and it is only when they fail that the blame goes to these experts. It is important that appropriate experts are consulted in the choice of material and erection of roofs at the outset.
REFERENCES


University of Ibadan Maintenance Department (2005), 2004 Annual Report of Building Maintenance, University of Ibadan.
