COMPRATIVE COST ANALYSIS BETWEEN THE USE OF ALUMINUM LONG SPAN ROOFING SHEET AND CEMENT SYNTHETIC FIBRE ROOFING SHEET AND THE TOTAL COST OF BUILDING

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Abstract

This paper examines the comparative cost analysis between the use of aluminum long span roofing sheet and cement fibre roofing sheet to the total cost of the building. Literature review revealed that the introduction of cement fibre roofing sheet to replace the asbestos roofing sheet, has greatly reduced the risk of cancer of the respiratory system in the built environment. Field data were obtained for aluminum and cement fibre roofing materials from bills of quantities priced by various consultant respondents. Using a simple independent sample T- Test the mean value of total cost of roofing for cement fibre was less than that of aluminum long span. The probability value was less than 0.05 level of significance adopted in the study, indicating that there were significant relationships between the variables tested? It was observed from the study that, (a) Cost of roofing sheet for both materials affect the total cost of building. (b) Cost of using cement fibre roofing sheet was less compared to aluminum long span roofing sheet. (c)Cost of carcassing for aluminum sheet was less than carcassing for cement fibre. (d) Total cost of roofing using aluminum sheet was more than that of cement fibre sheets.

Keywords: comparative, cost analysis, cement fibre, aluminum, bills of quantities

Introduction

Roof covering element covers a very important part of the building which gives the building upper closure, protecting the building from dilapidation and atmospheric effects such as wind, cold, heat, snow etc. The cost of roof covering has a strong contribution, in its role, in relation to the total cost of building. Therefore, the cost planning of roof in this case, must not be neglected, this is because of its contribution to the total cost of building. The cost planning involves the critical breakdown of proposed total expenditure for the project into allowances to be made for various elements of the building. It involves the preparation of cost plan, and subsequent cost checking to ensure, that the estimated amount is not exceeded. Seeley, (1983).

Generally, roof is meant to satisfy some basic functional requirements which influences the choice of roof and method of construction. These functional requirements are, Weather Resistance, Strength, Durability, Fire Resistance, Insulation, Condensation, Appearance and Economics. These factors help the developer to make his desired choice as to the roof type.

Literature review

Roof is an important element, which forms part of the general components of a building. This may be seen as the covering and supporting frame work on the top of a building. The basic function of the roof is to provide shelter from rain, snow, hot sun, wind and protection against frost and pollution, (Encyclopedia Americana 1981). Apart from providing shelter, the roof protect the interior part of the building from the external environment and add more life to a particular structure, in terms of forms, functions, aesthetics and the value of the building. Further more, the choice of roof type varies from one individual to another individual depending on the taste, financial strength and satisfaction that the individual intends to derive (Smith, 1979; Caleb, 1978).

Economic Importance of Roof

The cost implication of roof in building is that it is an expensive element, which must be given due consideration in a building project. The construction of roof requires both skilled and unskilled labour, this brings about the need to examine the actual cost proportion of the roof types (Aluminum long span roofing sheet and cement synthetic fibre roofing sheet) to the overall cost of the building project. Nyeke (2004). Since roof is an essential element, in the overall construction of any building, and plays a very important role, the need for roofing is preceded by the housing need. At any point where, the need for housing is mentioned, the need for roof cannot be ruled out. This is as a result of its importance, to the entire construction project.

According to Charles (2002), houses in most times could be occupied by people as long as it is roofed, even if the other basic components, are not in place but most time, no house will be occupied if there's no roof on its as cover.

Asbestos Cement

Asbestos is a composite material that consists of Portland cement reinforced with asbestos fibre. Hannat (1978) holds that asbestos tends to be coarse and abrasive to be useful by itself, which lead to diverse and popular composite mixtures. The proportion of cement to fibre (asbestos) varied over a range of 10% to 75% by weight, depending on the desired characteristics. John (1986) also opined that asbestos popularity in the building industry stemmed from its inexpensive processing and its special chemical that make it virtually indestructible. Asbestos is a fibrous silicate mineral that maintains chemical resistance especially to alkalis, fibre resistance, and mechanical strength due to high length to diameter ratio, flexibility, good friction and wear characteristics. It was first manufactured in the United States in 1905.

Brown (1992), said that because of the various forms of asbestos, with various components such as crystotile, amosite, crocidolite, anthophilite, tremolite, and actinolite are very dangerous and hazardous to the health of individuals, and as such should be phased out. He also was of the opinion that since 1967, statistics has revealed that over 70% of individuals, with cancer in the lungs are occupants of structures having asbestos as their roof covering. This brought about the use of cement synthetic fiber with different components of fibre.

According to Seeley (1995), most commonly used materials in years past has been asbestos cement which is made of fibrerised asbestos and Portland cement, the natural colour is grey, but it is also obtainable in other colours. it was equally stated that in past years, it is the most commonly used material for buildings, which are well suited for specific purposes such as garages, stores, and agricultural buildings.

Roger (1977) observed that asbestos poses serious hazards to health, as it has been found that, it causes cancer to the users of asbestos roofing sheet. The advisory committee on asbestos recommended in 1979 that the use of asbestos should be phased out, as a result of this, fibre reinforced cement slates using other fibre have been produced and were used extensively in the late 80s, which were covered by agreement certificates giving them a minimum life of 30years. Although BRE indicated that these materials are inferior to asbestos cement products in relation to their mechanical properties. The cement synthetic fibre is made of polyvinyl alcohol fibre and does not contain asbestos; the fibres are used as reinforcements with cement and other minerals.

The technology of Fibre Cement Roofing Sheet

Ilo (1983) states that asbestos is an excellent fibre that unites the properties of flame retard ness, abrasion resistance, high tensile strength, and its co tropic properties, it is impossible

to replace it with any other kind of fibre. He also opined that fibre cement production in which hatcheck (wet process) has been mostly used in the Europe or in other countries, most manufacturers now use mixture of reinforcing fibre and process fibre as an asbestos replacement recipe. They are polyvinyl alcohol (polyvinyl formal) fibre, and polyachlonitrile fibre.

Arnon (1990), says that since it become apparent in the early 70s through epidemiology studies in the united states that asbestos could become an induced cause of cancer, of the respiratory system, the search for and research for substitute products for asbestos has been conducted extensively in the various areas where it is used industrially e.g. the use of fibre cement, paints, resin reinforcement or anti-sag agents, and fillers for wines and liquors. This has greatly reduced the use of asbestos

John *et al* (1998) says that synthetic roofing materials have desirable performance properties, including durability. Most of them are produced in sheet form, he also opined that they have become viable alternatives because of the rising cost of labour and petroleum based bituminous materials, and the need for pliable and easily adoptable membranes for usual roof configuration. Based on the technological improvement of cement fibre roofing sheet, they come in various forms and properties the various types of cement fibre roofing sheet are now discussed.

Types of Cement Fibre Roofing Sheet

The various types of cement fibre roofing sheet are;

1) Superseven Corrugated roofing Sheet,
2) Super Lightweight and Coolite Corrugated Sheets,
3) Ultra seven corrugated roofing sheet and
4) Kololight weight corrugated roofing sheet.

They are manufactured from synthetic fibre (new technology NT), cellulose and Portland cement. In their natural state, they are light grey in colour and ranges of accessories are available. They are highly durable and last for a minimum of 40yrs, if correctly installed. Also they have a wide range of applications in roofing and vertical cladding work where a durable and aesthetically pleasing finish is desired. It is suitable for all kinds of residential, commercial, industrial and public buildings, and has extensively been used in Nigeria.

According to Eternite (2005), superseven corrugated roofing sheet are the ideal materials for roofing and cladding work where a durable finish is required. The sheets have found widespread acceptance in Nigeria for residential and non-residential applications. These include, large housing estates, private marionettes; public buildings, schools, and colleges as well as industrial and commercial buildings. The wide range of complementary accessories that are available further enhances their scope of application. These are two Piece corrugated wing ridges; two piece flat wing ridge, apron flashing piece, one Piece flat wing ridge, angular corner piece, eaves closure piece. The benefits of these roofing materials are; universal application, non combustible, strong and long lasting, good insulation property, rot and rust proof, completely weather proof, cost effective, ease of handling and installation, comprehensive technical support, as well as wide range of complimentary accessories.

The Aluminium Roofing Sheet

Aluminium is a silvery white non-ferrous metal obtained from bauxite by electrical processes, used principally as an alloy. It is light in weight, resistant to corrosion, fairly soft and reasonably ductile. Curwell in (1986) observed that within a period of 100 years, aluminium has advanced from being a rarely used metal to the second largest metal used world wide. The characteristics and properties which have brought about this dramatic

increase in the use of aluminum are its light weight, high strength, resistance to weathering, ease of forming, the ability to be treated with a variety of finishes, and its recycleability. An example of the long term durability of aluminium is the decorated aluminium sheet cladding on the dome of the st. Grocerhino church in Rome which was installed in 1887, and is still in good condition with virtually no maintenance, The types of Aluminium Roofing Sheets are:

1) Oven baked: - These are already colored from the factory and oven baked. They could come in various colours, such as red, horse blood, blue green, brown. etc.
2) Stucco: - However, the stucco are not coloured but are originally grey. This stereotype of roofing sheet is mostly used where aesthetics consideration is not a priority, but the functional requirement desired.

Features of Aluminium Long Span Roof

Economy in Supporting Structure: The super imposed weight of aluminium building sheets on the super structure is very minimal compared to other roof covering material. This ensures lighter support.

Health Hazards: aluminium building sheets pose no health hazards to the users (Crowther, 1994).

Resale Value: John (1978) observed that unlike other competitive materials, aluminium building sheets has a higher scrap value even after prolonged usage.

Appearance: aluminium profiled building sheet can look outstanding in its simplest form-plain mill finish. It provides a pleasing architectural beauty to all kinds of buildings with a touch of distinctive modernity, aluminium building sheet can be used extensively and economically, in areas such as;- Industrial buildings, Ware Houses/Workshops/Storage sheets, Conveyor gantry house, Community centers, Theatre halls, Green houses/garden houses, Ratio covers etc, (http: www aluminium.org).

Wind: aluminium building sheet is amply strong to resist wind forces.

Thermal Movement: aluminium has a relatively high coefficient of linear expansion, 0.000024 per degree centigrade. Lateral expansion of sheeting is readily accommodated by the corrugation/troughs. Expansion and contraction in the length of long sheets should be allowed for by providing over size holes for fixing and corresponding longs sealing washers.

Condensation: In most industrial buildings, the relative humidity of the inside air is not high enough for condensation to be a problem. Experience indicates that good ventilation is an adequate remedy.

Research Methodology

The data in the study were collected through primary sources. These were obtained from fifteen number (15 no) priced bills of quantities of a two bedroom flat roofed with aluminium roofing sheets and also of similar design of two bed-rooms flat roofed with cement fibre roofing sheets. Both design having a floor area of about 132 square meters. The bills were priced by cost consultants and prices obtained were separated into four parts for each roofing type under consideration. That is, cost of roofing sheets, cost of roofing members, total cost of roof and total cost of building. The data obtained were subjected to statistical analysis using the independent sample T-Test.

Table 1: Cost of Roof Components and Total Cost of Building (Aluminium Sheets)

BOQ no	Cost of Roofing sheet	Cost of Roof Carcassing	Total cost of roof	Total cost of building
1.	381000	294560	675560	3,455000
2.	383000	296550	679550	3,456000
3.	3800000	289500	669500	3,405000
4.	378500	286000	664500	3,375500
5.	377500	285000	662500	3,370400
6.	375500	280000	655500	3,368400
7.	380000	275000	655000	3,375500
8.	381000	294460	675460	3,455000
9.	384000	296450	680450	3,460000
10.	390000	299500	689500	3,510000
11.	400000	300000	700000	3,568000
12.	415000	305000	720000	3,470500
13.	410000	290000	700000	3,567000
14.	381000	275000	656000	3,450000
15.	375000	290000	665000	3,450000

SOURCE: Field Survey from Priced Bills of Quantity.

Table 2: Costs of Roof Components and Total Cost of Building (Cement Fibre Sheets)

BOQ no	Cost of Roofing sheet	Cost of roof carcassing	Total cost of roof	Total cost of building
1.	319300	302860	622160	3,386600
2.	316500	300760	617260	3,316500
3.	320000	305700	625700	3,395000
4.	321500	308500	630000	3,400000
5.	319500	302900	622400	3,390600
6.	320500	303000	623500	3,400000
7.	321000	304000	625000	3,501000
8.	323500	306000	629500	3,503500
9.	318000	299500	617500	3,489000
10.	319600	299600	619200	3,470000
11.	319100	298500	617600	3,450000
12.	318000	296500	614500	3,401500
13.	320500	300000	620500	3,350000
14.	319200	300500	619700	3,400000
15.	318240	297500	621300	3,412300

Source: priced bills

Table 3: Summary of Independent Samples T-Test

Location Tested	Mean values of variables		Results of observations				Inferences
	Aluminium	Cement Fibre	T-cal	T-tab	P-value	Remark	Action on Hypothesis
Cost of roofing sheet	386100	319780	0.55	2.05	0.000	SS	Reject Ho
Cost of carcassing	290468.0	301954.7	4.671	2.05	0.000	SS	Reject Ho
Total cost of Roofing	676568.0	621734.7	10.899	2.05	0.000	SS	Reject Ho
Total cost of building	3449087	342097	1.283	2.05	0.210	NS	Accept Ho

Source: Researchers Analysis of Data 2006
Key: SS – Statistically Significant, NS – Not significant

Data Analysis, Results and Discussion

Four (4) experiments were carried out to determine whether the cost of aluminium long span sheet differs significantly from the cost of cement synthetic fibre sheet considering 1) the roof covering material cost, 2) carcassing cost, 3) total roofing cost and, 4) total cost of building. The result shows a statistically significantly difference in the cost of roof covering material, the cost of their carcassing members, and the total roofing cost, with P-values of 0.000 for all of them. However, there was no significant statistical difference the total cost of building in each case with P-value of 0.210

Summary of Findings

Within the framework of the data, using both regression analysis and independent sample T-test and their various discussions, and results, the following constitutes the summary of findings.

1. Cost of roofing sheet for both materials affect the total cost of building
2. Cost of using cement fibre roofing sheet was less compared to aluminium long span roofing sheet.
3. Cost of carcassing for aluminium sheet was less than carcassing for cement fibre.
4. Total cost of roofing using aluminium sheet was more than that of cement fibre sheets.

Conclusion and Recommendation

The research concluded that there is significant statistical difference between the cost of aluminium roof covering and cement fibre roof covering with the aluminium roofing sheets more expensive. However, the cost of carcassing members for aluminium roofing sheets was less expensive relative to that of cement fibre sheets. The total cost of roofing work, that is, the cost of carcassing members and roof covering material was more expensive using aluminium sheets than using cement fibre roofing sheets.

Based on the above conclusions and from the findings in the literature review, it is recommended that where aesthetics is the priority in the design and the roof will not be subjected to too much super imposed loads, the aluminium roofing sheets would be ideal

because of its flexibility of design which can fit into virtually any design shape and form. However, where the emphasis is on cost savings and the roof would be subjected to super imposed loads such as snow, the cement fibre sheets would be recommended. Furthermore, it is recommended that roof work should be seriously taken into consideration during the processes of cost planning analysis, control and modeling.

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