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Causes Of Defects On External Wall Finishing Materials Of Buildings In Tropical Forest Area: A Case Study Of Selected Towns In Ogun State

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Abstract: ***All buildings are finished with different types of materials for various purposes. The type and format of application of finishes on a building depend on the effect the owner intends for it. Most finishing materials are selected without due consideration to the environment factors, thus service life of these materials are usually shortened, this paper examines some residential, commercial and institutional buildings that have defective external walls finishes in tropical forest areas with focus on Ilaro and some buildings in Abeokuta town. Each building selected for review was carefully studied and analyzed to identify the type of finishing materials and causes of their defects. Some occupants were interviewed for further information. The results show that most of the buildings finishing materials lost their service lives not just to the environmental factors but defective method of construction and other factors. Conclusion and recommendations were drawn from the result.***

Keywords: Defective External wall finishing materials, tropical areas

I. INTRODUCTION

External walls of a building are the parts that display the beauty of the building and protect the interior from all forms of intrusion from the environment. As the building ages the exterior finishing also deteriorates, however the effect of external weather conditions especially in a wet and humid environment usually reduce the service life of most exterior wall finishing materials. Evelyn A L T, Chew M.Y.L. and Harikrishna N., (2005) stated that with the advent of time, external finishes like any other building elements undergo deterioration and suffer loss in their decorative and protective functionalities and that deteriorating effects gradually and increasingly begin to show on the colour, texture and condition of these external finishes. This study looks critically into the effects of the wet and humid environment in tropical rain forest region have on materials used for exterior coatings of buildings and that whether those materials actually attain their normal service life before deterioration, and proffer solutions on how to protect building exterior from clement weather for sustainable performance.

Some areas in southern Nigeria fall within the tropical rain forest region (areas with significant tree cover) of the world and high rainfall of 2000 – 3000 mm is recorded per year in these areas. The world largest tropical rainforest are in South America, Africa and Southeast Asia (Wikipedia 2017). Some towns in Ogun state in Nigeria like Abeokuta, Itori, Ifo and Ilaro fall within this zone and are the main focus of this paper

A large number of buildings in our towns are coated with paint on sand-cement mortar and some are just left with unpainted or even fair faced brick walls, after a short period of exposure to the effect of weather and other environmental pollution on them their surfaces get deteriorated especially at the base and the upper parts of buildings that have parapet walls. Is this the problem of weather, workmanship or the materials used for exterior finish? Aluko and Akingbohungbe (2010) opined that the defects in buildings that call for maintenance are usually caused by cumulative effect of rain, wind and sun; pollution among other factors, It is better to protect external finishing materials from external weather conditions by design or type of materials used to reduce the

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frequency of maintenance as the cost of building maintenance can be as high as eighty percent (80%) of the initial cost of the building according to Igal M. S., and Monica P. (2004) who concluded in their study of Service Life of Exterior Cladding Component Under Standard Condition that, the maintenance and replacements costs of buildings account for 10–80% of initial capital costs.

II. LITERATURE REVIEW

In Nigeria, paint of different types and colors is used extensively as an external wall finishing material. It is also applied on concrete surfaces. Other forms of finishing are; non plastered and unpainted brick walls or block walls façade, mosaic wall tiles and other decorative wall tiles. These are not as common as the paint on plastered walls. Paint finish may not perform in the manner intended and fails to provide the desired functionality for the intended time period possibly due to its exposure to the adverse wet and humid environmental conditions, poor workmanship during application and inadequate quality of the finishing material or substrate. Durability of the external coating of building surfaces depends on prevailing climate effects and on a complex of physical and mechanical values of the materials used (Lentinen, 1996; Freitas , 1996, Bednar and Dreyer, 1999). There is a clear need to identify the different nature and influence of these factors in order to arrive at cost effective ways of preventing and dealing with such defects. The beauty of a building depends solely on the quality and appearance of its exterior walls that is why more attention is paid to exterior wall during maintenance. The cost of maintenance is sometimes up to 80% of the initial capital. Boussabaine and Kirkham (2004); Hajj and Horner (1998) also agreed that the maintenance and upkeep of the external finish of a building is seen as an essential component of any building program because of its decorative or aesthetic purpose thus epitomizing its image and provides protective functions to its underlying layers. Aluko, Olaniyi O, Ogunsote, Olu. Ola. (2013) on the other hand observed that in Nigeria, the cost of maintaining Festac Building, National Stadium and various Housing Estates all in Lagos has been on the astronomical increase. Thus they are usually left to decay to dilapidation state before they are rehabilitated. In Singapore, where building maintenance is done as at when due, the annual maintenance expenditure for residential buildings has risen from $11/m2 to $38/m2 over a period of about 10 years (Building and Construction Authority Pilot Study Report 2000).

EXTERNAL FINISHES AND CLIMATIC FACTORS

Exterior part of building enclosures and its coatings are affected directly by the climate of its environment. Climate is one of the major factors causing deterioration of building envelope and coatings. Chew and Harikrishna (2005), Norvaišiene Miniotaite and Stankevicius (2003) classified atmospheric factors into natural (precipitation, wind, temperatures, solar radiation) and complex chemical and biological processes caused by air pollution. (Ramanauskas and Stankevičius (2000) maintained that the durability of external finishes is determined by the following properties;

- ✓ Frost resistance, i.e. the capability of a moisture-saturated material to resist temperature fluctuation through freezing and thawing cycles
- ✓ Moisture resistance, i.e. the capability of a material to resist the periodical moisturizing and drying cycles
- ✓ Corrosion (chemical impact) resistance, i.e. the resistance to solutions of dissolved aggressive destructive chemical agents. UV radiation, causing photochemical reactions on surfaces, can also be considered as chemical impact.

In addition to these there is also the construction method that allows the periodic capillary action of underground water from the foundation to the super structural walls in waterlog areas. Haneef, Dickinson and Johnson (1999) summarized the mechanisms that contribute to deterioration as:

- ✓ Physical mechanisms. The presence of water is known to be a key factor in promoting the fracturing and erosion of building envelope and coating. Water penetrates the pores and cracks and causes mechanical stresses both by freezing and by the hydration and subsequent crystallization of salts.
- ✓ Chemical mechanisms. Some deposited chemical agents react with surfaces. Sulphur compounds have been indicted as the most critical factors in this regard, mainly because they are often acidic and can have high concentrations in city and suburban air; however, nitrogen compounds should be considered as well. Fluxes of trace gases (e.g., sulphur dioxide) can be high, especially when promoted by biological activity. Dissolution by chemical reactions with contaminants contained in precipitation is one of the most familiar eroding processes, particularly in the case of carbonaceous stone.
- ✓ Biological mechanisms. Many different biological factors have been found to be important. Growths of lichens, mosses, algae, mould, fungi and bacteria are capable of promoting surface deterioration. Some bacteria can synthesize sulphuric (or nitric) acid from airborne sulphur dioxide (or nitrogen oxides).

MATERIAL DEGRADATION AND WEATHERING

Deterioration and decay of materials of building enclosures is caused by chemically active impurities and unstable water-soluble formations migrating and chemically or physically reacting with the structural skeleton of the material. Mineralized water additionally dissolves the unstable formations of a material through further mineralization. Various chemical materials make new, weaker and easily washable products, which after the evaporation of water form deposit crystals of various volume, form and origin. These crystals enter the walls through pores and capillaries and destroy the surface of enclosures and spoil its appearance. Material degradation and loss of characteristic properties, as described by the performance of function, in the course of time in most cases occurs due to chemical or physical deterioration (Thomas, 1999)

Natural weathering is essentially a cyclic phenomenon also involving the wetting and drying of the surface. The detrimental effect of air pollutants on building materials has

been recognized for a long time and still causes major concern. (Johannson, 1990).

ACID RAIN AND ITS EFFECTS

Likens (2006), defined acid rain as the rain or any other form of precipitation that is unusually acidic, i.e. it contains elevated levels of hydrogen ions (low pH). Seinfeld, Pandis, and Spyros (1998) define acid rain as water vapour, which reacts with airborne acids and then falls to the surface of the earth. Acid rain is a popular term referring to the deposition of wet (rain, snow, sleet, fog, cloud water and dew) and dry (acidifying particles and gases) acidic components. (Bormann and Likens, 1974).

In Nigeria, numerous gas flaring points and fire outbreaks in oil installations, forest fires, decomposition of littered organic compost and vegetative degradation, rubber processing, use of worn out tires to roast poultry at the abattoir and to make bonfires during festive periods, ore smelting, used vehicles and generators with doubtful combustion efficiency have been indentified as potential sources of acid rain. (Nduka, John, Orisakwe, Orish Ebere, Ezenweke, Ezenwa, Chendo and Ezeabasili 2008) and Berresheim and Davies (1995) enumerated the causes as natural phenomena, human activity and acid deposition.

NATURAL PHENOMENA

The principal natural phenomena that contribute acid-producing gases to the atmosphere are emissions from volcanoes and those from biological processes that occur on the land, in wetlands, and in the oceans. The major biological source of sulphur containing compounds is dimethyl sulphide. Nitric acid in rainwater is an important source of fixed nitrogen for plant life, and is also produced by electrical activity in the atmosphere such as lightning. and livestock production. The gases can be carried hundreds of kilometers in the atmosphere before they are converted to acids and deposited. In the past, factories had short funnels to let out smoke, but this caused many problems locally; thus, factories now have taller smoke funnels. Dispersal from these taller stacks causes pollutants to be carried farther, causing widespread ecological damage. Sometimes back, it was rumoured that there was going to be acid rain in Nigeria which caused some panic among the citizens but Babajide (2010) explained that high humidity and that human activities like gas flaring, fumes from generators etc could be the major causes of acid rain.

HUMAN ACTIVITY

The principal cause of acid rain is sulphur and nitrogen compounds from human sources, such as electricity generation, factories, motor vehicles and coal power plants.

ACID DEPOSITION

Dry deposition contributes to the corrosion of materials; in most areas with substantial rainfall, the effect of wet deposition on building surfaces is more pronounced.

EFFECTS OF ACID RAIN ON BUILDINGS

Acid rain has been shown to have adverse impacts on forests, freshwaters and soils, killing insect and aquatic life-forms and having impacts on human health. (Miller and Galloway 1987). External buildings finishes have always been subject to attack by weathering; the effects of rain, wind, sun and frost accelerate the rate of this damage. Acid deposition affects marble, sandstone and paint. Cathedrals such as York Minster and Westminster Abbey have been severely affected in recent years. The Taj Mahal in India, the Colosseum in Rome and monuments in Krakow, Poland are continuing to deteriorate. Cologne Cathedral, Notre Dame, Westminster Abbey in Sweden, medieval stained glass windows have been affected by acid rain. (Schulz, Trubiroha, Schernau and Baumgart 2000). In Nigeria, Festac Building, National Stadium and various Housing Estates all in Lagos are typical examples. Ilaro is very close to Dangote Cement at Ibese and Lafarge cement at Ewekoro and they emit cement dust into the atmosphere.

EFFECT OF CAPILLARY ACTION ON BUILDINGS

Capillary action occur on building that are not properly constructed in waterlog areas, the foundation walls are raised directly from the footings through the soil to the roof without the provision of damp prove elements. Periodic rainfalls soak the wall from the foundation to the superstructure thereby weakening the exterior wall finishing and reduce the service life of the finishing materials. Plates 1 and 2 are examples of buildings that are affected by capillary action.

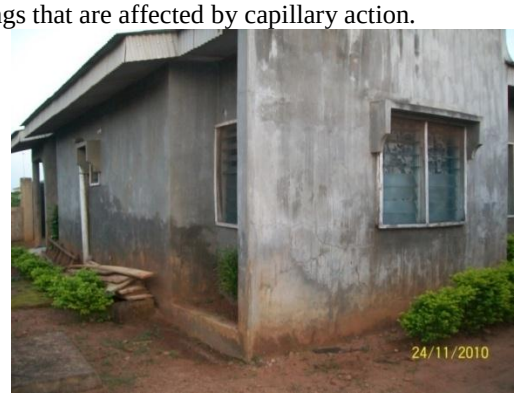


Plate 1

Plate 2

Residential Building affected by capillary action in Ilaro
Residential Building affected by capillary action in Abeokuta

III. METHODOLOGY

Literature Review of common materials used for exterior wall finish (Paint, Cement Screed Plaster, fair face brick wall etc) as well as causes of Defects in External Finish, Influencing Factors, Durability and Service Life Issues were discussed.

Visual Survey

Information about the following items was observed visually:

- Ambient Environment/ Weather
- Extent of Spread of Defects.
- Building Characteristics

Interview Survey was conducted to determine the Influence of the following items on surveyed buildings;

- Degree of Workmanship
- Construction year
- Building Characteristics.

Defect Index Model was

- Collection of climatic data
- Prediction of Onset and Extent of Defects
- Service Life of external Finish

Analysis of survey

- Findings and discussions
- Recommendations and conclusion

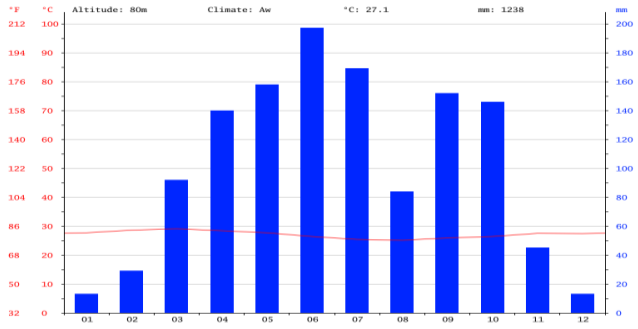
CLIMATIC CONDITION IN RAINFOREST REGION

No two locations no matter how close they are to each other and having similar geographical features can have the same climate conditions and using the climatic conditions of one location to estimate that of another location could be a blunder (Udo and Aro, 1999; Paldor, 2008). A tropical rainforest climate is usually found at latitude within 10 degree north and south of the equator which are dominated by Inter-tropical Convergence Zone. The climate is most commonly found in South America., central Africa and South East Asia. It is very hot and wet. The average temperatures are about 80 F all year round with the exception of cool nights. They (temperatures) have never dropped below 64^0F. It rains about 160 to 400inches each year.

Much of the equatorial belt within the tropical climate zone experiences hot and humid weather. There is abundant rainfall due to the active vertical uplift or convention of air that takes place there, and during certain periods thunderstorms can occur everyday.

CLIMATIC CONDITION IN ILARO

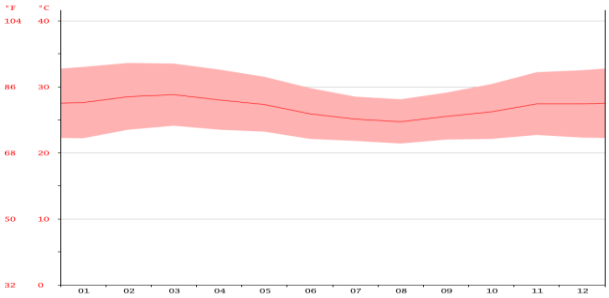
Ilaro falls within the Tropical Rainforest zone, its geographical coordinates are 6^0 53' 20" North and 3^0 1' 0" East and it is at 73m above sea level. Average annual temperature in Ilaro is 26.9°C and average annual precipitation is 1257mm. The lowest precipitation of 12mm occurs in January and the most in June with average of 218mm. Average temperature in August is 24.7C which is the lowest temp in the whole year. In March average temperature is 28.8C and It is the hottest month in the year. The daily temperature in Ilaro ranges between an average minimum of 23 °C to a maximum of 34.2 °C.



Source: https://en.climate-data.org/location/392390/

Figure 1: Annual rainfall pattern in Ilaro

The least amount of rainfall occurs in January. The average in this month is 13 mm. In June, the precipitation reaches its peak, with an average of 197 mm.



Source: https://en.climate-data.org/location/392390/

Figure 2: Temperature graph Ilaro

At an average temperature of 28.8 °C, March is the hottest month of the year. In August, the average temperature is 24.7 °C. It is the lowest average temperature of the whole year.

	January	February	March	April	May	June	July	August	Sept.	October	Nov.	December
Avg. Temp. (°C)	27.76	28.5	28.8	28	27.3	25.9	25.1	24.7	25.5	26.2	27.4	27.4
Min. Temp. (°C)	22.2	23.5	24.1	23.5	23.2	22.1	21.8	21.4	22	22.1	22.7	22.3
Max. Temp. (°C)	33	33.6	33.5	32.6	31.5	29.8	28.5	28.1	29.1	30.4	32.2	32.5
Avg. Temp. (°F)	81.7	83.3	83.8	82.4	81.1	78.6	77.2	76.5	77.9	79.2	81.3	81.3
Min. Temp. (°F)	72.0	74.3	75.4	74.3	73.8	71.8	71.2	70.5	71.6	71.8	72.9	72.1
Max. Temp. (°F)	91.4	92.5	92.3	90.7	88.7	85.6	83.3	82.6	84.4	86.7	90.0	90.5
Precipitation / Rainfall (mm)	12	33	93	131	180	218	156	72	146	154	45	17

Source: https://en.climate-data.org/location/392390/

Figure 3: Climate table // historical Weather data of Ilaro

Between the driest and wettest months, the difference in precipitation is 206 mm. The average temperatures vary during the year by 4.1 °C.

VISUAL SURVEY

Visual surveys were conducted from a sampling frame comprising of all the buildings randomly selected in Ilaro, Abeokuta, Ifo and Itori. These surveys recorded information about:

- ✓ Building characteristics pertaining number of storey, and colour of the external paintwork.
- ✓ Environment of the building which included proximity to, traffic and industrial areas.
- ✓ he occurrence of the various defects on the external finish in terms of extent of spread or area of façade affected.

Selected buildings are residential, commercial and institutional buildings of various shapes and sizes.

Individual owners of residential buildings and commercial buildings are responsible for their maintenance while the management of the institutions are responsible for the maintenance and upkeep of their various structures. Information about the age range to which these buildings belong was obtained from interview from respective landlords and Works Department of the institutions. Random sampling was adopted in the selection of these buildings.

INTERVIEW SURVEYS

Since the visual surveys are based on visual observation and judgment, it is not possible for them to capture information on the influence of the material composition of the paint and other materials that were used and their quality or the expected degree of workmanship during the last maintenance work on the existing condition of the finish materials. Some landlords and tenants of the buildings were interviewed to determine the ages, time of last repaint/maintenance.

SURVEY TOWNS

A total of 458 buildings were surveyed in four different towns Ilaro is the focus with 80.35% followed by Abeokuta 12.45% while Itori and Ifo shared the remaining 7.2% (Table 1). Ifo and Itori were selected because of their closeness to a dust emitting company (cement Company, Lafarge). Abeokuta is farther form the company but has urban setting with variety of building finishing materials than Ilaro (24.9km from Lafarge) and it is the state capital of Ogun state. All the towns fall within the tropical rain forest zone.

State	Town	Number of buildings Surveyed	Percentage (%)
Ogun	Ilaro	368	80.35
	Abeokuta	57	12.45
	Itori	17	3.71
	Ifo	16	3.49
TOTAL		**458**	**100**

Table1: Number of buildings surveyed in each town.
Source: Field survey (2017)

External Finish Materials of the Buildings

External building finishes used in this study area are paint, mortar plaster, ceramic/mosaic tiles, glass, stone and brick. However the major building finishing material is paint, which was 79.04% followed by cement rendered wall (13.97%). Tile/ glass finish was 2.62% while glass finish was 1.09% followed bys tone finish (1.75%) and lastly by brick wall which constituted 1.53 %. (detail in Table 2).

Type of Finish	Number	Percentage (%)
Painted Wall	362	79.04
Cement rendered wall	64	13.97
Tile / Glass finish	12	2.62
Glass Finish	5	1.09
Stone finish (cladding)	8	1.75
Brick wall	7	1.53
Total	**458**	100

Source: Field Survey (2017)

Table 2: Type of Finish

External Finishes And Climatic Factors

External surfaces of building enclosures and its coatings are directly affected by climate. Climate is one of the factors causing deterioration of building envelope and coatings. (Chew and Harikrishna 2005). Norvaišiene Miniotaite and Stankevicius (2003) classified atmospheric factors into natural (precipitation, wind, temperatures, solar radiation) and complex chemical and biological processes caused by air pollution. (Ramanauskas and Stankevičius (2000) maintained that the durability of external finishes is determined by the following properties;

- ✓ Frost resistance, i.e. the capability of a moisture-saturated material to resist temperature fluctuation through freezing and thawing cycles
- ✓ Moisture resistance, i.e. the capability of a material to resist the periodical moisturizing and drying cycles
- ✓ Corrosion (chemical impact) resistance, i.e. the resistance to solutions of dissolved aggressive destructive chemical agents. UV radiation, causing photochemical reactions on surfaces, can also be considered as a chemical impact. Haneef, Dickinson and Johnson (1999) summarized the mechanisms that contribute to deterioration as:
  - Physical mechanisms. The presence of water is known to be a key factor in promoting the fracturing and erosion
  - of building envelope and coating. Water penetrates the pores and cracks and causes mechanical stresses both by freezing and by the hydration and subsequent crystallization of salts. Freezing condition is not felt in Ilaro area but the environment is wet.
  - Chemical mechanisms. Some deposited chemical agents react with surfaces. Sulphur compounds have been indicted as the most critical factors in this regard, mainly because they are often acidic and can have high concentrations in city and suburban air; however, nitrogen compounds should be considered as well. Fluxes of trace gases (e.g., sulphur dioxide) can be high, especially when promoted by biological activity. Dissolution by chemical reactions with contaminants contained in precipitation is one of the most familiar eroding processes, particularly in the

case of carbonaceous stone. There are cement factories that emit cement dust at Ibese and Ewekoro therefore chemical actions on building finishing materials occur.

- Biological mechanisms. Many different biological factors have been found to be important. Growths of lichens, mosses, algae, mould, fungi and bacteria are capable of promoting surface deterioration. Some bacteria can synthesize sulphuric (or nitric) acid from airborne sulphur dioxide (or nitrogen oxides). This is common in wet regions like ilaro and its environs.

IV. FINDINGS AND DISCUSSION

The observation from the field revealed that (a) climate (b) material composition of external finish used, (c) quality of workmanship and (d) building characteristics can be identified as influencing the occurrence and propagation of defects on the external finishes. The occurrence of defects renders the finishes unsuitable in performing its stipulated functions and consequently affects the durability and service life of the finish. The interview provided information about the influence of the important factors under each of the four categories identified in the review (something that was not completely captured by the visual surveys) and their possible influence and effect on the occurrence of defects on the finishes.

CLIMATE

Under the influence of Climatic conditions, three main factors namely temperature, ultraviolet radiation from sunlight and moisture from wet environment are mainly responsible in causing material degradation and hence occurrence of defects and damage to the external building finish. These factors not only act individually to cause degradation but also have a synergistic effect meaning that their combined effects contribute to cause greater degradation of the finish. Tables 3 and 4 present the factors, the major considerations and defects associated with these factors.

Factor	Characteristic features	Associated defects
Temperature	Temperature and temperature fluctuations Amount of absorbed radiation depends on colour	Physical weathering and Cracking
Ultra Violet Radiation	Amount of UV radiation influenced by latitude, hours exposed to sunlight and angle of exposure of façade	Discolouration and Chalking
Moisture	Affects substrate and underlying layers of building	Blistering Efflorescence Blistering Efflorescence Microbial growth, Flaking
Wind	Wind speed affects concentration of pollutants	Microbial growth Deposit of dirt.
	hence rate of deterioration. Nature of wind affects dispersion of atmospheric pollutants	

Source: Chew and N. Harikrishna (2005)

Table 3: Factors under building characteristics and associated defects

Factors	Characteristic features/ Considerations	Associated Defects
Orientation	+ Façades directly exposed to sunlight undergo greater physical weathering leading to chalking of paint. + Facades facing away from direct radiation are comparatively colder and damper providing ideal conditions for algae and other microbial growth + The intensity and duration of sunlight that a surface receives affect the limit of runoff flow, the type of biological stains and hence the pattern of staining.	+ Chalking + Algae Growth + Staining
Height	+ Tall buildings are at greater risk to deterioration due to their direct exposure to impacting rain and ultraviolet radiation [Choi 1994] + Wind speed varies with height due to the level of openness as well as the instability of air at higher levels + Costs of maintenance and repair of defects to the façade higher for higher storey due to additional costs in the form of scaffolding + Safety during work in higher storey is another concern	+ Greater rate of weathering and discolouration at higher storey
Surrounded by other buildings	+ Presence of adjacent buildings provides a sheltering effect + May result in slower drying period for façade after it has been wetted, leaving it damp for longer periods and therefore promoting biological staining	+ Biological Staining + Algae growth
Age	+ Natural tendency of material to undergo deterioration with time + Condition and serviceability period of the underlying substrate layers of the building has an effect on the exterior paint finish + Gradual loss of protective and other properties of th paint finish itself with age	+ Cracking + Chalking + Flaking / Peeling

Source: Chew & Tan (2003)

Table 4: Building characteristics that affect the durability and service life of External finishes

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TYPE OF BUILDINGS

The buildings that were selected in ilaro are along Oja Odan road through Orita, Library and the main town market area were classified as residential, commercial, mixed used, religious and institutional. In Abeokuta the buildings were randomly selected along Olomore, Lalubu road and Itosin. Ifo and Itori building were also selected randomly along Lagos-Abeokuta express way. 64% of the buildings were used for residential and commercial purposes while 21% were used mainly for commercial purpose. 12% were used for institutional purpose. This suggested that majority of the buildings (98%) were put to constant use. Religious buildings in the study areas contain churches and mosques as indicated in table 5.

Type	Number				Total	Percentage (%)
	Ilaro	Abeokuta	Itori	Ifo		
Residential	186	22	7	6	**221**	48.25
Commercial	68	15	5	6	**94**	20.52
Institutional	54	10	0	0	**64**	13.97
Mixed Used	56	8	4	4	**72**	15.73
Religious	4	2	1	0	**7**	1.53
Total	**368**	**57**	**17**	**16**	**458**	100

Source: Field Survey (2017).

Table 5: Types of buildings

Source: Field Survey (2017)

Plate 3: Residential building at Sanni Abeokuta

Source: Field Survey (2017)

Plate 4: Residential building at Federal Polytechnic Ilaro

Source: Field Survey (2017)

Plate 5: A building at Orita Ilaro

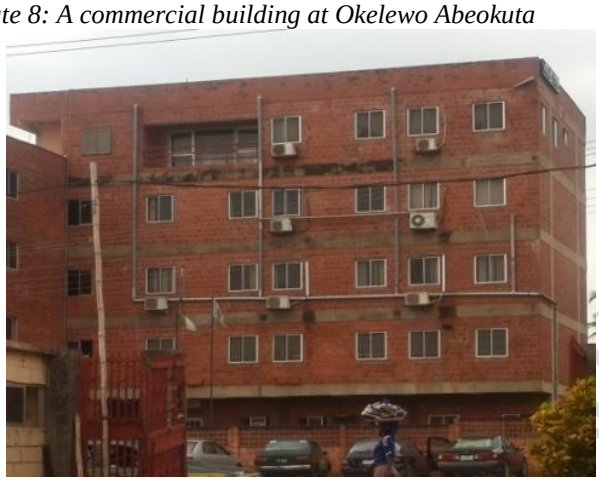
Source: Field Survey (2017)

Plate 6: A building at Library Ilaro

Source: Field Survey (2017)

Plate 7: A commercial building at Itori

Source: Field Survey (2017)
Plate 8: A commercial building at Okelewo Abeokuta



Source: Field Survey (2017)
Plate 9: A brick commercial building at Abeokuta

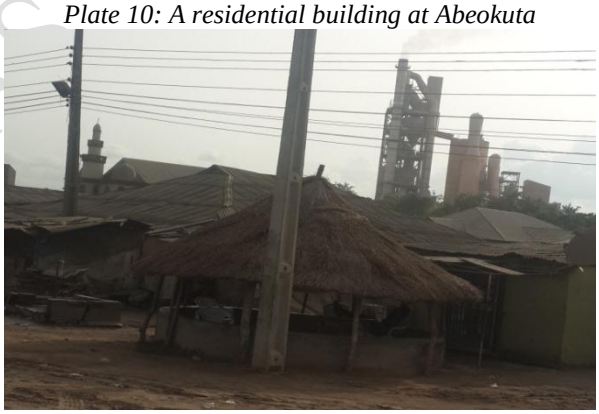
AGE OF BUILDINGS

In the analysis of data on the age of buildings in table 6, it was revealed that 40.39% of the buildings were built over 50 years ago while 51.97% were built within the period of 10-40 years. However, 7.64% were recently constructed within the last 10 years. There was loss of protective properties and the conditions of the underlying substrate were in shambles in most of the buildings. Over 73% of the buildings external finishes have not been replaced for the past 10 years while over 24% underwent some replacement within 10years and below as shown in table 7. Some of the residential buildings recently constructed have started to show signs of deterioration at their bases due to rising damp from the ground. Plates 1 and 2 There are seven religious buildings mosques and churches constitute 1.5% of the total number of buildings. . Generally, the external finishes were in a state of deterioration as a result of age of the buildings. Microbial growth, cracks, flaking and peeling were noticeable in some of the buildings.

Age of Buildings (Years)	Number	Percentage (%)
Above 50	185	40.39
Between 30 – 40	143	31.23
Between 10 – 20	95	20.74
Below 10	35	7.64
Total	458	100

Source: Field Survey (2017)
Table 6: Age of buildings

Source: Field Survey (2017)
Plate 10: A residential building at Abeokuta



Source: Field Survey (2017)
Plate 11: A residential building covered with cement dust at Itori

Time	Number	Percentage (%)
Above 50	45	9.83
Between 30 – 40	96	20.96
Between 10 – 20	204	44.54
Below 10	113	24.67
Total	458	100

Source: Field Survey (2017)
Table 7: Time of replacement of buildings finish

EXTERNAL FINISH MATERIALS OF THE BUILDINGS

The exterior finishes used in the study areas are paint on cement screeding plaster, mortar plaster alone, ceramic tiles, glass, stone, block and brick. The common building finish used was paint which was 51.53% followed by cement rendered wall (28.82%). Brick and Stone finishes constituted

16.59%, while ceramic tile, glass, were rarely used as each constituted 1.75 % and 1.31% respectively (Table 8).

Type of Finish	Number	Percentage (%)
Painted Wall	236	51.53
Cement rendered wall	132	28.82
Brick or block wall	56	12.22
Stone finish	20	4.37
Tiles (Ceramic and mosaic wall tiles)	8	1.75
Glass Finish	6	1.31
Total	458	100

Source: Field Survey (2017)

Table 8: External Finish materials of the buildings

OBSERVATIONS

In the painted surfaces, the effect of greater rate of weathering was observed as cracks were noticeable and there was general loss of appearance, stains, peeling off, separation of layers and flaking of the paint. Building façades were directly exposed to sunlight and were subjected to greater physical weathering leading to chalking of paint.

The painted buildings were rendered with cement plaster most of which were bungalows and storey0 building types and of mixed use. The mixed-used buildings have their ground floor used as commercial purposes while the upper floors were mostly residential. It was observed that buildings whose façades were directly exposed to sunlight underwent greater physical weathering and facades facing away from direct radiation are comparatively colder and damper providing ideal conditions for algae and other microbial growth. Discolouration and deposit of dirt were common features of these buildings. (Plates 3 and 4). The intensity and duration of sunlight that a surface receives affects the limit of runoff flow, the type of biological stains and hence the pattern of staining. (Chew and Tan 2003).

STATE OF BUILDINGS

The analysis of the state of buildings in table 9 showed that 18.34% were in sound state, 38.43% requires minor repairs while 43.23% needed major repairs. Findings show that most of the buildings in the three towns were in very poor state as only about 18.34% of them were in sound condition. A greater proportion of the buildings required minor or major repairs to bring them to good quality. The state of repairs of the buildings takes into consideration the soundness of the roofs, walls, floors and most importantly the external finishes. The soundness of wall and floor means that there are no cracks, surface wear, tearing or peeling of plaster or paint from their surfaces.

State	Number	Percentage (%)
Sound	84	18.34
Require minor repair	176	38.43
Require major repair	198	43.23
Total	458	100

Source: Field Survey (2017)

Table 9: State of buildings

V. CONCLUSION AND RECOMMENDATIONS

CONCLUSION

Climatic environment of the rainforest region can reduce the expected service life of any exterior wall finishes that are not correctly specified and properly installed thereby causing defacing of the building earlier than expected therefore it is better to identify and assess various factors influencing the occurrence of defects on the external finish so as to provide a systematic way of incorporating durability of the materials at the design stage.

The major factors affecting the durability of external building finishes and hence causing reduction in service life of the building finishes have been identified and grouped under four categories– climate, material composition of the finished used, degree of workmanship and building characteristics.

To keep maintenance cost to a minimum, it is necessary to strive for prevention of any possible occurrence of defects in the first place by eliminating or minimising the influence of these factors and accordingly cater to their effects during their formulation and design process as well as during the application process; this would ensure that the desired service life for the finish is attained.

RECOMMENDATIONS

Some form of control can be exerted on the factors falling under the categories of climate, surrounding environment of a building, material composition, degree of workmanship, building design and detailing. Particular attention should be paid to;

- ✓ A general inspection of plastered surfaces should be made about every fifteen years. The cementitious mortar was the least durable that is Service Life Expectancy = 15. (Igal M. S.1 and Monica P. 2004)
- ✓ A thick cementitious mortar plaster with water retardant paint will give the best weather-proofing and durable results on hollow block walls.
- ✓ Substrate for tiling and rendering must be free from dirt, rigid and sound to avoid the reduction in the service life of the tiles.
- ✓ In waterlog areas adequate measures must be taken at the sub structural level to prevent underground water from rising to the super structural level through capillary action.
- ✓ Particular attention should be paid to the undulating surface where the thickness of the rendering is likely to be uneven. This can give rise to variable stresses and cause debonding.
- ✓ Waterproof paint should be adopted for exterior wall finish in dry and wet regions for optimum performance and attainment of the expected service life of the paint.

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