DEFECTS IN BUILDING AND CIVIL ENGINEERING INFRASTRUCTURES AND THEIR MAINTENANCE (EDEWOR HOUSING ESTATE ENERHEN AS A CASE STUDY)

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ABSTRACT
The implementation of maintenance works in building and civil engineering infrastructure faced many nuisance issues due to defect repetition, as a result of this, this presentation identifies the various components of building that are prone to constant maintenance reportusing Edewor Housing Estate, Enerhen as a case study. And the paper also identifies which of these components requires everyday, annual, special, addition/alterations or preventive maintenance repairs. The paper also discussed some examples of type of defects and their likely causes. It is recommended that the control or preventive measure should be during the design and implementation stages of the building.

KEYWORDS: *Fittings, operational activities, annual repairs, everyday repairs, likely causes, hairlines, finishes, structural cracks, defects in building services, symptoms.*

INTRODUCTION

Defects in building and civil engineering infrastructure maintenance works aims at effective and economic method of keeping the building and services fully utilized using the selected case study buildings. It involves numerous skills as influenced by occupancy and the performance level expected of a building (Henning et al, 2015).

The objectives of infrastructure maintenance works are about: preservation, restoring back its original standards and improvement of the facilities depending upon the development that is taking place in the infrastructure.

Building maintenance is work undertaken to keep, restore or improve every part of a building, its services to a currently acceptable standard and to sustain the utility and value of the facility.

Building repairs and maintenance services mainly includes works undertaken for maintaining proper condition of buildings, its services and works in ordinary use (Henning et al, 2015). The use for which buildings are designed is the main factor in determining the required standard of maintenance. Excessive building maintenance should be avoided. At

the same time, building maintenance should ensure safety to the occupant or the public and should comply with the statutory requirements (Spegard, 2020). The need also depends upon intensity of usage. This study is concerned with the many nuisance issues due to defect repetition and prone to constant maintenance repairs. The study was restricted to carefully chosen three buildings at Edewor Housing Estate off Enerhen road, Uvwie Local Government Area of Delta State, Nigeria.

Deterioration of building structures and services to unsatisfactory quality level of requirement of the users defines building defects. Hazards leading to serious or fatal injuries are caused by defects in buildings (Branganca et al, 2014). Most defects can, at their early stages, be discovered through visible or detectable symptoms. If not promptly rectified, minor defects can develop into serious ones, causing failure or sudden collapse, endangering lives and becoming more costly to rectify.

The term building is defined as any roofed structure that encloses space and is intended for use as a shelter (for people, animals or property) or for recreational, industrial, commercial or other functions. Maintenance of building-related assets such as building services, site improvements and temporary buildings that provides storage or shelter, should be reported as building maintenance. Though building defects are in two categories of structural and non-structural defects, the most common types of building defects includes: defective or faulty electrical wiring, structural defects that can result to or cause cracks, rot or collapse, damage as a result of earth settlement and or land movement, plumbing defects as a result of faulty installations, not enough proper drainage systems, not enough ventilation, cooling or heating systems, inadequate fire protection prevention systems, insufficient insulation or sound proving, infestation such as dry rots, wood rots, fungus, termites or vermin also result in building defects (Califonia Civil Code 896).

For planning purpose and undertaking maintenance, buildings and building-related valuables are broken down to component levels (Canh Vu et al, 2016); the examples of building components levels that may require maintenance reporting are:

The Building Substructure
Ground slabs damp-proofing or other membranes, sub-soil drainage, ducts, pits, bases and service tunnels and Internal swimming pools.

The Building Superstructure
Concrete precast and in-situ floors, structural connections (together with their associated finishes), watertight covering over the top of the building structure (roof) external walls, all external doors, all internal walls, internal doors and, internal screens or partition (Aker, 2015).

The Building Finishes
Wall finishes, floor finishes and ceiling finishes

Fittings
Benches, cupboards, shelving, racks, seats, suit rails and all the built-in or fixed items that furnish or equip the building.

Building Services
Sanitary fixtures, sanitary plumbing, water supply, gas service ventilation, (system to circulate air), air conditioning, fire protection, electric light/power, communication and transport (e.g lifts).

External works/services
Storm water drainage (pipe runs from the external faces of buildings), sewer drainage, water supply, gas, fire protection, electric light and power, communication, special services, roads, footpaths, paved areas, car parks,

playground, kerb, water-tank, gates, trees/plants roots, trees/plants branches, vermin problems and activities associated with erosion control (Ecdge, 1999).

Building maintenance related services
Payment of statutory fees such as ground rent, electricity bills, water bills, tenement rate and other related bills.

Operational activities
Building operational activities are routine functions undertaken for hygienic, aesthetic and security purposes and for the supply of utilities. These activities are necessary to keep the building in a habitable and usable condition. In some instances, these routine functions may be undertaken at the same time as maintenance activitiesand/or by the same service provider. In such cases, cost for building operational activities should be charged to operational or other budgets (Sapp, 2017). Three operational activities includes:

Pest control
Pest control is considered a building operational activity. This includes activities associated with the regular treatment for and eradication of red-back spiders, cockroaches, dust mites, lice, mosquitoes, dogs, and possums.

Security services
Services related to the monitoring and operation of a security system should be considered building operational activities requiring maintenance report as well (Sapp, 2017). Examples includes:

- Alarm monitoring and false alarm charges
- Mobile security patrols
- Alarm monitoring phone line rentals
- Security audits
- Provision of security personnel

Refuse/waste collection and disposal
The collection and disposal of general refuse and other waste is considered a building operational activity (Ashrae, 2006). Examples include:

- Removal of general refuse
- Emptying grease traps/septic
- Cleaning acid traps
- Providing sanitary services
- Removal of trade waste

Operational personnel
In circumstances where personnel are provided for the operation of buildings, their services should be considered building operational activities (Ashrae, 2006). Example include:

- Boiler operators/attendants
- Sewerage plant operations
- Janitors
- Gardeners
- Security staff

Operational consumables and utilities
The supply of operational consumables and utilities used for the delivery of a department's services is considered a building operation maintenance (Sapp, 2017). Examples include:

- Pool chemicals
- Material for water purification or treatment purpose
- Water
- Gas
- Fuel for engines and generator sets
- Office consumables such as guillotine blades, first aid kits
- Any form of material used to neutralize disposed acidic waste
- Electricity
- Telecommunication services

Classification of Building Repair And Maintenance Services. According to Pederese et al (2015) classification of building repair and maintenance services are as

follows:

i. The everyday maintenance works
ii. Annual maintenance works
iii. Special maintenance works
iv. Addition and alterations works
v. Preventive maintenance works
vi. Supply and maintenance of furniture and furnishing articles repairs

The everyday maintenance works

The everyday repairs include service repairs which arises from time to time in the services of the buildings such as in plumbing works, water supply, etc ((Ashrae, 2006). examples for such repairs are removing chokage of drainage pipes, manholes, restoration of water supply, replacement of blown fuses, repairs of faulty switches, watering of plants, lawn mowing, hedge cutting sweeping of leaf falls etc. the purpose of this maintenance service is to ensure satisfactory continuous functioning of various services in the buildings (Kohler et al, 2003).

Annual maintenance works

This maintenance service is carried out to maintain the aesthetics of buildings and services as well as to preserve their life, some works like white washing, distempering, painting, cleaning of lines, tanks etc. are carried out periodically. These works are planned on year to year basis (Kohler et al, 2003).

Special maintenance works

Special repairs of building are undertaken to replace the existing parts of buildings and services which get deteriorated on ageing of buildings. It is necessary to prevent the structure and services from deterioration and restore it back to its original conditions to the extent possible (Kohler et al, 2003).

Addition and alterations maintenance works

The works of additions/alterations are carried out in buildings to suit the special requirements of occupants for functional efficiency. The facilities in buildings are updated by carrying out such works (Kohler et al, 2003).

Preventive maintenance works

Preventive maintenance is carried out to avoid breakdown of machinery and occurrence of maintenance problems in buildings and services (Canh Vu et al, 2016). Works or preventive maintenance are carried out on the basis of regular inspection survey. Preventive maintenance includes works to prevent deterioration of building parts (which depends on climatic conditions), pollution, fungi, the insect attack, subsidence flooding, intensity of usage, careless usage, seepage etc (https://www.maintenaceassistant.com/preventive-maintenance/>, 2015).

METHODOLOGY

The study was based on personal experience of the author, practical visitation to site and secondary data from journals. The study was restricted to carefully chosen three buildings at the Edewor Housing Estate off Enerhen Road, Uvwie Local Government Area of Delta State. Some of the secondary data consulted from journals through goggle for buildings includes the following amongst other:

- Aker Solution. "Proposal Regarding " Operation And Maintenance Strategy" For a TLP in BJØRNAFJORDEN." 2015
- Ashrae. "Ashrae green guide: the design, construction, and operation of sustainable buildings."Atlanta: GA: American Society of Heating, Refrigerating and Air-conditioning Engineers, 2006.
- Bragança, Luís, Susana M. Vieira and Joana B. Andrade. "Early Stage Design Decisions: TheWay to Achieve Sustainable Buildings at Lower Costs." The Scientific World Journal(2014): 8.
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RESULTS AND DISCUSSION

Results

The study sampled three residential buildings at the Edewor Housing Estate situated at Enerhen near Warri. Tables 1 & 2 summarises the findings based on investigation carried out by the author during site visit.

The services components of the building have a relatively shorter life span than the building structure components. Defects in the services components usually lead to failure requiring repair or servicing.

Table 1: Identified common defects in the three building components sampled at Edewor Housing Estate.

Defective concrete, spalling or loose plaster in soil fit		
S/No	**Symptoms identified/observed on site**	**Suspected likely causes**
i.	• Surface with water/rust staining, water leakage • Patterned cracking • Bulging, falling off of concrete patches with reinforcement exposed, often rusty • Falling off of plaster/tiles	Defective concrete as a result of ageing is commonly found in old buildings. Persistent water leakage may affect these steel reinforcements. Weak concrete mix, or overloading are also common causes in spalling.
ii.	**Water seepage from external wall, window, roof, or from ceiling or soffit**	
	Symptoms identified/observed on site	**Suspected likely causes**
	• Water staining • Peeling off of point or wall paper • Water dripping • Growth of fungus • Defective concrete, plaster or tiles • Rust staining	External water seepage could be due to a variety of reasons including cracks on external wall, honey comb concrete, defective sealant at window, defective waterproofing membrane at roof, defective external water and drainage pipes, etc
iii.	**Structural cracks in walls**	
	Symptoms identified/observed on site	**Suspected likely causes**
	• Cracks that penetrate through finishes into the concrete or bricks • Long, continuous cracks across width of wall • Diagonal cracks at corners of window or door • Cracks with rust staining	Structural cracks may be caused by many factors, e.g. excessive movement of the building structure, unwanted ground settlement, serious overloading, weaknesses caused by corrosion/deterioration of materials, or damage by

		materials, or damage by accidents, or poor design/construction, etc. detailed investigation must be carried out to identify the cause(s) which must be removed or rectified before the cracks are repaired
iv.	**Structural cracks in columns and beams**	
	Symptoms identified/observed on site	**Suspected likely causes**
	• Cracks that penetrate through finished down to the concrete or bricks • Spalling	Structural cracks may be caused by many factors, e.g. excessive movement of the building structure, unwanted ground settlement, serious overloading, weaknesses causedby corrosion/deterioration of materials, or damage by accidents, or poor design/construction, etc. detailed investigation must be carried out to identify the cause(s) which must be removed or rectified before the cracks are repaired
v.	**Non-structural cracks in plaster or other finishes with cement sand rendering as base**	
	Symptoms identified/observed on site	**Suspected likely causes**
	• Hairline cracks • Multi-directional crack (shrinkage cracks) • Crack between panel walls and structural elements e.g. brick wall andbeams/columns	Cosmetic shrinkage cracks in plaster or other forms of finishes will affect the appearance only and do not pose any safety concern. They are small hairline cracks developed within the finishes layer not penetrating down to

		the reinforced concrete structure.
vi.	**Defective external wall finishes (mosaic titles, ceramic tiles, stone cladding or curtain wall)**	
	Symptoms identified/observed on site	**Suspected likely causes**
	• Debonding of finishes/titles from wall structure resulting in "hollow sound" when tapped with a hammer. • Cracking of wall surfaces • Bulging with hollow base • Falling off • Cracks • Loosening of parts	The defects could be due to ageing, structural movements, defective workmanship during installation, thermal movement, defective or missing expansion joints, damage by external factors (e.g. galling objects during typhoon), ingress of water into the gap between the finishes or tiles and the structure, etc.

Source: Authurs SiteVisit (2020)

Table 2: Identified common defects in the three building services works sampled at the Edewor housing estate.

S/No	System	Symptoms identified/observed on site	Suspected likely causes
i.	• Water supply	• Insufficient water pressure or flows	• Blockage or leakage of components of the supply system such as pipes or valves
		• Brownish water/grit and deposit	• Rusty pipes or dirty supply tank
		• Stoppage of supply	• Pump failure breakage or supply pipe
		• Water seepage	• Defective water tanks, pipes (pipe joints) or valves
		• Unclean water, algae growth dirt and deposit	• Defective or missing water tank cover
		• Sudden rise in consumption	• Leakage in the system after water meters
		• Noisy water pumps, noisy water inlets	• Defective water pumps, undue water pressure

ii.	• Electricity supply	• Stoppage of supply/system breakdown • Sudden or frequent fuse or circuit breaker cut off leading to stoppage • Heating of switches and wires • Sudden or frequent stoppage and large power consumption • Electric sparks or shocks electrocution	• Failure of fuse or circuit breaker • Earth leakage, overloading • Overloading • Uneven distribution of phases • Inadequate earth bonding
iii.	• Fire services	• Inadequate water pressure • No water supply • Water leakage, rusty stains • Alarm not working (when tested), false alarm or warning lights on signal panels • Portable equipment lost or misplaced glass panels of alarm switch box broken • Non-functioning of equipment	• Blockage or leakage of components of the supply system such as pipes or valves • Failure of pump, breakage of the supply system • Damage, corrosion or failure of pipes, joints or valves • Alarm wiring defect, short circuit • Inadequate protection or poor management • Inadequate maintenance or servicing
iv.	• Lift and escalator	• Stoppage, excessive noise during operation, indicator lamps off, unstable lifting, malfunction of buttons and indicator lamps • Occasional overrun • Doors not closing properly • Defective mechanical parts, frequent stoppage, alarm signals	• Ageing of parts mechanical failure • Landing misalignment • Parts ageing, mechanical failure, rubbish obstructing operation • Inadequate servicing
v.	• Air conditioning heating	• Not cool enough, not warm enough • Noisy, no air movement	• Poor efficiency, leakage of refrigerant dust and dirt at heat transmission fins • Loosen parts, blocked, air ducts and grilles needs cleaning

		• Engines sound normal but no air movement • Noisy blowers or propellers movement • Poor indoor air quality • Dripping and substandard output of cool or warm air • Noisy blowers or propellers movement	• Misalignment of motor shafts • Insufficient fresh air intake, mal-function of intake air filter • Insulation failure • Misalignment of motor shafts

Source: Author Site Visit (2020)

DISCUSSION

All the three buildings used as case study has similar symptoms and suspected likely causes. The symptoms observed as a result of field visitation and their suspected causes are all shown in tables 1 and 2. When there is any inherent defects both in design and construction or as a result of climate weather external factor or as a result of inadequate maintenance wear and tear, the identified observed symptoms during site visits are sure to happen resulting to why they need maintenance. The maintenance cost rises disproportionately to a higher level and anticipated life of building is reduced. All the buildings components deteriorate from the time they are completed as a result of defects due to design and construction. The rate of deterioration depends on a number of factors. Not all the factors can be controlled by the occupants of the building. Some of the control or preventive measures for the likely causes should be adequately put in place during the design and construction stages.

Defect occur in various forms and to different extents in all types of buildings, irrespective of age. The following all contribute to the occurrence of defects in buildings and they should be controlled and prevented during design and construction stages;

- The large varieties of building materials used that may not be well congruent with one another;
- Construction techniques that may not be defect proof, inconsistent or sub-standard workmanship.
- Use of unsuitable construction details
- Extreme site conditions undermining performance standards
- Natural deterioration
- Attacks by pollutant
- Improper uses of the completed buildings

Of the four major categories which influences the environment conditions of buildings which are: indoor air quality, thermal environment, acoustics and lightening (Ashrae, 2006), the finding revealed that thermal and acoustics are environmental factors peculiar to the Edewor Housing Estate due to the fact that hazards such as atmospheric pollution and noise as a result of the presence of many industrial activities built up along the ever busy Enerhen and Udu river industrial area.

CONCLUSION

Building maintenance work is usually taken to keep or improve every part of the building. It is aimed at effective and economic method of keeping the building and services fully utilized. Building maintenance objective

amongst others, is to preserve the building component and services in good operating condition and restoring its original standards. The building maintenance works often touches all its components which include substructure, superstructure, finishes, fittings, services, external works, and operational activities. Common defects in building and their likely causes are identified. These includes defective concrete, spalling or loose plaster in soffit, water seepage (from external walls, window, roof or ceiling/soffit), structural cracks in columns/beams, non-structural cracks in plaster or other finishes with mortar as base, and finally, defective external wall finishes. The paper also discussed the following defects in services; water supply, electricity supply, lift escalators, air conditioning and heating. The study results in Tables 1 & 2 has shown that: concrete aging in old buildings, constant water leakage, weak concrete mix, overloading, cracks, honey comb concrete, earth differential settlement, blockage of pipes and installation failure are amongst causative factors of defects in buildings and civil engineering infrastructures. The author's vast experience of over the years on-the-spot observation of what is on ground during visit to Edewor Housing Estate in which it was obvious that the buildings are old, the obvious dilapidated components levels of the buildings and the lack of maintenance are the reasons for the evidence observed that are clearly the causative factors of the defect enumerated above.

RECOMMENDATIONS

i. It is recommended that control measures should be considered in early stages of design and implementation.
ii. Appropriate right choice of building materials should be used during construction stages.
iii. Compulsory selection of suitable construction techniques should be recommended.
iv. Ensuring adequate specifications for construction and installation work during the design stage.
v. An effective and efficient supervision throughout construction and rectification of defects prior to final certification should be effected.
vi. Provision of adequate space for landscaping with proper design is compulsory.
vii. Right choice of experienced workmen is key to preventing causes of defects.
viii. Depending upon the nature of work, immediately after the date of completion, building should be maintained for initial period of 3 to 6 months as there can be teething troubles in any new construction.

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