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FIRE SAFETY DESIGN STRATEGY TOWARDS A PROPOSED HOSTEL DESIGN IN SOME SELECTED TERTIARY INSTITUTIONS IN NORTH EAST

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Abstract:

This study dwells on "Fire safety design strategy towards a proposed hostel design in some selected tertiary institutions in the northeast. This is because fire requires specific conditions for it to occur through a source of ignition, these conditions are present in all buildings, as the by-product of design choice. Hence, fire can start at any time in a building depending on what caused it. As a result of incident of fire disaster, there has been public outcry of the need to reconcile these issues with building codes and fire safety designs. This research will aim at reducing the chances of fire incidences in hostel buildings by design strategies, and enhance the fire resistance for safe evacuation to a place of total safety. The research design adopted is case study. An assessment checklist and rating scale is the instrument used for data collection. The population of study are four student hostel buildings in The Polytechnic, Bali, Taraba State. These hostel buildings are selected based on convenience sampling techniques. The research is concluded by giving appropriate design guide and recommendations that professionals concerned with fire safety strategies will use in order to help in the evolvement of design that best provide for safety of the occupants.

***Keywords**: Students hostel, Fire outbreak, Design strategy, Fire safety*

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Introduction

Student learning can be enhanced and made more effective when learning environment is made adequate and appropriate. Students' hostel management is very vital in attaining quality tertiary education for sustainable development (Modebelu & Agommuoh, 2014). Modebelu & Agommuoh (2014) declared that hostel accommodation is considered the most essential of all enabling school environmental factors. Accommodation or housing is one of the physiological needs that are pre - requisite to the quality survival of the students in terms of health, academic performance, and learning. Accommodation is the pivot, around which, all the activities of students revolve. Modebelu & Agommuoh (2014) also stated that there is an urgent need for adequate housing of students for qualitative implementation of educational programmes and students ' welfare. It is then very necessary that every educational institution, particularly every university, should design and plan to give students the best affordable accommodation. Ernst and Neufert (2006) pointed out that, the provision of these hostel facilities are usually guided by set standards as well as the number of students expected to reside in it. Ojo, Ologunagba, Ojo&Olabintan(2013) asked whether " Hostel Accommodation in tertiary Institution : To be or not to be " He observed that hostel accommodation in tertiary educational Institutions has not been receiving adequate attention in the past . The trend of fire outbreak in building has become a major source of concern for all. There have been some incidences of fire in hostels, where the occupant lost their live and properties. Obia (2014) reported that the whole Madam Tinubu hall of the University of Lagos was a perfect pandemonium following a fire outbreak that occurred in the female hostel of the University of Lagos (UNILAG).

Nwafor (2014) again reported the case of Three students of Ebonyi State University Abakaliki that were critically burnt in a gas explosion inferno that gutted kings palace hostel of the University. Duru (2014) reported another fire outbreak in a students' hostel an early morning inferno, yesterday, razed a block of the Benue State University, BSU, female hostel in Makurdi, the state capital. Fire in buildings poses serious challenges to fire fighters. The potential combinations of a large number of occupants, numerous ignition sources, high fuel loads and sleeping occupants create several issues that can be difficult to resolve. These issues need to be reconciled with the building codes, fire safety design and cost constraints of the project (Shao - Hoon, 2001).

Therefore, this study finds it necessary to carry out this research on how to avoid the problem than coping with it. This entails that identifying the problems and attitudes associated with fires in buildings at the study area is a problem which needs to be addressed through proffering solution as discovers in the following findings.

Statement of Problem

Fire hazards in hostel buildings in the study area are alarming and worrisome as a result of their recurring devastating outcome. Students are continually faced with the challenge and potential risk of fire incidences from carelessness, poor or absence of prohibition policies and control on fire safety strategies, overcrowding, poor general good housekeeping, indiscriminate behaviour, etc. Above all, a foremost problem is at the design stage of the hostel building which is agreed to be ultimately responsible for creating a coherent fire-resistant design approach into the entire fabric of the building as a passive or protection measure. However, the inadequate measures and other similar factors mention above become a serious threat to the students’ lives in the study area which is why this work is here to address the incidence. This is done through various architectural strategies applied in solving the trend of fire outbreak in building which has become a source of concern for occupant.

Aim and Objectives

The aim of this research is to examine ways of limiting chances of fire incidences in hostel building and enhance the fire resistance for safe evacuation to a place of total safety. This is achieved through the following objectives:

i. To determine the level of fire risk in the hostel under study.
ii. To evaluate the amount of compartmentalization applied in the hostels under study.
iii. To determine the effectiveness of means of escape in the hostels under study.
iv. To ascertain the effectiveness of accessibility for fire fighters in the hostels under study.

Review of Related Literature

Fire Outbreak in Nigerian Hostels

The containment of fire outbreak in Nigerian hostels has been a major challenge in the country. This is evident enough from the ongoing crisis in the country where student's lives are at stake as well as their belongings. Ozor (2015) narrated a fire incident which occurred in the University of Nigeria, Nsukka where a female hostel was completed razed by fire as a result of power surge. No lives were lost but the outcome resulted to the loss of property worth millions of naira. The fire could not be contained because the fire fighters ran out of water. There was no provision of water hydrant to control the fire outbreak. This drawback gave the unfortunate chance for the fire to spread to other rooms. Mary (2016) narrated an event of fire that was also caused by power surge. This happened in Bethel female hostel in Abubakar Tafawa Balewa University, Bauchi state. Power surge has always been marked as a source of fire in hostels. However, in most cases, it has always been an assumption. No proper fire risk assessment has been appropriately carried out to determine the possible cause.

In the University of Lagos, fire started as a result of student's carelessness. It was gathered that a student used a hot plate to cook and kept the heated plate under the bed. The heat from the hot plate was the source of the fire. Samson (2014) also narrated the same incidence that was caused by a cooking hot plate which resulted to an inferno in Moremi hall in Obafemi Awolowo University. Cooking strategies can be said to be one of the major problem of students in hostels. This might have emanated from inadequate or no provision of storage utility space, no provision for kitchen facilities or the problem of proper orientation of room activities.

Fire hazards can also be fatal to human lives in hostel accommodations. An unfortunate event occurred in the College of Education Agbor, Delta state, where two female undergraduate siblings were burnt to death following an inferno that razed the entire fabric of the hostel building (Ogwuda, 2014). Nadi (2015) narrated how a whole block that accommodated about 50 students got razed by fire and killed two students while several others were injured. Fire equipment were completely absent to contain the outbreak and the cause could not be determined. A far more dreadful event occurred in Government Girls Secondary School, Kano, where 7 female students died as a result of stampede as they struggled to escape the building through a narrow gate. The hostel was the largest of the 13 hostels in the school but was reduced to rubbles because of the inferno that gutted the entire structure. The possible cause could not be ascertained. Thus, the incident remained a mystery. Fire incidence in hostels keeps going on and on in the society and all over the world.

Fire Hazards

For a fire to start, three things are needed:

1) a source of ignition;

2) fuel; and

3) oxygen

If any one of these is missing, a fire cannot start. Taking measures to avoid the three coming together will therefore reduce the chances of a fire occurring. The remainder of this step will advise on how to identify potential ignition sources, the materials that might fuel a fire and the oxygen supplies that will help it burn.

Sources of ignition

You can identify the potential ignition sources in your premises by looking for possible sources of heat, which could get hot enough to ignite material found in your premises. These sources could include: (a) smokers' material, e.g. cigarettes, matches and lighters; (b) naked flames, e.g. candles, night lights, gas or liquid-fuelled open-flame equipment; (c) electrical, gas or oil-fired heaters (fixed or portable); (d) boilers (e) hot processes, e.g. welding by contractors; (f) cooking equipment and Xs activities; (g) machinery with hot surfaces (h) faulty or misused electrical equipment, e.g. electric blankets, computers, vending machines (i) lighting equipment (fixed and movable), e.g. halogen lamps or table lamp and (j) obstruction of ventilation equipment.

Intumescent and Ablative Materials

Mroz et al (2016) narrated that fire protection barriers enable to create fire resistant compartments preventing fire spread. Separation of larger buildings into smaller fire resistant compartments, increases the safety of the building occupants. Effective fire compartment barriers seal all openings like electrical services. Electrical service transmits power by cables placed either in cables trays or in cables trunking. In case of transmission lines, the fire protection of opening and cables itself is at highest value. In order to separate occupancies from fire, the openings are often sealed with intumescent material while ablative materials are used commonly as protective paint like coating for cables protection. When considering steel structure and its susceptibility to damage under fire, intumescent and ablative materials may be applied successfully as well.

Method /Approach

The research design that is adopted for this research work is a descriptive research whereby the data generated are documented in their natural setting without manipulation of any variable and seeks information as they exist. A case study as a descriptive research design tool is used to obtain detailed information of each event, one phenomenon at one place over an extended period of time which is clearly defined and quantified in this research work.

Population of the Study

The population for this study covers all the entire students' hostel of Federal Polytechnic Bali, Taraba State University, Adama Moddibo University, Yola, Abubakar Tafawa Balewa University Bauchi.

Method of Data Collection

Questionnaire which is constructed inform of scales for field observation was used for data collection in this study. It was divided into three sections. The first section comprises some basic questions regarding the background of the researchers such as age, qualification,

working experience, study level and gender. The second section consists of closed ended questions where the observer selects from multiple choice options listed under such questions as responses for the questions asked. The third section consists a list of open-ended questions where the researchers are required to provide independent responses to these questions in writing. A total number of 75 questionnaires were administered in each of the study location. This allows the researchers to retrieve adequate questionnaires for subsequent analyses that is targeted at 50. The 50 were randomly selected through simple sampling technique which facilitated the analysis in this study. The total frame is 300 from which 75 is scouted form each institution in the study area.

Method of Data Presentation and Analyses

The data collected is tallied from the raw questionnaires, organized and computed to percentages. These were then tabulated and some data presented in simple bar chart, selection of appropriate graphical presentation among the two (Table and bar chart) depended on convenience.

Result and Discussion

In this section, the results of data analysis and the findings were presented. The presentations were made systematically in the order of the research questions of this study, which are presented on tables and graphical charts below.

RQ. 1 What is the level office risks in the hostel buildings under study?

In order to answer the above research question, the mean of the level of fire risk is calculated based on the studied cases and the summary of finding is presented in Tables and figures

Table 1 and 2 show the variables of the level of fire risk in regards to sources of fuel applied to the studied buildings, standards as established by literature, field observant at the time of visit, rating scale, mean and remark.

The level of fire risks of sources of fuel showed that highly flammable liquids recorded a very high risk of 100%. Conventional laundry activities (drying of cloths) recorded a high risk of 80%. Combustibility of wall and ceiling linings recorded a medium risk of 66%. Combustible waste recorded a low risk of 56%. Stock of combustible materials recorded a medium risk of 76%. Carpets recorded a medium risk of 66%. Curtains, drapes and blinds recorded a low risk of 56%. Bedding recorded a very high risk of 100%.Upholstery recorded a medium risk of 66%.

Table 1: Level of fire risk in regards to sources of fuel in the studied hostel buildings.

S/N	Attributes	Standards	Field Observations				Rating Seale				Mean Value	Percentage (%)	Remark
	Sources of Fuel		Hostel 1	Hostel 2	Hostel 3	Hostel 4	Hostel 1	Hostel 2	Hostel 3	Hostel 4			
1.0	Highly Flammable Liquids: Gases, Chemicals, Liquids & solvents, Liquid-based products	Prohibition policies on large amount of flammable substances. Keep safe in fire resisting stores.	Store is absent	Store is absent	Store is absent	Store is absent	5	5	5	5	5	100	Very High Risk
2.0	Conventional Laundry Activities (Drying of cloths)	Ensure adequate outdoor drying facilities. Drying areas must be free from fire risk.	Outdoor drying of cloths on clothes line	Outdoor drying of cloths on clothes line	Indiscriminate drying of cloths in high fire risk areas	Indiscriminate drying of cloths in high fire risk areas	1	1	5	5	4	80	High Risk
3.0	Combustibility o Wall & Ceiling Linings	Combustible linings must be FR-treated. Reduce large areas of combustible linings. Use fire resisting linings	Fire resisting linings. No fire retardant treatment.	Fire resisting linings. No fire retardant treatment.	Moderate areas of hardboard	Large areas of hardboard	2	2	4	,	33	66	Medium Risk

		especially in fire risk areas.											
4.0	Combustible Waste: Paper, rags, cardboard, etc.	Ensure good general housekeeping. Waste bins should be located 10m away building.	Adequate waste bins(general good housekeeping). Waste bins located morethan10m away building	Inadequate waste bins (poor general housekeeping)Waste bins located 0-5maway building	Adequate waste bins (general good housekeeping). Waste bins located 5-10maway building	Inadequate waste bins (poor general housekeeping). Waste bins located 0-5maway building	1	3	2	5	2.3	56	Low Risk
5.0	Stock of Combustible Materials: Fabrics, papers, cardboards, wood, etc.	Separate stock of combustible materials from sources of ignition and by fire resisting construction.	Adequate store but non-fire resisting	Inadequate storage facilities	Inadequate storage facilities	Inadequate storage facilities	3	4	4	4	3.3	76	Medium

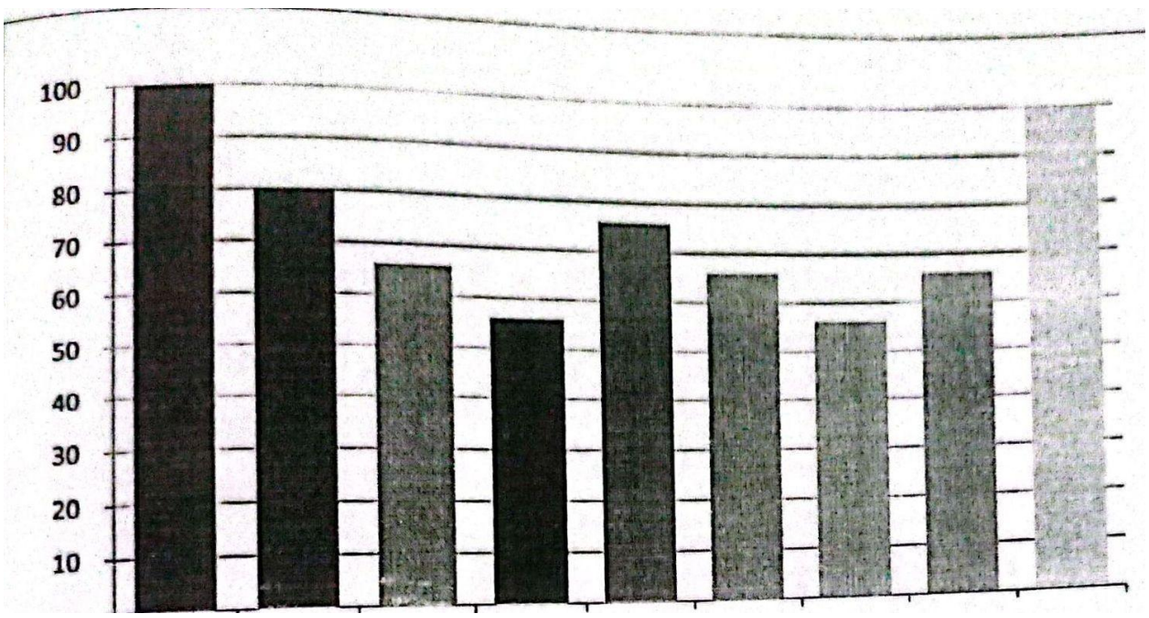
1=Very Low Risk, 2=Low Risk, 3-Medium Risk, 4=High Risk, 5-Very High Risk.
Source: The Regulatory Reform (Fire Safety) Order (2005) / Field Survey: 2023

Table 2: Level of fire risk in regards to sources of fuel in the studied hostel buildings continuation.

S/N	Attributes	Standards	Field Observations				Rating Scale				Mean Value	Percentage	Remark
	Sources of Fuel	Preferred Flammability index for low fire risk=36 and below. For optimum performance, apply FR-treated to furniture & furnishings to reduce fire risk.	Hostel 1	Hostel 2	Hostel 3	Hostel 4	Hostel 1	Hostel 4	Hostel 4	Hostel 4			
	Furniture & Furnishings: Carpets, curtains, upholstery & bedding												
7.0	Curtains, drapes and Blinds		Acetate Materials	Nylon materials	Acetate materials	Polyester materials	3	2	3	3	2.8	56	Low Risk
8.0	Upholstery		Polyester Upholstery	Cotton upholstery	Wool upholstery	Acrylic Upholstery	3	5	1	4	3.3	66	Medium Risk

5=Very high Risk, 5= Very High Risk. 1=Very LowRisk, 2 = Low Risk, 3= Medium Risk, 4 = Hi

Source: The Regulatory Reform (Fire Safety) Order (2005) / Field Survey: 2023



■(A). Highly Flammable Liquids (100)

■(B). Conventional Laundry Activities (80)

(C). Combustibility of wall and Ceiling Linings (65)

■(D). Combustible Waste (55)

■(E). Stock of Combustible Materials (75)

(F). Carpets (65)

(G). Curtains, Drapes and Blinds (55)

(H). Upholstery (65)

(I). Bedding (100)

Figure 1: Bar chart showing the level of fire risk of sources of fuel in the studied hostel buildings.

Author's field survey (2023).

Table 3: Level of fire risk in regards to sources of ignition in the studied hostel buildings.

S/N	Attributes	Standards	Field Observations				Rating Scale				Mean Value	Percentage	Remark
	Sources of Ignition		Hostel 1	Hostel 2	Hostel 3	Hostel 4	Hostel 1	Hostel 2 —	Hostel 3	Hostel 4			
1.0	Heat Generating Processes: Hot Plates, stoves, cookers, etc.	Cooking areas must be fire-resisting, safe and separate from sleeping areas. Fire blankets and extinguishers should be readily available.	Indiscriminate cooking activities in fire risk areas	Indiscriminate cooking activities in fire risk areas	Indiscriminate cooking activities in fire risk areas	Indiscriminate cooking activities in fire risk areas	5	5	5	5	5	100	Very High Risk
2.0	Open Flames: Candles, kerosene lamps, oil lamps, etc.	Ensure prohibition policies on the use of open flames in indoors. Use modern lanterns as alternative.	No prohibition policies. Modern lanterns frequently used	No prohibition policies. Open flames frequently used	No prohibition policies. Open flames Frequently used	No prohibition policies. Modern lanterns frequently used	3	5	5	3	4	80	High Risk
3.0	Smoking Habits	Ensure prohibition polices on smoking in high fire risk areas. Receptacles for cigarette ends.	No prohibition policies and signage on smoking in fire risk areas.	No prohibition policies and signage on smoking in fire risk areas.	No prohibition policies and signage on smoking in fire risk areas.	No prohibition policies and signage on smoking in fire risk areas.	,	5	5	5	5	100	Very High Risk

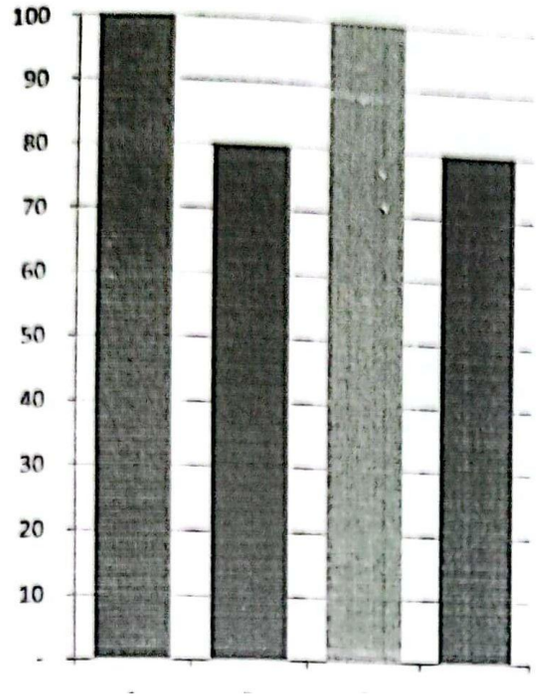
4.0	Electrical Equipment and Fittings	Avoid overloading. Repair or replace faulty or damaged fittings or equipment. Check and inspect regularly.	Overloaded power supply socket outlets	Potential sparks from exposed naked wires	Equipment and fittings are in good condition	Overloaded power supply socket outlets	5	5	1	5	4	80	High Risk

1=Very Low Risk, 2=Low Risk, 3=Medium Risk, 4=High Risk, 5-Very High Risk.

Source: The Regulatory Reform (Fire Safety) Order (2005) / Field Survey: 2023

Sources of Ignition: Table 4 shows the variables of the level of fire risk in regards to sources of fuel applied to the studied buildings, standards as established by literature, field observant at the time of visit, rating scale, mean and remark.

The level of fire risk of sources of ignition showed that heat generating processes recorded a very high risk of 100%. Open flames recorded a high risk of 80%. Smoking habits recorded a very high risk of 100%. Electrical equipment and fittings recorded a high risk of 80%.



- (A). Heat Generating Processes
- (B). Open Flames
- (C). Smoking Habits
- (D). Electrical Equipment and Fittings

Figure 2: Bar chart showing the level of fire risk of sources of ignition in the studied hostel buildings.

Author's field survey (2023).

RQ 2. What is the amount of compartmentalization applied in the hostels under study?

In order to answer the above research question, the mean of the amount of compartmentalization will be calculated based on the studied cases and the summary of finding will be presented in Table 4 which shows the variables of the amount of compartmentalization applied to the studied buildings, standards as established by literature, field observant at the time of visit, rating scale, mean and remark. It showcases that the amount of compartmentalization of sub-dividing common vertical walls (for fire rating) showed that 60% of CMU (Concrete Masonry Unit) cores was moderately applied and 0% of CMU (Concrete Masonry Unit) aggregate mix was not applied in the studied hostel buildings. It also displays that Reinforced Concrete Walls, Floors and Roof Slabs (for Fire Rating).

The amount of compartmentalization of reinforced concrete walls, floors and roof slabs (for fire rating) showed that 80% of concrete slab minimum equivalent thickness was well applied and 100% of concrete slab minimum concrete cover was very well applied in the studied hostel buildings. At the same time, Reinforced Concrete Columns (for Fire Rating). The amount of compartmentalization of reinforced concrete columns (for fire rating) showed that 90% of minimum column size was very well applied and 60% of minimum column concrete cover was moderately applied in the studied hostel buildings. Reinforced Concrete Beams (for Fire Rating) The amount of compartmentalization of reinforced concrete beams (for fire rating) showed that 100%of beam width and minimum concrete cover was very well applied in the studied hostel buildings.

Table .5

S/N	Attributes	Variables	Standards	Field Observations				Rating Scale				Mean Value	Percentage (%)	Remark
				Hostel 1	Hostel 2	Hostel 3	Hostel 4	Hostel 1	Hostel 2	Hostel 3	Hostel 4			
1.0	Sub-dividing Common Vertical Walls(for Fire Rating)	CMU (Concrete Masonry Unit)Cores	Empty-2hr Partially-2 to 3hr Fully-4hr. -Core materials: perlite, vermiculite, grout, expanded slag, shale, slate & sand.	Empty Core(2hr)	Empty Core(2hr)	Empty Core(2hr)	Empty Core(2hr)	3	3	3	3	3	60	Moderately Applied
		CMU (Concrete Masonry Unit)Aggregate mix(%)	Gravel (60%o): Pumice (40%) =4hr Gravel (70%≥) reduces fire resistance to 3hr	Not applied	Not applied	Not applied	Not applied	1	1	1	1	1	20	Not Applied

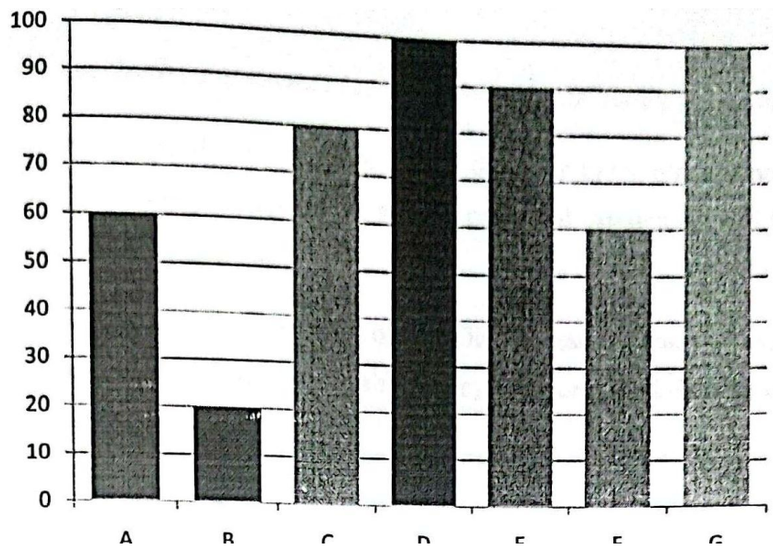
2.0	Reinforced Concrete Walls, floors and Roof slabs(for Fire Rating)	Concrete Slab Minimum Equivalent Thickness	Aggregate type/Minimum Thickness (mm)for Fire Rating -Siliceous/ 87.5 to 115 (1-2hr)/175 (4hr)-Carbonate/ 80 to 142.5 (1-3hr)/ 165(4hr)-Sand-lightweight/ 67.5 to 115(1-3hr)/135(4hr) -Lightweight/ 62.5 to 110 (1-3hr)/127(4hr)	Thicknes s150mm/ Siliceous aggregate type	Thicknes s150mm/ Siliceous aggregate type	Thicknes s150mm/ Siliceous aggregate type	Thicknes s150mm/ Siliceous aggregate type	4	4	4	4	4	80	Well Applied
		Concrete Slab Minimum Concrete Cover	Aggregate Type/Minimum Conc. Cover(mm) for Fire Rating -Siliceous -Carbonate -Sand-lightweight or 18.7-4hr or less lightweight	Conc.Cov er25mm/ Siliceous aggregate type	Conc.Cov er25mm/ Siliceous aggregate type	Conc.Cov er25mm/ Siliceous aggregate type	Conc.Cov er25mm/ Siliceous aggregate type	5	5	5	5	5	100	Very Well Applied

3.0	Reinforced Concrete Columns (for Fire-Rating)	Minimum Column Size	Aggregate Type/Minimum Column Size(mm) for Fire Rating -Siliceous/200-300(1-3hr)/350(4hr) -Carbonate/200-275(1-3hr)/300(4hr) -Sand-lightweight/200-262.5(1-3hr)/300(4hr)	Columnsize300mm/Siliceous aggregate type	Columnsize400mm/Siliceous aggregate type	Columnsize300mm/Siliceous aggregate type	Columnsize350mm/Siliceous aggregate type	4	5	4	5	4.5	90	Very Well Applied
		Minimum Column Concrete Cover	Aggregate/Minimum Concrete Cover (mm)for Fire Rating -Siliceous/25-50(1-3hr) -Carbonate/25(1hr) -Sand-lightweight/50(2-4hr)	Conc.Cover25mm/ Siliceous aggregate type	Conc.Cover25mm/ Siliceous aggregate type	Conc.Cover25mm/ Siliceous aggregate type	Conc.Cover25mm/ Siliceous aggregate type	3	3	3	3		60	Moderately Applied

4.0	Reinforced Concrete Beams (for Fire Rating)	Beam Width &Minimum Concrete Cover	Beam Width/Minimum Concrete Cover(mm)for Fire Rating 125mm-31.25mm-lhr to 4hr 175mm-18.75mm-1hr to 4hr ≥250mm-18.75mm-1hr to 4hr	Beamwidth225mm/Conc.Cover25mm	Beamwidth225mm/Conc.Cover25mm	Beam width 225mm/Conc.Cover25mm	Beam width 225mm/ Concrete Cover25 mm	5	5	5	5	5	100	Very Well Applied

1-Not Applied, 2 =Fairly Applied, 3 = Moderately Applied, 4=Well Applied, 5=Very Well Applied.

Source: Concrete Reinforcing SteeI Institute (2015) / Field Survey:(2023)



■(A). CMU (Concrete Masonry Unit) Cores

(B). CMU (Concrete Masonry Unit) Aggregate mix (%)

(C). Concrete Slab Minimum Equivalent Thickness

■(D). Concrete Slab Minimum Concrete Cover

(E). Minimum Column Size

(F). Minimum Column Concrete Cover

(G). Beam Width & Minimum Concrete Cover

Figure 3: Bar chart showing the amount of compartmentalization applied in the studied hostel buildings.

Author's field survey (2023).

RQ.3 What is the effectiveness of means of escape applied in the hostels under study?

In order to answer the above research question, the mean of the effectiveness of means of escape is calculated based on the studied cases and the summary of finding which is presented in Table .5 and 6. The tables show the variables of the effectiveness of means of escape applied to the studied buildings, standards as established by literature, field observant at the time of visit, rating scale, mean and remark. Travel Distance: The effectiveness of means of escape of travel distance showed that 46% of one direction was fairly applied and 66% of more than one direction was fairly applied in the studied hostel buildings. Escape Routes:

The effectiveness of means of escape of escape routes showed that 100% of occupants capacity was very well applied, 100% of width of escape was very well applied and 100% of height of escape route was very well applied in the studied hostel buildings.

4.1.3.3 Corridors

The effectiveness of means of escape of corridors showed that 26% of length of corridor was not applied in the studied hostel buildings.

4.1.3.4 Refuge

The effectiveness of means of escape of refuge showed that 0% of total safety space was not applied in the studied hostel buildings.

4.1.3.5 Exit Doors

The effectiveness of means of escape of exit doors showed that 0% of fie rated door was not applied, 70% of direction of opening was moderately applied and 96% of occupant capacity exiting door was well applied in the studied hostel buildings.

4.1.3.6 Stairways

The effectiveness of means of escape of stairways showed that 100% of width of stairs was very well applied in the studied hostel buildings

Discussion

This research sought to ascertain the extents to which fire safety design strategies is applied in the studied hostel buildings where applicable. Therefore, the objectives are achieved through addressing the questions below in this work.

RQ.1 What is the level of fire risk in the hostels under study?

In the course of carrying out fire risk assessment in the studied hostel buildings, it clearly showed that little or no attention has been paid on managing potential threats that could cause fire incidences. Sources of ignition and fuel are still a threat in the Nigerian hostels. A common factor is overcrowding, which increases fire hazards by any additional occupant in a space as a result of lack of space. This addition adds to the fuel loads which in turn increases chances of fuel and ignition, creates over loads in electrical points and yields to shortage of storage spaces. Fire resistant storages spaces for storing flammable and combustible were not provided from observation in the course of this risk assessment, therefore the threats can hardly be measured. According to Regulatory Reformed (Fire Safety) Order (2005), there must be prohibition policies of flammable substances and must be kept safe in fire resisting stores in order to check high tendencies of fire risk. School management has a vital role to play in the impact of fire risks in hostels, which is evident from poor prohibition policies to hinder indiscrimination of spaces, especially areas with high potential threats such as cooking with hot plates. According Ebenehi et al (2017), fire safety strategy should be a continuing process such that fire safety systems are regularly checked and maintained. This is because fire takes place without warning allowing building occupants limited time to react either to extinguish the fire or to escape

RQ.2 What is the amount of compartmentalization applied in the hostels under study?

Approved Document B (2010) stated that in order to contain internal fire spread (structure), the building shall be designed and constructed so that, in the event of fire, its stability and integrity will e maintained for a reasonable period. The structural system of the studied hostel buildings were all designed with load bearing walls running all through the floors with sandcrete hollow blocks at 225mm thickness. This system of construction gives room for good sub-division of vertical spaces into compartments in containing fire spread. According to Concrete Reinforcing Steel Institute (2015), size and thickness of walls, concrete floor slabs, columns, beams, concrete covers and type of aggregate greatly has an impact in fire penetration in the event of fire outbreak. It also stated that proper attention must be given to openings, insulation, fire-stopping and seals to ensure integrity of concealed spaces. Deliberate alterations are made to building elements in order to certain fire ratings, thereby buying more time for safe evacuation. The studied hostels have shown to meet these standards from the mode of construction used, however, fire rated walls were not considered in all the hostels especially in areas with high fire risks like kitchens.

RQ. 3 To what extent is the effectiveness of means of escape applied in the hostels under study?

HM Government (2006) stated that exit doors on escape routes and final exit doors should normally open in the direction of travel, and be quickly and easily openable without the need for a key. Checks should be made to ensure final exits are wide enough to accommodate the number of people who may use the escape routes they serve.

The width of escape routes, occupants' capacity escaping in a route and height of escape route all met the required standards in the studied hostel buildings. However, long corridors and long travel distance was not taken into consideration at design stage which is a setback to travel distance. Refuges or total safety space in the event of fire outbreak was not provided in all the hostels, thereby limiting safe evacuation especially for the physically challenged persons. Rowan (2011) recommends that all escaping doors must be fire rated and capacity escaping largely depends on the door clear width. Observation shows that escape doors in the hostels in some cases do not swing to the direction of escape.

RQ. 4 To what extent is the effectiveness of accessibility for fire fighters applied in the hostels under study?

From the observation carried out, provision of fire fighter access was completely neglected in all the studied hostel buildings. Rowan (2011) stated that a building having up to 7.5m high must have a firefighting shaft and must consist of firefighting lobby, protected stairway, fire main outlet, valve, self-closing fire doors and a firefighting lift for buildings above 18m.

The minimum turning circle between kerbs was fairly applied with a minimum turning circle of less than 10 meters, which did not meet the minimum requirements of the Rowan (2011), which is 16.8m for pump appliance and 26m for high reach appliance.

Fire mains and hydrants were not applied and were completely neglected in all the studied hostel buildings. Rowan (2011) states that fire mains inlet should be accessible and visible to a pumping appliance within 18m of the main inlet to the connection point; provide hydrants for buildings more than 280㎡ and 100m away from an existing fire-hydrant; provide alternate means of hydrants and provide vehicle access to the building.

Recommendations

1. Fire safety should as a matter of need should be incorporated into legislative guidelines and policies that would encourage the design of fire safety in hostels. This is to safe guard the life and property of Nigerian students. It will also enhance the continuity of the building in question.
2. Polytechnics and relevant authorities should give attention to the following recommendation in the design and construction of hostel building.

a) Internal fire spread.

For the purpose of inhibiting the spread of fire within a building, the internal structure:

i. Buildings should be so designed and constructed that, in the event of fire; its stability will be maintained for a reasonable period, which will buy time for escape and evacuation.
ii. Buildings should be sub-divided with fire resisting construction, where this is necessary to inhibit the spread of fire within the building.
iii. Buildings should be so designed and constructed that the unseen spread of fire and smoke within concealed spaces in its structure or fabric is inhibited where necessary.

b) Means of escape in case of fire.

i. Buildings should be so designed and constructed that there are adequate means of escape in case of fire from the building to a place of safety outside the building, capable of being safely and effectively used.
ii. Alternative escape routes from building require the presence of two or more doors as far apart as possible.
iii. The actual width of stairs will be determined by the number of people expected to use the stairs in case of an emergency.

c) Fire Detection and Alarm.

i. Emphasis should be given to the provision of fire detection and alarm system, requirement for an automatic detection and alarm system provides an early awareness of fire and therefore gives more time for the occupants to escape.
ii. Emphasis should also be given to the provision of emergency lighting to provide illumination along escape routes to allow safe movement towards and through exits while emergency exit signage these will help in giving direction in the process of evacuation during fire outbreak.

d) Management.

Training and education at all levels plays an important part in this and the management responsible for a building should have the responsibility to ensure that people in the building understand the risk attached to various activities they undertake, carry out fire risk assessment by skilled fire safety personnel and check overcrowding.

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