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DAMPNESS PATTERN IN HALLS OF RESIDENCE IN SELECTED EDUCATIONAL INSTITUTIONS IN LAGOS, NIGERIA

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Educational institutions in Nigeria be it public or private, old or new, require improvement on the buildings, facilities and infrastructure. Such improvement will not only enhance their performances and ranking but will also reduce the number of students aspiring for degrees in other countries with its antecedent effects on the society. Seeking improvement connotes reducing building defects/deterioration thereby creating a conducive environment that stimulates, supports and sustains learning, teaching, research and innovation. Dampness plagues both new and old buildings and contributes more than 50% of building envelopes' defect, discomfort or failure. This study therefore examined dampness in selected educational buildings in Lagos. The purpose was to identify the pattern of dampness in halls of residence with a view of providing data that will inform decisions to be taken by the stakeholders. The objectives were to evaluate the prevalent sources of dampness and the frequency of occurrence as well as the evaluation of the halls that have the highest effect of dampness. The study population comprised 11 out of the 13 under-graduates halls of residence in the study area. The research design involved visual inspection of the halls based on a number of indicators that characterise the different sources of dampness and the use of moisture meter and condensation test to get objective readings on some identified walls. This analysis was done using mean and percentage on excel sheets. The results revealed that all the five sources of dampness namely; condensation, ground water, penetration damp, pipe leakage and rising damp were prevalent in the halls. Symptoms of pipe leakage and condensation, however, were more prevalent. Out of the 11 halls of residence that were inspected, 4 of the halls showed severe effects of dampness. The readings from the moisture meter indicated rising damp at height of 560mm with condensation from the inner side of the wall. It was concluded that a larger percentage of the effects of the damages done by dampness in the halls originated from pipe leakages and condensation. In addition, the height attained by the rising damp on the external wall was as a result of pool of water at the foot of the wall. Building Surveyors need to be invited to conduct further investigation on the sources of the dampness and the consequences while the institution management needs to attend to the halls with high severity index in order to forestall further deterioration.

Keywords: dampness, defects, halls of residence, moisture meter, symptoms

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INTRODUCTION

A larger percentage of public educational institutions in Nigeria suffer from inadequate buildings and infrastructure. This has been partly attributable to poor funding, misuse of facility by occupants, bribery and corruption amongst others and partly due to lack of maintenance culture (Ugwu, Okafor & Nwoji, 2018; Faremi, 2016; Odediran, Opatunji & Eghenure, 2012; Adenuga, 2012). This is in contrast with what is obtainable in other climes, whereby the educational facilities are not only equipped with adequate buildings, infrastructure and technology but also generate income for the countries (Ugwu, et al. 2018). Buildings are indispensable for the promotion of productive activities and social development, their economic values thus need to be protected for the well-being of all users (Olatunji, Aghimien, Emmanuel, Akinkunmi & Temitope, 2016). Users' well-being however, is a factor of the quality of indoor air with other variables, hence indoor air quality needs to be controlled or regulated to minimise the burdens associated with its negative effect (Hänninen, 2011). Students' hostels/halls of residence as important aspects of educational facilities generally and in public universities specifically today portray the absence of maintenance culture (Faremi, 2016; Adenuga 2012; Odediran et.al., 2012). Consequently, researches on tertiary institutions in the last few years also revealed the state of most educational institutions in the country. Though, there is nothing built on the face of the earth that is deprived of defects given enough time, as all buildings have stipulated service life: the service life and the comfort to be derived however can be elongated when defects are identified, curbed or minimised.

Dampness is one of the defects plaguing buildings, globally. Dampness is an excessive quantity of moisture within building materials and components which cause deterioration, thereby resulting into unacceptable internal environmental conditions (Zam, Emilia, Karmegam & Sapuan, 2017; Young, 2007). Apart from causing deterioration of the structure, dampness or moisture penetration often result in damage to façade and finishing and in severe cases adversely affect occupants (Seeley, 1987; Hollis, 2000; Palaty & Shum, 2012). The World Health Organisation (WHO, 2007) guidelines purport that health hazards is a chain of complex events that are linked to penetration of water indoors and excessive moisture, which invariably lead to biological, physical and chemical degradation with its resultant emission of substances hazardous to health (Sun & Sundell, 2013; Heseltine & Rosen, 2009). Nonetheless, the Nigerian climatic condition and deficiency inadequate students' accommodation enhance dampness as a potent agent of deterioration. There is a need therefore to have a thorough knowledge on issues relating to excessive water or dampness, the consequences and the factors responsible in order to control or regulate it.

Numerous studies have been conducted with a view to providing better understanding on the definitions concept and sources of dampness (Ortiz, et al., 2016; Saijo, Nakagi, Ito, Sugioka, Endo & Yoshida, 2009; Dedesko & Siegel, 2015); causes of dampness (Young, 2007; Agyekum, Ayarkwa, Koranteng & Adinyira, 2013), the symptoms of dampness (Saijo, et. al., 2004; Agyekum, et. al., 2013), the effect of dampness (Agyekum & Salgin, 2017; Palaty & Shum, 2012; Bornehag, Blomquist, Gyntelberg, Jarvholm & Sundell, 2005) and mitigation/remedial actions to dampness (Ahmad & Rahman, 2010; Sauni, Uitti, Jauhiainen, Kreiss, Sigsgaard & Verbeek, 2013). A thorough review of these studies revealed some research gaps. Most of the studies conducted are vastly in the residential sector and sparsely in the commercial sector. Efforts are concentrated on methodologies for assessment, symptoms and effect rather than mitigating the effects. Consequently, more than fifty percent of the studies are localised and lastly studies on dampness and moisture penetration in Nigeria are sparse (Ogbu, 2017; Olanrewaju & Anifowose, 2015; Mijinyawa, Adesogan & Ogunkoya, 2007). More importantly, this study is necessitated by the growing trends of dampness and the degree to which damage is done on halls of residence in tertiary institutions, in terms of value and utility. This study is set out to fill some of these gaps.

This is part of a larger study on defects and deterioration in educational institutions' halls of residence in Nigeria, whose purpose is to develop a framework on thorough understanding of defects associated with dampness, the factors responsible and the consequences with a view to providing a data base that may inform decisions by key stakeholders, more so that the need for sustainable/near-zero energy buildings are clamoured globally. Two objectives are set for the purpose of this study. The first objective is to determine the prevalent sources of dampness and the frequency of occurrence in halls of residence within the study area. The second objective is to assess the halls of residence with the highest symptoms of dampness. The benefits of dampness control and mitigation include increased building value, occupants' comfort/or improved health, low maintenance cost and longevity. The assessment of the various types of defects, their sources and consequences will be a good take off to generating data on university buildings and this will be instrumental in formulating policies that will help put Nigerian universities and students' performance on a good pedestal.

LITERATURE REVIEW

Dampness or moisture in buildings

Most of the materials used in the construction of buildings are porous in nature. Thus, an appreciable quantity of water, also known as moisture, will be present in a relatively 'dry building'. A building element or component that retains this amount of water is said to be damp. Different qualitative terms used to denote the presence of excess water or moisture in buildings include dampness, condensation, damp patches, damp spots, water collection and moisture problem. Agyekum and Ayarkwa, (2014) define dampness as the wetting of structural elements through moisture rise by capillary action. Dampness signifies a wide array of signs (also known as dampness indicators / symptoms / characteristics) of moisture damage of variable spatial extent and severity (Ahmad & Abdul-Rahman, 2010).

A building will be described as 'damp', when the effect of the amount of water present as a result of current or prior moisture movement becomes visible through wetting of building components, salts forming on masonry, tidemarks. discolouration/stains of plaster/paintwork, removal of finishes, mould/algal/fungal growth, efflorescence, peeling/bulging of paint, water drips, uplift of tiles, rotting of skirting, peeling of wall papers, misty smell and a sensation of humid interior (ICOMOS, 2016; Agyekum & Ayarkwa, 2014). Dampness and moisture problems result in physical, biological or chemical deterioration of a building or its materials.

It undermines structural integrity of wall elements, reduces thermal insulation, affects the comfort of the occupants and if left unattended to in the long run, may endanger life (Heseltine & Rosen, 2009; Straube, 2002). The prevalence of defects and deterioration originating from water and dampness exposures in cold climate is estimated at 5% to 30%, whereas in moderate and warm climates it is estimated at 10% to 60% (Zam , Emilia, Karmegam & Sapuan, 2017). Its potent negative effect is well established. Efforts to mitigate such are therefore required. Straube (2002) as well as (Haverinen-Shaughnessy, et. al., 2012) opine that for any moisture problem to occur, there must be in existence a moisture source, route or means to travel, a driving force to cause moisture movement, a moisture-friendly material and temperature differentials . These factors are inherent in climatic conditions, building designs and construction, building characteristics and users' orientation. Incidentally, these are issues that are to be resolved by all stakeholders.

Sources of dampness

Four to seven different sources of dampness exist in the literature. Bornehag, et. al. (2001) and Sharon's (1996) study on historic buildings (as reported by Halim, Harun & Hamid, 2012) posit five sources of dampness thus: dampness emanating from the top of the building wall and absorbed into the wall; dampness caused by capillary action of the damp soil taken up through foundation or low-lying walls; leaking of water pipes or mechanical equipment in the building; the internal dampness resulting from the internal activities such as cooking and building processes such as human respiratory system or temperature control and finally, dampness resulting from the restoration and maintenance of building. Trotman, Sanders and Harrison (2004) gave four classifications namely; condensation, rain penetration, rising damp and ground water movement. Dampness is also classified as originating from either liquid moisture or from the air. Typical examples of dampness from liquid moisture are rainwater penetration, ground moisture and pipe leakages. Dampness sources from the air covers condensation, high humidity and dampness due to hygroscopic salts. These sources are the means through which water gets into buildings. Based on this classification; dampness can result from one or a combination of the under- listed sources (Agyekum, et.al. 2013) as briefly explained.

Plumbing Leakages

Straube, (2002) opine that a great amount of water can penetrate into a building through defective plumbing components thereby resulting into dampness or moisture problems. These problems set in when there is a disruption along network of pipes, fittings and appliances, that is, when there are leakages (Burkinshaw & Parrett, 2003). Leakages can arise when joints are incorrectly made or fail; the pipe material corrodes or decomposes; loss of joints integrity due to acidic intrusion or accidental introduction of foreign object. Dampness due to leakages can also occur due to defective rainwater goods (ICOMOS, 2016). Other sources of dampness due to plumbing works include failures in mains water pipes, heating systems, or foul water. A very small drip, if left unattended to can result in saturation of building components. Water seeping or flowing from pipes often result in dampness and damage to finishes which can be detected by localised stains, algal/fungal growth and a presence of moisture that is unrelated to the weather (Ortiz, Ortiz, Martín & Vázquez, 2016; Trotman, Sanders & Harrison, 2010).

Condensation
Condensation is the release of water that occurs internally when air comes into contact with colder building components. Curtis (2007) posits that condensation occurs where water in the air inside a building condenses on a cooler surface due to cold spots or cold bridges. Condensation commonly affects rooms where a large amount of moisture is produced, such as kitchens, bathrooms and bedrooms (Burns, 2010). These are areas with a poor-ventilation tendency and short intense heating cycles which do not allow the walls to fully warm up (Curtis, 2007). Other areas where condensation can be prominent include stair-halls/lobbies, stores wardrobes/cupboards built against external walls and behind furniture or pictures. Excessive condensation frequently results in severe mould growth which can in turn create health hazards. Damp patches can appear on plaster walls in odd places, particularly on outside walls and sometimes, ceiling, appearing and disappearing on a regular basis (Mahdavinejad, Javanroodi & Hashemi, 2013; Ryan, 2002; Bornehag,et. al. 2001). Condensation on surfaces or structures is an indicator of dampness and microbial growth.

Rising Damp
Burkinshaw and Parrett (2004) submit that rising damp occur when water rises upwards, from the ground, through the pores of masonries, cracks in buildings, or the floors of buildings. The process is known as capillary suction or capillarity. Capillary suction becomes stronger as the pore size gets smaller; if the pore size is fine enough damp may rise many metres in a wall, until the upward suction is balanced by the downward pull of gravity. The height to which water will rise in a wall is limited by the rate of evaporation of water from the wall surfaces. The evaporation rate for external surfaces is related to the nature of the masonry materials, surface coatings, climate, season and the wall orientation. The presence of salts in building components affected by rising damp is not always feasible to a casual observer, thus a component that shows minor height or symptoms of rising damp initially would increase humidity and cause serious damage after a while. Salt attack usually presents itself as salty brownish-yellow patches after much damage would have been done to materials such as brick or mortar as the salts dissolve or disintegrate. The normal limit for rising dampness ranges from 0.5 m to 1.5 m above ground level (Halim & Halim, 2010; (Muhamad, Azree & Nangkula, 2015; Mahdavinejad, Javanroodi & Hashemi, 2013; Ryan, 2002).

Ground Water and Penetration Dampness
Ground moisture problems relate to the entry of groundwater into a building which may originate from drainages below ground surface or standing water. Moisture may enter via upward movement through the bases of walls or floors. Rising damp differs from ground water in the sense that rising damp rises through capillary action while ground water does not depend on capillarity (Burkinshaw &Parrett, 2003; Trotman & Harrison,2004; Trotman,et. al.,2010).Water penetration through a building enclosure depends on the simultaneous occurrence of three things: the presence of water; an opening through which water can enter and a physical force to move the water (Beall, 2000). This is however influenced by gravity, air currents, capillary suction, surface tension, kinetic energy, air pressure and hydrostatic pressure (Beall, 2000). Penetration dampness takes place when the forces enumerated re-direct moisture inform of drips from air conditioning, overflows from overhead tanks, rain water, pipe leakages, or water from other sources in

horizontal directions (NSWHO, 2005). Dampness from horizontal penetration produces small localised patches of dampness and decay, whereas rising dampness may affect the base of a whole building. Prolonged dampness is injurious to buildings and the occupants as excessive dampness lead to growth of microbes such as fungi and bacteria that act as agents of disintegration/degradation. The degradation /decomposition of materials further release other substances that are hazardous to health (Heseltine & Rosen, 2009).

Diagnosing dampness

Diagnosis of dampness is a prerequisite to conducting remedial actions. A number of visual signs exist for dampness. A study conducted in Denmark as reported by Agyekum, Ayarkwa, Koranteng and Adinyira (2013)) infer that rising damp is associated with symptoms such as salt efflorescence, deterioration of rendering or mortar, deterioration of wooden parts of buildings, and so on. Rising dampness may show as a high-tide-like stain on wall paper and other interior finishes, and when it is severe, as blistering of paint and loss of plaster. Mould growth which may lead to health issues are associated with rising and penetration dampness in buildings (Abisuga, Famakin & Oshodi, 2016). Condensation is associated with mould growth, usually on top of walls and ceilings (Burns, 2010). Dealing effectively with the problem of dampness requires the adoption of an organised system of investigative procedures to confirm all the sources of dampness and to ensure that the recommended remedial works are appropriate (Halim et al., 2012). Such a system must commence with identifying and recognising symptoms or signs of dampness. There are four major stages to any dampness investigation. These are visual inspection, investigations using moisture meters/ non-destructive tests, a more detailed investigation/destructive tests and homing-in on the problem/assessment study (Halim et al., 2012; Burkinshaw & Parrett, 2004).

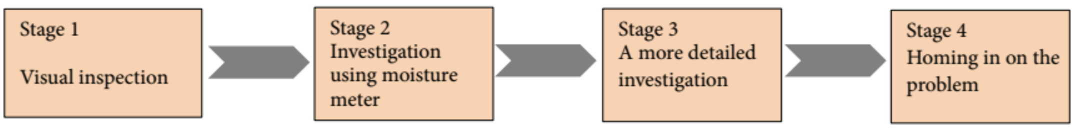

Figure 1: The four-stage approach to dampness investigation Source: (Halim et al., 2012; Burkinshaw & Parrett, 2004). Page 24

The visual inspection serves as the preliminary assessment for further investigation and confirmation. Here, identification of a dampness problem is based on the indicators/symptoms/characteristics such as staining of water, cracking, rotten timber, decay, blistering, fungus growth, and so on. This stage requires the knowledge of the behaviour of relevant building materials and construction techniques (Burkinshaw & Parrett, 2004). The next stage involves the use of instrument for the diagnosis of dampness. This instrument is known as moisture meter (Protimeter). A moisture meter detect moisture content in materials such as wood, masonry and concrete, by indicating the moisture content in percentage (%MC) and relative humidity. A moisture meter can be obtained as a pin-less (capacitance), as pin (resistance) meter or as a combination of both types (Wilson, 1999). Moisture meters are used to inspect or observe materials or elements of construction in place without causing alteration, damage or destruction to the fabric of the building (Agyekum et. al., 2013). While the third stage of diagnosis requires a disruption to building elements whereby building samples are taken and tested in the laboratory, the fourth stage is a bit higher in the sense that destructive tests and examinations that require opening up building parts are conducted. Here, greater emphasis is placed on the sampling which aims at confirming moisture conditions (within walls and floors) by drilling out masonry samples. The decision on where samples are drilled and how they are drilled depend on the kind of investigation undertaken and the prevailing site conditions (Halim, et. al, 2012).

The first two stages of the procedure for dampness investigation were adopted for this study. By utilising these two methods, the sources and the causes of dampness can be identified through a careful observation of the symptoms. Generally, the observation is carried out by looking at specific symptoms that are peculiar to each of the sources of dampness, tracing the causes, that is, what led to the symptoms and getting the most re-curing sources and causes of dampness. The moisture meter was used to take objective readings on the walls that appeared to be severely affected in order to get the actual moisture content that will be used for further investigations.

RESEARCH METHODOLOGY

This study aimed at investigating the prevalent sources of dampness and the frequency of occurrence as well as the evaluation of the halls that have the highest effect of dampness in halls of residence in University of Lagos using the first two stages of the 4-tier dampness diagnosis assessment method. Eleven out of the thirteen halls of residence in the University was chosen. Two of the halls were not chosen because they were newly remodeled.

Stage one-visual observation: The first stage involved visual observation of the halls. This was done to reveal the prevalent sources of dampness based on the mean score of the indicators. To achieve this, a checklist of a minimum of 2 dampness indicators and maximum of 5 was developed for each source of dampness; namely condensation, ground water, penetration damp, pipe leakage and rising damp. These gave a total indicator of 19 for the 11 halls of residence which were graded on a scale of '1-3'ranging from '1' for nil to '2' for moderate and '3' for severe based on a minimum area of 200mm by 200mm. Four (4) trained research assistants inspected the halls. The indexes for the halls were then computed using Excel sheet. The scale used for the indexes is 0-0.9 for indicators that were not visible/present, 1.0-1.99 for moderate indicators while 2.0-2.99 is for severe indicators. The computation was done based on an average score of 1.50 which is the mid-way of the Likert scale adopted corresponding with 'moderate' symptom. The frequency was computed using percentages.

A second checklist was prepared to assess the halls with the highest effect of dampness on 6 building elements and components namely; walls, floors, roof, finishing, doors/windows and timber fittings/furniture, each with an indicator ranging from 3 to 6 items. The severity indexes for the 6 components for each hall were computed using Excel sheets. The hall with the highest value, signifying the highest severity index, has the highest effect of dampness. The checklist is as shown in Appendix I, with the records of some of the effects of dampness on the halls- by photographs, in Appendix II.

Stage two- the use of a Moisture Meter: The second stage of this study was done with the aid of a moisture meter on walls that have been identified. Grids of 210mm by 210 mm were prepared on the wall as shown in Appendix IV. The moisture meter used is Smart Sensor Moisture Meter ((Model AS971, Pin-type) (Please see Appendix III). The measurement range is recorded at 0% to 70% relative humidity (rh) and moisture content (mc) of 1.5 to 2.5%. The readings are interpreted thus:

> 2.5% mc with 21-70% rh indicate very wet wall
1.5-2.5% mc with 12-20% rh indicate wet wall
<1.5% mc and less than 12% rh indicate dry wall

The sketches for the wall and the grid lines are in Appendixes IV to VI with the result presented in Figure 2. In addition to the objective measure through a moisture meter, condensation test was also carried out on another wall in Hall No. 1 as seen in Appendix VII.

The study area

The study was conducted in University of Lagos, Lagos State. The University is located in the South-Western geopolitical zone of Nigeria . It was founded in 1962. The main campus is located at Akoka, Yaba, while the Medical Campus of the College of Medicine is located a few kilometers from the main campus at Idi-Araba, Surulere all on the Lagos mainland. The university has many other residential facilities and services for both staff and students. The university has fourteen academic units comprising a broad range of professional faculties and schools. Most faculties are located on the main campus except the Faculties of Pharmacy, Clinical Sciences, Basic Medical Sciences, and Dental Sciences, which are located within the College of Medicine in Idi-Araba. According to the Census carried out in 2013, the university boasts of Academic staff of 1,123, Administrative staff of 1,065 and 57,183 students (44,602 undergraduates and 12,581 postgraduates). Eleven (11) halls of residence were selected from the main campus. These halls of residence are for both male and female undergraduate students. The two other halls of residence were not selected as one was just newly remodelled and the other one is for both postgraduate and undergraduate students.

RESULTS AND DISCUSSIONS

The results for the checklists and the objective measure are as presented.

The prevalent sources of dampness and frequency of occurrence in halls of residence

The first objective of this study was to evaluate the prevalent sources of dampness and the frequency of occurrence in halls of residence. To achieve this objective, each of the five (5) dampness sources (condensation, ground water, penetration damp, pipe leak and rising damp) was described with a number of indicators/characteristics and the average scores taken while the frequency was computed using percentages. The result is as presented in Table 1.

Table 1 reveals that all the dampness sources highlighted are frequently experienced in the halls based on the average mean score of 1.55 that tallies with moderate indicators. However, the indicators of condensation and pipe leak are more rampant. This implies that symptoms experienced from these two sources of dampness are more pronounced. All the 5 dampness sources have percentages ranging from 17 to 24. This range is close to the percentages obtained from the study of Haverinen-Shaughnessy, et al., (2012) in three countries. This is an indication that all the 5 sources of dampness namely; condensation, ground water, penetration damp, pipe leakage and rising damp contribute to moisture problems in the halls. The most frequently experienced moisture problems however are majorly from pipe leakages, followed by condensation.

Table 1:Sources of dampness and frequency of occurrence in halls of residence in Lagos

Dampness Sources	Mean	Sum	1(Nil)	2(Mod)	3(Sev)
Penetration Dampness (17)					
Wetness of wall based on the direction of water	1.55	17	5	6	0
Water from horizontal direction	1.55	17	7	2	2
Ground Water (19)					
Pools from washing areas/ damaged or blocked drain	1.55	17	6	4	1
Ever present pool even without rain	1.91	21	3	6	2
Rising Damp (20)					
Pronounced defect at plinth level	1.91	21	2	8	1
uneven horizontal line/brown patches/tidal mark	1.55	17	6	4	1
Water rising above one foot with surrounding pool of water	1.55	17	5	6	0
Falling off /deterioration of skirting, tiles, wallpaper close to plinth level	1.55	17	6	4	1
Deterioration to plaster from ground level	2.45	27	1	4	6
Condensation (21)					
Presence of cold surfaces to external walls	1.82	20	5	3	3
Water vapour/Mist/condensation drips at window	2.36	26	0	7	4
Moisture/mist at floor-to-floor junction	1.82	20	4	5	2
Wet spot behind furniture	1.91	21	3	6	2
Misty odour in building space	1.55	17	6	4	1
Plumbing (24)					
Pool of water/Constant flooding	1.91	21	2	8	1
Localised stains	1.45	16	7	3	1
Stand-alone patches around ducts, pipes/air-conditioners	2.18	24	1	7	3
Uplifting of components	2.55	28	0	5	6
Loosening of tiles in bathrooms, kitchen and laundry	2.82	31	0	2	9

NB:0-0.9=indicators not visible, 1.0-1.99= indicators moderate and 2.0 -2.99= indicators severe.

Effect of dampness on halls of residence

The prevalence of the effects of the dampness on the halls was assessed based on the severity of the dampness on 6 building elements and components. The severity index for each component per hall was then computed. The result is presented in Table 2.

The severity indexes of the effect of dampness indicators on floors, walls, roofs, furniture and fittings, doors and windows as well as finishing are as presented in Table 2. The results showed that Hall 1, which is one of the oldest male hostels, located North-West of the university has the highest effect of dampness. This is followed by halls 2 and 5 in that order. However, there is the need to conduct stages 3 and 4 of the 4-tier dampness assessment method on the halls to know the extent of the effect and what is responsible. The implication of this preliminary assessment is the highlights of which halls have the highest prevalence dampness problems. This might inform the speed for maintenance/remedial works. The photographs taken from the halls are presented in Appendix II.

Table 2: Effect of dampness on halls of residence

Dampness Indicator/halls	1	2	3	4	5	6	7	8	9	10	11
Roofing (3)	0.67	0.78	0.33	0.67	0.56	0.44	0.67	0.44	0.56	0.56	0.56
Walls (5)	1.00	0.87	0.47	0.67	0.87	0.80	0.73	0.80	0.80	0.53	0.73
Floors (3)	0.80	1.00	0.50	0.50	0.70	0.50	0.50	0.50	0.50	0.50	0.50
Plaster and Finishing (5)	0.93	0.73	0.33	0.60	0.80	0.53	0.67	0.87	0.67	0.33	0.60
Doors,Windows and Balustrades (3)	0.78	0.78	0.44	0.67	0.67	0.56	0.56	0.67	0.67	0.44	0.67
Timber Fittings and Furniture (6)	0.83	0.67	0.33	0.50	0.56	0.39	0.67	0.67	0.56	0.44	0.00
	5.88	5.66	2.91	4.10	4.78	3.72	4.29	4.44	4.24	3.31	3.56
	1ST	2ND	11TH	7TH	3RD	8TH	5TH	4TH	6TH	10TH	9TH

NB:0-0.9=nil, 1.0-1.99= moderate and 2.0 -2.99= , 1,2,3,-11=halls of residence

Readings with moisture meter

The readings obtained and visual observation

The external wall under observation was located on the North-North-West of hall of residence No.1. Hall No. 1 has 3 suspended floors with H-shaped interlink walkway at the first floor, and was constructed in 1974 with cast-in-situ technology on pile foundation. There is a pool of water with some debris at the foot of the wall. The pool of water originated from a damaged rain water-good from the roof. This has resulted into the wall showing dark brown patches, greenish colour, considerable discolouration at the lower level, flaking of mortar and peeling of paint. The pool of water at the foot of the wall has some greenish colour, indicating that 'part of the coloured water' has risen up. The relative humidity readings that ranged from 8.5% to 36.0%, reduced from the foot of the wall upwards, indicating that the dampness was in a progression. The end of the dark brown patches terminated just before the top of the 3rd layer grid (2E-F and 3E-F). The relative humidity at this point was 24%. This height was measured as 560mm which indicated the height of the rising damp. (Please see Appendixes IV to VI and Figure 2). The moisture meter showed grids 2D-E as 'dry', 2E-F as 'wet' 2-3A-F as 'wet' and 3-5A-E as 'very wet'.

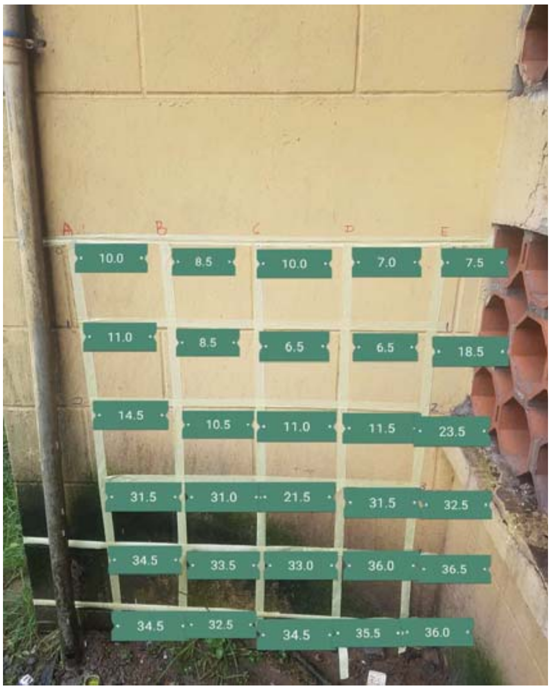

Figure 2: Moisture Meter Readings

DISCUSSION OF FINDINGS

The results of the analysis are hereby discussed based on the objectives.

Prevalent sources of dampness and frequency of occurrence in halls of residence
The findings revealed that most of the indicators of dampness are present in varying degrees in all the halls which inferred that condensation, ground water, penetration dampness, pipe leakages and rising damp are in existence. Pipe leakages, however took the lead based on the degrees of the indicators such as constant pool of water/flooding in the wash areas, localised stains on walls closed to the toilets and bathrooms, stand-alone patches around air-conditioners, long-continuous and pronounced patches traceable to air-conditioner ducts and drips from taps and wash basins as well as uplifting/loosening of floor tiles and wall tiles where pipes are installed. The second most prevalent dampness source is condensation. This was evident from the presence of cold surfaces on window panes close to external walls during the early hours of the day, water vapour/misty droplets on the soffit of upper floors, wet spots behind lockers/cupboards/wardrobes and beds that are placed close to walls. The implication of these results is that all the 5 sources of dampness are prevalent with pipe leakages and condensation having the highest frequency of occurrence.

Evaluation of the halls of residence with the severe perceived effect of dampness
A further scrutiny on some building elements and components namely; walls, floors, roof, finishing, doors/windows and timber fittings/furniture showed the extent of the perceived moisture damage on the halls of residence. The indexes for each of the halls based on the 6 components observed revealed that 2 out of the 11 halls have severity indexes of over five out of a total of six point. The inference here is that the effect of dampness varies from one hall to the other based

on a number of some inherent factors. Efforts should thus be concentrated on the identification of the specific prevalent causes of the damage for appropriate cause of action. These halls with perceived dampness-damage require urgent attention to avert further damages based on the indicators. Similarly results on defects in educational institution have been observed (Abisuga, Famakin & Oshodi, 2016).

Implication of moisture content readings and observation on hall no.1
The moisture meter readings on one of the walls of the halls with severe perceived moisture problem revealed a rising damp at a height slightly lower than 600mm. The height of the brown-dark patches and the greenish colour revealed that the wall is porous and permeable thereby making it possible for water to travel up through capillary action, with probable salts deposit. The inner side of the wall in discussion houses a large store which could not be accessed. The damage done on the wall is already evident from mere observation, additional test however need to be conducted in order to know the types, the sources and the quantity of salts present and the likely further damage. One might feel that a rising damp of 560mm might not be worrisome, the effect on this wall is however obvious based on the colour at the plinth level and the high concentration of moisture based on the moisture meter readings. The 560mm height could have resulted due to the wall location, which is on the North-North-West of hall No.1, thereby making it difficult to get enough sunlight and air movement that will facilitate evaporation. The minor test carried out on condensation revealed that the condensation is from the wall. This calls for further concerns.

Please see Appendix VII.

CONCLUSIONS AND RECOMMENDATIONS

Following the results of the visual observation and moisture meter, the following conclusions are drawn:

i) The 5 sources of dampness (condensation, ground water, penetration damp, pipe leakage and rising damp) are prevalent in the halls.
ii) Pipe leakages and condensation have the highest frequency of occurrence
iii) 2 of the 11 inspected halls were severely affected by dampness problems.
iv) A rising damp at a height of 560mm was attainable based on a standing pool of water at the wall.
v) Further investigations are to be conducted on the sources of and frequencies of dampness as well as the causes,
vi) Laboratory test need to be conducted on the presence of or otherwise of salts in the wall with rising damp

Based on the findings that emanated from this study, it is recommended that Building Surveyors and Health Personnel be invited to conduct further investigation on the sources of the dampness, causes and the consequences while the health personnel investigate if there is any relationship with the dampness sources identified and the well-being of the occupants of the halls.

In the meantime, the halls identified with perceived severe dampness problems should be given adequate attention by the management to forestall further consequences and finally, the rising damp presence was enhanced by the pool of water and the collection of debris, the sources of the pool of water and the debris should be attended to with immediate effect. In other words, inspections should be carried out in the halls and attention given to the necessary repair and maintenance works as at when due.

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APPENDIXES

Appendix 1:Specific dampness indicators

Effect of Dampness on Halls of Residence

DAMPNESS INDICATORS/EFFECT	1	2	3	4	5	6	7	8	9	10	11
ROOFING											
Leaking roof											
Rotting of roof members											
Decaying roof/ceiling members											
WALLS											
Blistering , Flaking and peeling											
Bleaching											
Mould growth											
Discolouration /stains/unaesthetic patches											
Efflorescence											
FLOORS											
Ingress of water through floors											
Uneven floor due to previous and excessive water intrusion											
Deterioration of flooring materials/coverings											
PLASTER AND/OR FINISHING											
Cracking/spalling/ softening/crumbling of plaster											
Loosened wall paper											
Deterioration of floor covering											
Falling of /lifting/chipping of tiles											
Appearance of wetness/staining in tiles											
METAL DOORS, WINDOWS, BALUSTRADES 3											
Discoloration of metals											
Corrosion/Decay of metals											
Blistering of protective coating											
TIMBER FITTINGS AND FURNITURE											
Warping of doors/rot/decay											
Fungal growth											
Crumbing of timber fixtures e.g. cabinets											
removal/damages to skirtings											
Swelling of timber fittings											
Unaesthetics pathes/odour behind fittings											

Appendix II : Pictorial representation of dampness observed at hall No. 1

Plate Ai: Front elevation of hostel

Plate Aii: growth of fungus on wall

Plate Aiii: swelling of paint from pipe leakage

Plate Aiv: chipping and falling of tiles on wall

Plate Av: growth of moss on wall

Plate Avi: chipped tile on floor

Dampness problem observed at hall of residence No.1.

Observed in this hall of residence are pipe leakages, tile chipping, discolouration, mould and fungal growth, spalling of structural members as shown in plates i-vi..

Appendix III: Moisture Meter Plates

Appendix IV to VI :Gridlines

Plate A::The grids being marked out on the wall

Plate B: The grids completely marked out and numbered.

Plate C: Taking readings at the base of the wall

Plate D: The identified wall showing symptoms of rising damp

Appendix VII: The condensation test result indicating condensation from the inner side (face of the wall) of the foil paper

Appendix VIII: Moisture meter readings