**UNIVERSITY OF EDUCATION, WINNEBA**

**COLLEGE OF TECHNOLOGY EDUCATION, KUMASI**

# ASSESSING THE EFFECT OF DAMPNESS IN THE LOWER PARTS OF BUILDING IN THE DZOWULU LOCALITY

**EDINAM AKPALU-BOATENG**

**AUGUST, 2017**

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**A RESEARCH REPORT SUBMITTED TO THE DEPARTMENT OF CONSTRUCTION AND WOOD TECHNOLOGY EDUCATION, FACULTY OF TECHNICAL EDUCATION, UNIVERSITY OF EDUCATION, WINNEBA IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF TECHNOLOGY**

**(CONSTRUCTION) DEGREE**

**AUGUST, 2017**

# DECLARATION

## STUDENT'S DECLARATION

I, AKPALU-BOATENG EDINAM, declare that this project work, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE: ...................................……….. DATE: …..................................

## SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of project work as laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: MR. M. K. TSORGALI

SIGNATURE: ...................................…………..

DATE:………………….......................

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# DEDICATION

This research work is dedicated to Mrs. Augustina A. Boateng, Mrs. Josephine Atsu, Mrs Delali Dovie, and Mr. Emmanuel K. Akpalu whose continuous support has helped me to complete this program.

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# ABBREVIATIONS

**Figure**

| | |
|---|---|
| Fig | Figure |
| Tab | Table |
| DPC | Damp Prove Course |
| DPM | Damp Prove Membrane |
| No. | Number |
| % | Percentage |
| A.E.S.L | Architectural and Engineering Services Limited |
| Wgt. | Weight |
| Con. | Container |
| In | Inches |
| Etc. | Et cetera |
| Blk. | Blocks |
| Plst. | Plaster |

# ABSTRACT

Dampness is one of the most common defects found on buildings. It mostly occurs at the lower parts of walls. This study was conducted to assess the effect of dampness at the lower parts of buildings in the Dzowulu locality. The methodology adopted was through literature review, visual survey, laboratory tests and interview with construction professional. The findings show that dampness at the lower parts of buildings is very prevalent in the Dzowulu locality. It also reveals that, it is as a result of the presence of moisture in the soil, and the main source of this moisture is rising damp. The finding of this study can be used for future references. This study will go a long way to enlighten clients, construction professional's especially contractors and the public as whole on this topic. Recommendations were given to serve as suggestions to be applied so as to rectify or prevent the occurrence of the problem. One very useful recommendation was the construction of a well on the compound and the water occasionally pumped out. The use of appropriate construction methods was also recommended.

# CHAPTER ONE

## 1.0 INTRODUCTION

### 1.1 Background of the study

Buildings are structures constructed to accommodate humans, animals, goods and equipment, etc. A well-constructed building with quality or durable structural components using the appropriate constructional method is expected to last for a long number of years before there would be any major deterioration or defect on the building, which would require an expensive maintenance.

There are so many defects that are found on buildings Such as cracked walls, corrosion of metals, wood rot, stained wall surfaces, damp patches on walls, etc. These defects or deterioration need to be identified and rectified with the quickest alacrity, so as to prevent the loss of lives, property and the comforts that occupants of the affected buildings enjoy. (Trotman *et al*., 2004; Noy & Dauglas, 2006). That notwithstanding, defect or deterioration do hinder the ideal functions of the building or even lead to failure of the building components or the structure as a whole.  Dampness at the lower parts of buildings is one of the most prevalent problems or defects in buildings. This problem can be found on most buildings in cities, towns and villages, and Dzowulu and its environs are no exception. In fact, dampness that makes its way into structures or inhabitation may damage the structure and provide suitable conditions for the growth of hazardous microbes.

Thus, occurred dampness damages often require costly refurbishment operations if they are not perceived on time. As a consequence, controlling or preventing dampness in buildings is an important task. (Daya, Duffuaa, Raouf, Knezevic & Kadi, 2009).

There is therefore the need for proficient and correct diagnoses so as to guarantee an effectual application of remedies.

The various effects due to the presence of moisture in buildings mainly results in poor serviceability of the buildi33ng, ugly appearance and structural weakness of the buildings. (Oxley & Gobert, 2011)

The study therefore aims at investigating the causes, effect and remedies of dampness at the lower parts of residential buildings in the Dzowulu locality and its environs.

## 1.2 Statement of the Problem

Dampness at the lower parts of walls is prevalent in the Dzowulu locality. Dampness is the situation where moisture exists in the fabrics of the buildings in Dzowulu. As a result of the presence of moisture in the buildings over a period of time, the building component begin to disintegrate making the paint to flick off the wall, the plaster separating itself from the block/concrete wall. It also makes the unplastered wall to wear over a period of time, it promote the growth of mold and algae which ends up decolorizing the building. As a result of this situation, corrective maintenance of buildings is increasingly becoming expensive as the dampness normally mars the attractiveness or aesthetic value of the affected walls and any attempt to sustain the beauty and comfort of the occupants will mean repainting almost every year irrespective of the type of paint used.

This study aims at investigating the causes of dampness at the lower parts of residential buildings in the Dzowulu locality, as well as fishing out the effect of the dampness so as to reduce the maintenance cost of buildings in the Dzowulu locality. To reduce this problem to the barest minimum, professionals should be consulted before, during and after construction of the buildings.

### 1.3 Purpose of the Study

Dampness at the lower part of building has the ability to mar the beauty or the aesthetic value of the building, affect the components of the building or the structural elements as a whole and more so affect the comfortability of the occupants in the Dzowulu locality. The purpose of this study is therefore to find solutions to the dampness at the lower part of buildings for a better community.

The objectives of the study are to:

a. Assess the dampness at the lower parts of walls of buildings.
b. To identify the sources of the dampness at the lower part of buildings.
c. Recommend ways to correct the situation of dampness at the lower part of buildings:

### 1.4 Research Methodology

1. Survey of sample buildings were carried out in the Dzowulu locality
2. Consultations were made to related text books, journals, etc.
3. Consultations were made with construction professionals.
4. Soil samples were taken and examined at the laboratory.

### 1.5 Scope of Work

The study is limited to dampness at the lower part of buildings in the Dzowulu locality. The discussions on the sources, effects, diagnosis and remedies are limited to what is experienced in the Dzowulu locality.

### 1.6 Organization of Chapters

The main topic for this research is assessing dampness at the lower parts of walls of buildings in Dzowulu and its environs.

The main works contained in this research are put into five chapters.

Chapter one talks about the introduction to the project topic, objectives of the study, research methodology, the statement of the problem, and the scope of work.

Chapter two talks about the literature review by coming out with the meaning of dampness, sources of dampness, causes of dampness, effects of dampness and possible diagnosis of dampness at the lower parts of buildings from journals, internet, existing textbooks written by different authors, etc.

Chapter three explains the research methodologies used in obtaining data and information for writing the project.

Chapter four deals with data analysis which is based on the data obtained from the questionnaires and personal data acquisitions.

The last chapter then concludes the whole project by giving suitable recommendations to the existing problems and also suggests ways of preventing future occurrences.

# CHAPTER TWO

## 2.0 LITERATURE REVIEW

### 2.1 Introduction

This chapter deals with review of literature with respect to dampness at the lower parts of building. Dampness is undesirable when it occurs in buildings. It is a phenomenon which occurs in the structural components (especially walls), which is normally evident on the surfaces of walls. It is a common defect that is known to many people by its symptoms or signs on walls. The number of walls of buildings affected by dampness during their useful life span is enormous in the Dzowulu locality and its environs. The causes of dampness are enormous and variable and its effects are often extensive and detrimental to the life span of the building.

### 2.2 Concept of Dampness in Building

Dampness simply means wetness or moistness. And therefore dampness with respect to buildings or in buildings is defined as follows;

a. Dampness is the wetting of structural elements through moisture rise by capillary action (Seeley, 1976).

b. Structural dampness refers to the presence of unwanted moisture in the structure of a building, either as a result of intrusion from outside or condensation from within the structure. (Barry, 1999)

With respect to this project, it is the amount of wetness satisfactory to cause deterioration of a particular material used for the construction of a building. (Oxley & Gobert, 2011)

## 2.3 Sources of Dampness

The major sources of dampness at the lower part of buildings can be identified as follows:

### 2.3.1 Rain or Moisture Penetration as a Source of Dampness.

Damp from rain penetration will vary with the weather conditions, including the direction and strength of the wind. Failure in any single element of the building structure can allow large volumes of rainwater to pour into walls, spreading outwards as it filters down through the structure. Such a failure is most visible during or just after rain, where soaked sections of the wall are most easily seen. Even small volumes can drain behind wall face renders and be drawn into the core of the wall. In cases of flooding incidents the porous nature of traditional walls determines how quickly they become saturated, and transport the penetrating moisture some distance from the source. The type and method of wall construction coupled with the quality of material normally influences the degree of wind-driven rain penetrating into walls. The possibility of wrong selection of the type of mix, and the thickness of the render also has influence on the amount of moisture penetration into the walls of the buildings. (Marshall, Worthing, Heath, 2003)

Gravity flow can be the most powerful means of moisture transport. Very large quantities of liquid or water, often measured in liters per second, can flow downward through openings, cracks, pipes, or air spaces when driven by gravity. Gravity flow requires relatively large openings (of the order of a millimeter thus 0.04 in, or higher) since capillary suction forces tends to overwhelm gravity forces in smaller pores. Gravity can drive rainwater that penetrates through a leaky window into a wall, or water in the soil through a crack in the foundation walls. The size of the flows and the sources are often sufficient to cause catastrophic failures. (Barry, 1999; Marshall, Worthing, Heath, 2003).

### 2.3.2 Rising Damp as a Source of Dampness.

This is the technical term describing moisture rising up in a wall. It is caused by moisture in the ground soaking up into the building and will often leave a tide mark. The most likely cause is the presence of water in the soil or the water table being too high. Rising damp becomes evident in the form of stained walls, blistering and peeling paintwork as well as salt accumulation up to about 1.2 – 1.5 meters high according to Marshall, Worthing, Heath (2003). Rising damp can arise for various reasons, the common causes are; failure of an existing damp proof course (DPC) and bridging due to rising of either external or internal ground levels.

Capillary suction moves liquid moisture slowly and steadily through porous materials from regions of high concentration to regions of low concentration. The smaller the pores, the more powerful the capillary suction but the slower the flow. Although the rate of moisture transport by this mechanism is relatively slow in the soil than the building, it can act for years. (Barry 1999; Noy & Daouglas,2005; Chudey, 2008)

### 2.3.3 Faulty Plumbing Works as a Source of Dampness.

A small leak in a water supply, central cooling or internal drainage pipe can cause extensive dampness over a period of time, although the signs of dampness may only appear some distance from the leak. For the same reason, the results of leaking, blocked and misplaced gutters and downpipes can easily be mistaken for rising damp or rain penetration. Upstairs bathrooms can become defective and a minor leak in a waste pipe for instance can, over time, develop a substantial amount of dampness. This is often not noticed until it becomes serious. Older water and sewer pipes are subject to corrosion over time. Slow leaks at plumbing joints hidden within walls and ceilings can ultimately rot floor boards, stain ceiling plaster, and lead to decay of structural members Careful investigation is the only answer for tracing these sources of dampness (Marshall, Worthing, Heath, 2003).

### 2.5 Transportation or Movement of Moisture

Knowing the most common sources of moisture that cause damage to the building component is the first step in diagnosing moisture problems. But it is also important to understand the basic mechanisms that affect moisture movement in buildings. Moisture in building exist in two states: liquid and vapor according to Lstiburek, & Carmody, (1991). It is directly related to pressure differentials. For example, water in a gaseous or vapor state, as warm moist air will move from its high pressure area to a lower pressure area where the air is cooler and drier. Liquid water will move as a result of differences in hydrostatic pressure or wind pressure. It is the pressure differentials that drive the rate of moisture migration in either state. Because the building materials themselves has an amount of resistance to moisture movement, the rate of movement depends on two factors: the permeability of the materials when in contact with moisture and the absorption rates of materials in contact with liquid. (Marshall, Worthing, Heath, 2003)

The mechanics, or physics, of moisture movement is complex, but if the driving force is difference in pressure, then an approach to reducing moisture movement and its damage is to reduce the difference in pressure, not to increase it.

Forms of moisture transport are particularly important to understand in regards to buildings-infiltration, capillary action and gravity flow. The way a building handles air and moisture today may be different from that intended by the original builder or architect, and poorly conceived changes may be partially responsible for chronic moisture conditions, (our concentration is on the liquid state). (Marshall, Worthing, Heath, 2003).

Moisture moves into and through materials as a visible liquid (capillary action). Moisture from leaks, saturation, rising damp, can lead to the deterioration of materials and cause an unhealthy environment. Moisture from leaks often can travel great distances down walls and along construction surfaces, pipes, or conduits. The amount of moisture and how it deteriorates materials is dependent upon complex forces and variables that must be considered for each situation in a different research.

Determining the way moisture is handled by the building is further complicated because each building and site is unique. Water damage from blocked gutters and downspouts can saturate materials on the outside, and high levels of interior moisture can saturate interior materials. Difficult cases may call for technical evaluation by consultants specializing in moisture monitoring and diagnostic evaluation. In other words, it may take a team to effectively evaluate a situation and determine a proper approach to controlling moisture damage in buildings. (Chudey, 2008; Kubal 2008)

**Capillary action** as mentioned earlier occurs when moisture in saturated porous building materials, such as masonry, wicks up or travels vertically as it evaporates to the surface. In capillary attraction, liquid in the material is attracted to the solid surface of the pore structure causing it to rise vertically; thus, it is often called rising damp, particularly when found in conjunction with ground moisture. It should not, however, be confused with moisture that laterally penetrates a foundation wall through cracks and settles in the substructure. Not easily controlled, most rising damp comes from high water tables or a constant source under the footing. In cases of damp masonry walls with capillary action, there is usually a whitish stain or horizontal tide mark of efflorescence that seasonally fluctuates about where the excess moisture evaporates from the wall. (Marshall, Worthing, Heath, 2003) This tide mark is full of salt crystals, that have been drawn from the ground and building materials along with the water, making the masonry even more sensitive to additional moisture absorption from the surrounding air. Capillary migration of moisture may occur in any material with a pore structure where there is a constant or recurring source of moisture. The best approach for dealing with capillary rise in building materials is to reduce the amount of water in contact with materials. If that is not possible due to chronically high water tables, it may be necessary to introduce a horizontal damp-proof barrier, such as slate course or a lead or plastic sheet, to stop the vertical rise of moisture (it will be discus into details later). Moisture should not be sealed into the wall with a waterproof coating, such as cement purging or vinyl wall coverings, applied to the inside of damp walls. This will only increase the pressure differential as a vertical barrier and force the capillary action, and its destruction of materials, higher up the wall. (Marshall, Worthing, Heath, 2003)

## 2.6 Factors That Contribute to the Occurrence of Dampness

Dampness at the lower part of buildings can be avoided to a large extent. Certain precautions can be taken with respect to decisions making, method of construction, maintenance, etc.

The following are contributing factors that lead to the occurrence of dampness:

### 2.6.1 Inadequate Investigation or Information

To investigate is to examine carefully, survey; inspect, measuring and researching of ground conditions, condition of repair of existing structures etc. prior to sale, construction, design etc. In this case, before a person puts up a building at a particular location, one need to gather enough information about the location. For instance, the water table, the type of soil (clay, sandy, etc.), the bearing capacity of the soil, the topography of the place, etc. These information aids the engineer and the architect when designing the building. This is not the case most of the time. Enough information is not gathered before designing the building, thereby contributing to poor design of the building. (Chudey & Greeno 2010; Davies & Jokiniemi, 2008; Merritt & Ricketts, 2008; Peck, Hanson & Thornburn, 1974).

### 2.6.2 Faulty Design Decision as a Contributing factor to the Occurrence of Dampness in Building

According to Ching, 2008, the design team has a major role to play when it comes to the construction of a building. The design team is the first point of contact. The design team has the responsibility of making the right decision and therefore any faulty design decision taken has the tendency in contributing to the occurrence of dampness. Faulty design account for a significant number of building failures. (Wood, 2009)

i. Lack of knowledge about the basic properties of materials. For example, failing to make allowance for the differing thermal and moisture movements of materials used in construction

ii. Failing to follow well established design criteria on the choice of structural system and materials selection (wood, 2009)

iii. Use of new materials or innovative forms of construction, which have not been properly tested in use. (Riley & Cotgrave, 2011)

iv. Misjudgment of user and climatic conditions under which the material will have to perform.

v. Poor communications between the construction team and the design team during construction.

vi. Complicated design details.

### 2.6.3 Wrong Construction Methods

Poor supervision and workmanship as well as poor quality of materials, non-adherence to the necessary precautions by the use of wrong constructional methods, lack of precision and accuracy, and ignorance are all contributing factors. Many researches had been done to prevent this problem. However, this problem still exists. If this problem is avoided, occupants will enjoy comfort in their homes, reduce the maintenance of building. (Wood, 2009)

The quality of the workmanship is another aspect that has been giving contractors a bad name. The Construction Industry is supposed to wrestle this issue by using qualified professional and laborers. Besides, lack of enforcement and supervision also contribute to these defects. However, a good project management team acting on behalf of the client should be able to look after the interest of its clients by making sure the contractors do not compromise on the quality of the workmanship through its resident engineer. (Barry, 1999, Wood, 2009).

This method of continuous construction is not appropriate because;

1. When the building settles,it is possible to reduce the room height
2. It is easy for moisture to travel to the top
3. When there is a crack at the base, it is easy to stretch or extend to the lintel level because the oversite concrete which is to serve as a barrier is absent. Moisture is able to travel through cracks

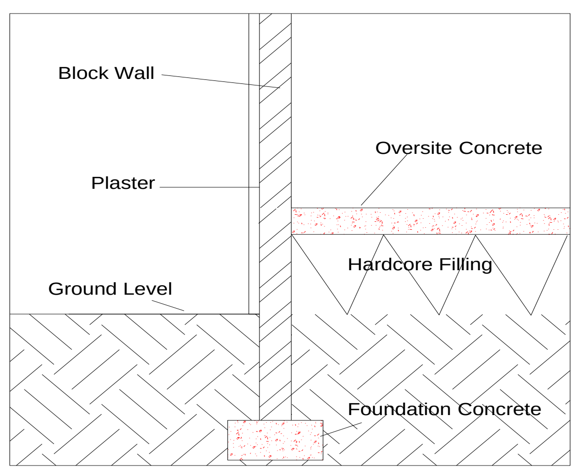


Fig. 2

**Fig. 2.1 Wrong construction method**

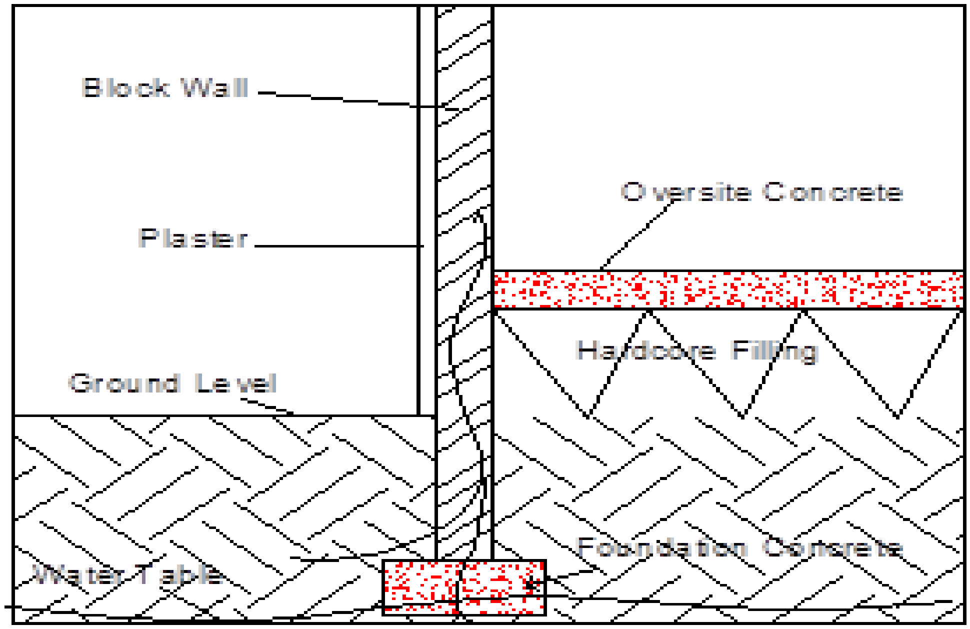


**Fig. 2.2 Closeness of foundation to water table**

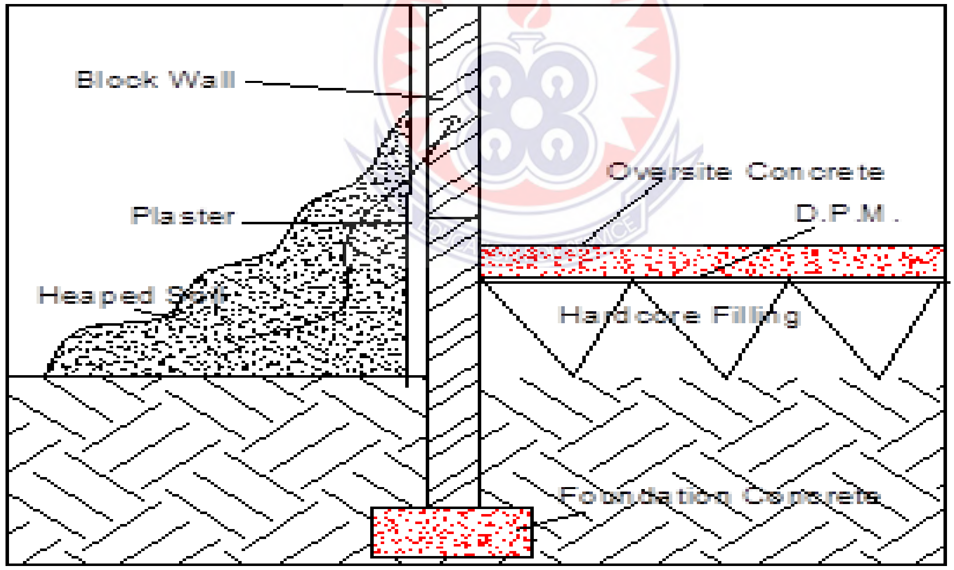


**Fig. 2.3 Heaped soil or porous material a medium for moisture movement across the D.P.C.**

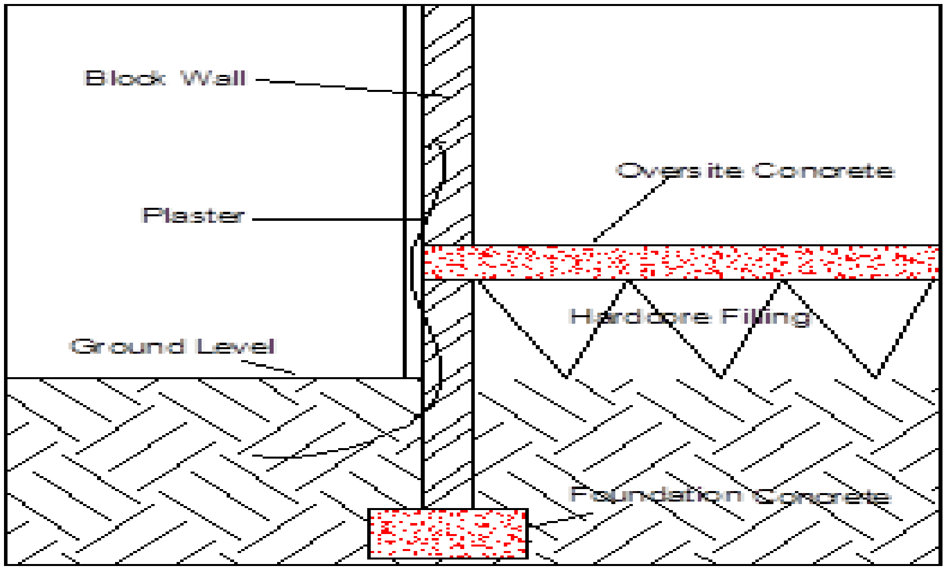


**Fig. 2.4 Moisture can easily travel through weak and porous block and plaster**

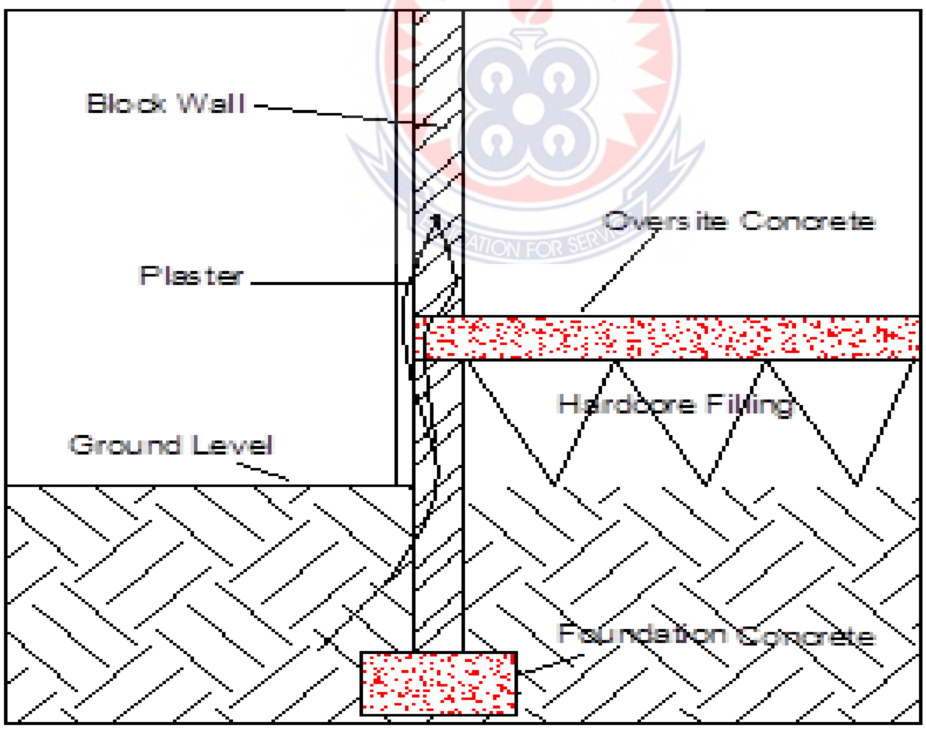


**Fig. 2.5 Movement of Moisture traveling through weak and porous oversite concrete**

### 2.6.4 Poor Maintenance Culture

Building maintenance can be defined as all-inclusive and continuous activities aimed at prolonging the life span or services life of the building to enable it function to its maximum purpose. (Wood, 2009) In the view of Seeley (1983), maintenance is seeking to preserve a building in its initial state. As we may be aware of, we are only concerned with the cost of getting the building erected, and we are most of the time not made aware of the yearly maintenance, operational and replacement cost. Sometimes, the total cost of these three essentials might be close to the construction cost.

### 2.6.5 Material Deficiencies

The use of inferior building materials can cause significant problems, such as inferior blocks, windows that leak or fail to perform and function adequately, even when properly installed. (Wood, 2009)

## 2.7 Signs or Symptoms of Dampness in Building

Signs are said to be the visual effect that can be seen or are visible on the structure. According to Wood (2009), some of the visible signs on walls caused by dampness are;

i. Horizontal tidal marks
ii. Straining decorations above ground floor level
iii. Efflorescence
iv. Dry rot
v. Disintegration of building component
vi. Isolated damp patches.
vii. Peeling wallpaper
viii. cracked paint work

ix. rusting metal

x. Mold (grey, green, blue, black, white)

Dampness at the lower parts of walls is more common in external walls in moister surroundings as compared to internal walls due to the high degree of exposure of the external walls to the weather. (Wood, 2009; Marshall, Worthing, Heath, 2003)

## 2.8 Effects of Dampness in the lower parts of buildings

A building or construction defect is a defect or deficiency in the design, construction, or materials on a construction project. Broadly speaking, building defects fall into two (2) categories: defects that affect the performance of the structure, and defects that affect the appearance of the structure. From the legal perspective, a building defect is defined in somewhat different terms. Legally, a building defect is a violation of the applicable building code, a violation of the standard of care in the community in which the project is located, or a violation of the manufacturer's recommendations (Robert S.Mann, 2007)

Defect is the nonconformity of a component with a standard or specified characteristic. Defect is used at times as a synonym for failure.

Moisture in a property is one of the main causes of rapid deterioration and all efforts must be made to find the cause or causes of the dampness and eliminate it. For the residents of a damp house, all kinds of health problems will arise, as well as the massive expense if left for too long.

The following are some of the effects of dampness

1. A damp building creates unhealthy living and working conditions for the occupants. (Lstiburek & Carmody, 1991; Marshall, Worthing, Heath, 2003)

2. The presence of damp condition causes efflorescence on building surfaces which ultimately results in the disintegration of bricks, stones, tiles etc and hence reduction of strength of the building component. Efflorescence occurs as a result of the presence of an appreciable quantity of salts in a rising damp. When rising damp carry the salts up into the walls of the structure at the level where the moisture evaporates leaving behind the salts, this salt can often be seen as a whitish powered paint on the surfaces of walls. This situation decolorizes buildings. (Kubal 2008; Marshall, Worthing, Heath, 2003)
3. Chalking of rendered and unrendered walls. It is the softening and crumbling of plaster into smaller particles or powder. This is as a result of non-quality materials or chemical reaction in the presence moisture. (Marshall, Worthing, Heath, 2003)
4. Dampness in building cause bleaching and flaking off of paints which results in the formation of coloured patches on the wall surfaces. This is as a result of the loss of adhesion between the paint and the wall surfaces because of the presence of moisture. (Marshall, Worthing, Heath, 2003)
5. It results in the corrosion of metals used in the construction of buildings, thereby reducing the strength of the metal component. (Wood, 2009)
6. The materials used as floor coverings such as tiles are damaged because they lose adhesion with the floor bases. (Marshall, Worthing, Heath, 2003)
7. Timber when in contact with damp condition gets deteriorated due to the effect of warping, buckling and rotting of timber. (Wood, 2009)
8. All the electrical fittings get deteriorated, causing leakage of electric current with the potential danger of a short circuit. (Oxley & Gobert, 2011)

9. Dampness promotes the growth of termites and hence creates unhygienic conditions in buildings. (Marshall, Worthing, Heath, 2003)
10. Dampness when accompanied by the warmth and darkness, breeds the germs of tuberculosis, neuralgia, acute and chronic rheumatism etc. which sometimes result in fatal diseases. (Lstiburek & Carmody, 1991; Marshall, Worthing, Heath, 2003)

The effects of dampness are enormous (Marshall, Worthing, Heath, 2003)

## 2.9 Diagnosis of Dampness at the Lower Part of Walls

Diagnosis is the identification or verifying the cause of dampness (Burkinshaw & Parrett, 2004)

Since the diagnosis is expected to reflect the true picture of the situation on the ground, it is therefore necessary to undergo an accurate diagnostic tests or procedure. This is so because inappropriate diagnosis will result in wrong remedial treatment

In diagnosing, the general approach is first of all coming out with all the possible causes after careful examination of all symptoms.

When one recognizes that there is a dampness problem it is usually because of the visual appearance of the surface, for instance, spoiling or staining. It is important to note that the above defects are all manifest at the surface and are assessed literally at the surface, visually or by instruments.

It is then followed by the identification of the true cause by the process of elimination. This is done by taking a critical look at the characteristics or symptoms of the effects. Instruments such as moisture meter can also be employed to aid in the investigation. (Burkinshaw & Parrett, 2004)

## 2.10 Damp Prevention Methods

Damp prevention methods in construction is any type of method applied to buildings to prevent moisture from having access to the fabric of the building (Oxley & Gobert, 2011). In preventing the onset of rising or penetrating damp or dampness at the lower parts of buildings in totality; there are various options to choose from, including:

- **Deflection as a prevention method against rain**

  The climate and the site play a large role in defining the rain exposure that a building is exposed to. The first line of protection is siting plants or trees around the building. In this way, exposure of the building to the prevailing driving rains is protected against by plantings, and landscaping.

  The shape of the roof (peaked roof), and overhangs (roof gutters) also has a critical impact as they reduce rain deposition by a substantial amount.

  Peaked roofs and overhangs protect walls from rain by shadowing and redirecting airflow. Hipped roofs provide an opportunity to shelter the walls from rain on all four sides of the building and also increase the resistance to damage during high winds. Buildings with wide overhangs will be exposed to much less wind rain. (Lstiburek & Carmody, 1991)

- **Drainage as a prevention method**

  Provision of drain all-round the building is as important as the overhang. In this case the drain redirects the water from a non-overhang roof. None the less, the drain can also redirect the water from running rain water or mini flooding in the direction of the building. (Lstiburek & Carmody, 1991)

- **Drying as a prevention method**

  Ventilation is also important since it can reduce or control the amount of moisture in the fabric of a building. Air movement in and out of a building can, under the proper conditions, remove or dry out a large quantity of moisture in buildings. It is important for architects, draftsmen or designers design buildings that has more access to ventilation, so as to allow for a lot of air movement in and out of a building. (Chudley & Greeno, 2006)

- **Pavement as a prevention method**

  Apart from plantings, and landscaping which is purposely to control windy rains and splashes on walls, one could also consider paving the entire compound with concrete or pavement blocks. This could be quite expensive, but it prevents the soil around the building from accessing moisture which may in turn transfer it to the substructure. In as much as using pavement to solve the issue of dampness, it also beautifies the surrounding. (Hornbostel, 1999)

- **Well construction as a prevention method**

  The construction of a well strategically situated on the compound can go a long way to help with the issue of dampness. This is one good way of solving the issue of rising damp. The water table around the building is reduced when a well is constructed and periodically the water is pumped out. (Chudley & Greeno, 2006)

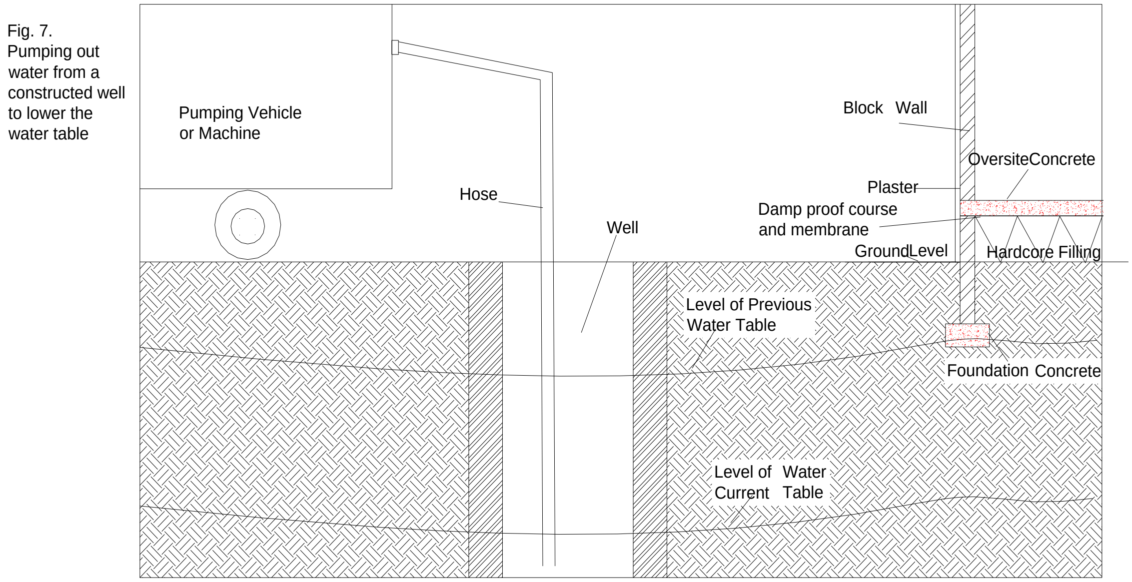


**Fig. 2.6 Pumping out water from a constructed well**

- **Installation of subsoil drainage system as a prevention method**

Subsoil drainage can also be used to improve the stability of moisture in the ground or lower the humidity of the site. Subsoil drains consist of porous or perforated pipes laid dry jointed in a rubble filled trench. Porous or perforated pipes allow the subsoil water to pass through the body of the pipe as shown in fig.2.7. The water collected by a subsoil drainage system has to be conveyed to a suitable outfall such as a river, lake or surface water drain or sewer. (Hall & Greeno, 2007)

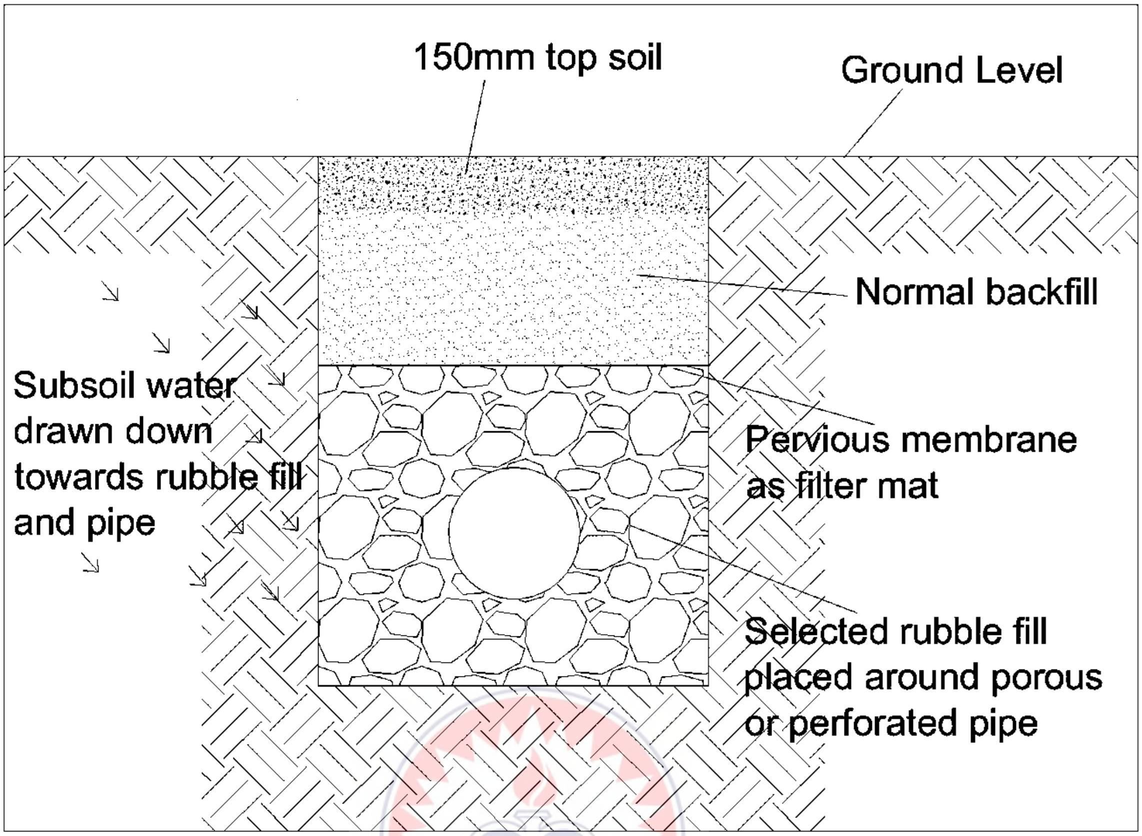


**Fig. 2.7 Subsoil drainage system**

- **Damp proofing as a prevention method**

Damp proof membranes and damp proof course are layers or membranes of water repellent materials such as bituminous felts, mastic asphalt, plastic sheets, cement concrete, mortar, metal sheets, etc. which are introduced in the building structure at all locations wherever water entry is anticipated or suspected. The best location or position of D.P.C. in the case of building lies at plinth level or structures without any plinth level should be laid at least 15cm above ground level. The damp proof course is provided horizontally and vertically in floors, walls as shown in fig. 2.8. (Chudley & Greeno, 2006)

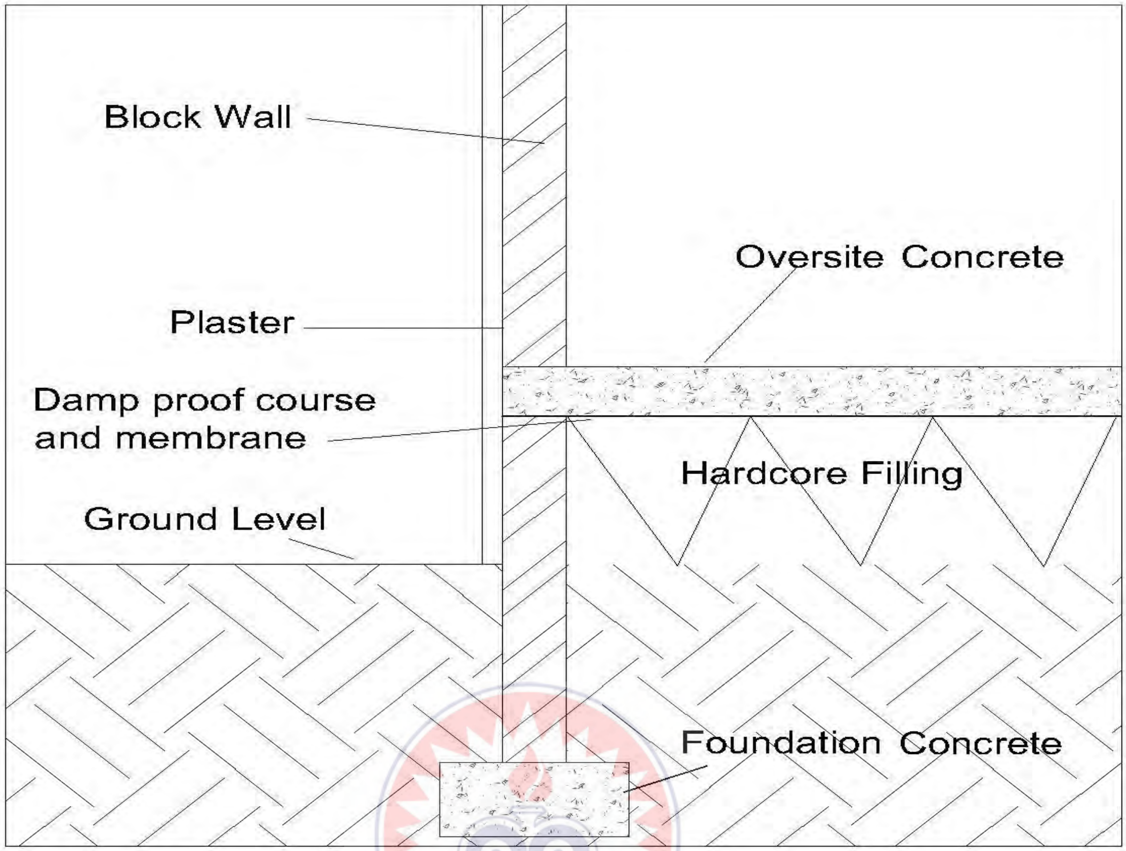


**Fig. 2.8: Incorporation of D.P.C. and D.P.M.**

- **Surface treatment as a prevention method**

The surface treatment consists in filing up the pores of the material exposed to moisture by repainting the plinth of the building with water proof paint. In cases where the plaster at the plinth is deteriorated, the plaster should be removed and re-plaster with an appropriate mix containing water proof cement. If possible, one should excavate up to the foundation level of the external facade and plaster.

In cases where the building has efflorescence, remove the efflorescence from the surface of the wall with non-metallic bristle brushes before treating the surface. (Oxley & Gobert, 2011; Chudley & Greeno, 2016)

- **Repair faulty plumbing fittings**

  Replace older pipes and fixtures or faulty plumbing fittings subject to leaking or overflowing. (Oxley & Gobert, 2011)

- **Use of appropriate materials and construction methods**

  Some defective components found in the structure of buildings are as a result of the inferior or non-quality materials used (Ransom, 1987). During construction or repairs one should always use appropriate traditional building materials. The inappropriate use of materials often has an adverse effect by inhibiting moisture movement and dispersal. Poor workmanship can also create or contribute to damp problems. Water penetration through walls can occur as a result of weak mortar joint or inferior blocks. It is easy to create cracks when we have continuous joint in the building, and moisture can be absorbed through fine cracks and porous materials, but cannot then evaporate back out through the waterproof surface and is held within the wall.

  It is therefore important to use appropriate building materials and construction methods (Barry, 1999).

- **Cladding as a prevention method**

  The use of non-porous walling unit will drastically reduce damp penetration than the use of a more porous walling unit. Tiling the external wall will very much prevent driving rain or damp penetration (Brookes & Meijs, 2008).

# CHAPTER THREE

## 3.0 RESEARCH METHODOLOGY

### 3.1 Introduction

This chapter deals with methods and techniques employed in data collection. It involved the research design, population, Sampling Techniques and Sampling size, and Data Collection Techniques

### 3.2 Research Design

The research design adopted for the study is descriptive design. This design was adopted for the study so as to be able to establish; the existence of dampness of buildings in the municipality, the source of dampness in the affected buildings and effects of the dampness on the various buildings through observation and survey

### 3.3 The Population

The population includes all buildings, and construction professionals such as engineers, quantity surveyors, architects, and lecturers within Dzowulu and its environs with some basic knowledge and experience in construction.

### 3.4 Sampling Techniques and Sample size

The sampling technique adopted for the selection of respondents for the study is purposive sampling technique.

Purposive sampling was used because the researcher needed people with knowledge, skills or experience in the topic that is being researched into, and also selected buildings that are affected with dampness.

Sample buildings and respondents included in the samples were selected to meet the criteria. The sample buildings are those affected with dampness at the lower parts of building. For every fifty (50) buildings counted, 25 to 38 of them had signs and symptoms of the presence of dampness at the lower parts of the building in the various locations. The researcher then zoomed in to 5 seriously affected buildings which were evident with signs of dampness from each of the following locations; presby junction, railway line, Dzowulu central, school junction and north Dzowulu. Out of the five buildings from each location, one was selected from each location as a result of its serious signs of defects.

The respondents also included persons from the following category: two consulting firms, one construction firm, Accra Municipal Assembly, Ghana High Way Authority, A.E.S.L, Ghana Water and Sanitation Authority and Accra Technical University.

Persons from the university particularly lecturers in the building department of Accra Technical University who are involved in the design of buildings in one way or the other, and some construction students in Accra Technical University who are resident in Dzowulu.

The other categories are made of construction professionals such as Civil Engineers, Quantity Surveyors and Architects who also happen to be key stakeholders in the construction industry in Accra.

A sample of 20 respondents was selected from the groups of respondents. Mouton (1996) defines a sample as elements selected with the intention of finding out something about the total population from which they are taken. A convenient sample consists of subjects included in the study because they happen to be in the right place at the right time (Polit and Hungler, 1993). The respondents included 4 Architects, 6 Structural Engineers, 5 Quantity Surveyors, 1 Soil specialist, 2 Lecturers and 2 construction students.

### 3.5 Data Collection Technique

The following data collection technique were employed to gather information for the study. The following procedure was employed to be able to get the necessary information in Dzowulu and its environs.

They involved:

- Visual Survey
- Interview
- Laboratory tests

#### 3.5.1 Visual survey

This involves physical survey of affected buildings in the municipality. It involves visual inspection of twenty-five (25) sample buildings selected from the Dzowulu locality. The survey was aimed at careful identification of the effects of dampness at the lower parts of affected sample buildings.

#### 3.5.2 Interview

The researcher interviewed construction professional which included; Architects, Structural Engineers, Quantity Surveyors, Soil specialist, Lecturers and construction students. All making a total of 20 professionals. The professionals were from the following organization; two consulting firms, one construction firm, Accra Municipal Assembly, Ghana High Way Authority, A.E.S.L, Ghana Water and Sanitation Authority and Accra Technical University. The questions asked during the consultation were aimed at:

1. Enquiring how familiar the respondent is with the subject of dampness at the lower parts of buildings in Dzowulu.
2. Based on experience what could be the causes and sources of dampness in Dzowulu and its environs?
3. Soliciting the opinion of respondent concerning the solution in rectifying an already existing problem in Dzowulu.
4. And also precautions to take in preventing dampness at the lower parts of buildings for newly proposed buildings in Dzowulu and its environs.

The issues that arose during the interview with regards to the causes of dampness at the lower parts of buildings are; Inadequate Investigation or information, Faulty design decision, Inferior building materials, Wrong construction methods, and Poor maintenance culture.

It also came out that the sources of dampness at the lower parts buildings are; Rising Damp, Rain or moisture penetration, Faulty plumbing works, Moisture entrapped during construction or maintenance and Accidental flooding.

**Laboratory test**

Samples of soil and some components of the building were taken from the buildings affected by dampness at the lower parts of walls in Dzowulu and its environs. Laboratory test was conducted laboratory on the 11th October, 2017. Five (5) trail pits were dug at variable depths and soil samples taken at each layer. Moisture content test was done to determine the content of moisture in the soil.

**Procedures of the test**

The aim of this test is to establish the presence of moisture and find out the amount of moisture in the soil around the building and material during the period of the survey. Sample soils were taken at various depths close to the foundation in all the trial pits. Likewise, sample materials like piece of block, concrete and plaster were taken from four buildings.

The various sample soils and materials were put in containers and sent to the laboratory at Accra Technical University.

The weights of sample wet soils and materials with its containers were taken, after which they were kept in an oven with a temperature of about $100^0$c for 24 hours. After which weights of the sample dry soils and materials with its containers were also weighed. The weights of the sample dry soils and materials were deducted from the weights of the sample wet soils and materials to obtain the weights of the moisture in the soil and materials.

**Formulae used in table**

Let Weight of container = A

Weight of wet soil =B

Weight of dry soil =C

Weight of container + wet soil = D

Weight of container + dry soil = E

Weight moisture content = F

i. Weight of wet soil = Weight of container + wet soil minus Weight of container.

   B = D - A

ii. Weight of dry soil = Weight of dry soil minus Weight of container.

C = E - A

iii. Weight moisture content = Weight of wet soil minus Weight of dry soil

F = B - C

iv. Percentage of moisture content = Weight of moisture divided by Weight of dry soil multiplied by hundred

$$\frac{F}{C} \times 100$$

# CHAPTER FOUR

## 4.0 RESULTS AND DISCUSSION

### 4.1 Introduction

This chapter is focused on the findings and discussion of dampness at the lower parts of building in Ghana specifically Dzowulu locality which is the main purpose of this research work. The field data collected was analyzed using pie charts and tables for easy interpretation and understanding.

### 4.2 Result of Visual Survey

The following are defects which were mostly found on rendered walls, block walls which were not rendered and concrete.

**Damp Patches on walls**

From the survey, damp patches were formed on the parts of walls of buildings that looked wet. These areas are relatively dark and not bright as the greater surface of the wall. The damp patches have rendered the wall discolored, thus marred the beauty of the walls of the buildings. With reference to table 4.1, damp patches were detected on twenty-four (24) sample building, representing ninety-six percent (96%) of the building samples out of a total of 25 samples studied

**Peeling off of Paints on walls**

As shown in figure 4.1, peeling off of paints on building were visible where paints where paints flake off from the walls as a result of the lack of adhesion between the paint surface. The constant presence of moisture in the wall caused the paints to loss adhesion thereby peeling off of a shown in Fig. 4.1 and Fig. 4.2. It was noted that eighteen (18) building samples representing seventy-two percent (72%) had their paints surfaces peeled off. This situation was noted as the major defect observed on the walls of most buildings during the visual survey.

**Fig. 4.1 Peeling off of paints, cracks, stains and patches of mold**

**Efflorescence on wall surfaces**

In this situation, the wall surfaces of the buildings appeared as whitish powdery substances on wall surfaces as a result the presence of salt in the moisture. The rising damp carries the salts up into the walls of the structure to where the moisture evaporates leaving behind the salts. This salt substance evaporates and results into a whitish powered paint on the surfaces of walls. According to the survey as shown in table 4.1, efflorescence was detected on six (6) building samples which represented twenty-four percent (24%).

**Chalking of rendered or unrendered walls**

The observation of rendered an unrendered walls revealed that chalking or wearing of plaster and blocks were visible. In Fig. 4.2, the moisture in the plaster and block has led to the disintegration of the sand particles into powder. The study however showed that chalking occurred as a result of either wrong mortar mix on chemical reactions or both due to the presence of moisture. From table 4.1, it was observed that twelve (12) our of twenty-five (25) building samples surveyed were identified as having this defect representing forty-eight percent (48%).

**Fig. 4.2 Chalking of block**

**Stains and patches of mold**

From the survey, patches of mold were found on walls as shown in Fig 4.1 and 4.3 Moisture in building materials promoted the growth of microbes on walls. The microbe growth depends on the moisture, temperature conditions, time and nutritive status of the materials. From all of these conditions moisture was seen as the key factor for the growth of microbes.

The presence of some microbes such as mold of fungi has some health effects. Buildings that has been affected by moisture lead to massive growth of mold within a very short period of time. From table 4.1, building samples affected with Stains and patches of mold on them are twenty (20) which represent eighty percent (80%) of the selected sample.

**Fig. 4.3 Peeling off of Paints, Stains and patches of mold**

**Disintegration of building components**

It was observed that moisture has caused the disjointing or breakup of building components, between block wall and floor concrete, block wall or concrete and wooden frame, as shown in Fig. 4.4. The constant presence of moisture in the building structure has rendered the fabrics of the component loose adhesion and also promoted wood rot. Out of twenty-five (25) building samples, disintegration of building components was present on nine (9) building samples which represent thirty-six percent (36%).

**Fig. 4.4 Disintegration of building components and Wearing of plaster**

**Tab. 4.1 Result of the Visual Survey**

| Observed defect | No. of building | % of defective building |
|---|---|---|
| Damp Patches | 24 | 96.0 |
| Peeling Off of paints | 18 | 72.0 |
| Efflorescence | 6 | 24.0 |
| Chalking of render | 12 | 48.0 |
| Stains and patches of mold | 20 | 80.0 |
| Disintegration of building components | 9 | 36.0 |

### 4.3 Result of Interview

Consultations were made with persons working with two consulting firms, one construction firm, Accra Municipal Assembly, Ghana High Way Authority, A.E.S.L, Ghana water and Sanitation Authority and Accra Technical University making a total of 20 professionals. Table 4.2, table 4.3 and Fig. 4.5 are based on the responds of the professionals. Table 4.2 suggested that dampness at the lower parts of the walls caused by inadequate investigation and information prior to designing the building.

Table 4.3 and Fig. 4.5 also show that rising damp is the most source of moisture in building which represent ninety percent of the respondents. This is following by rain or moisture penetration which as a percentage of eighty-five percent (85%).

**Tab. 4.2 Responses of the professionals regarding the causes of dampness**

| Causes | No. Of respondents | Percentage (%) |
|---|---|---|
| Inadequate Investigation or information | 15 | 75 |
| Faulty design decision | 14 | 70 |
| Inferior building materials | 12 | 60 |
| Wrong construction methods | 5 | 25 |
| Poor maintenance culture | 13 | 65 |

**Tab. 4.3 responses of the professionals regarding sources of moisture**

| Sources | No. Of Respondents | Percentage (%) |
|---|---|---|
| Rising Damp. | 18 | 90 |
| Rain or moisture penetration. | 17 | 85 |
| Faulty plumbing works | 5 | 25 |
| Moisture entrapped during construction or maintenance | 2 | 10 |
| Accidental flooding | 1 | 5 |

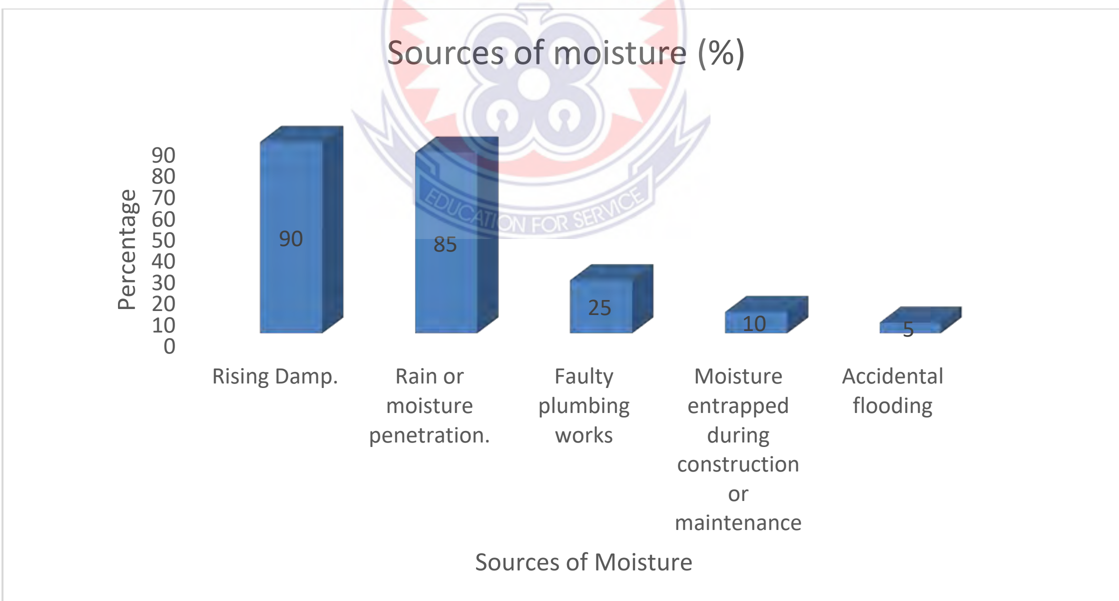


**Fig. 4.5 Responses of professionals regarding the source of dampness**

### 4.4 Laboratory test results

As shown in the table below, the various locations in the Dzowulu locality and its environs have deferent scenarios or situations of moisture content in the ground.

For instance with reference to Tab.4.4, the situation at north Dzowulu is quit challenging, in that the laboratory result shows moisture content of twenty-four percent (24%), twenty-one point seven percent (21.7%) and twelve point eight percent (12.8%). This is due to the fact that the soil has varied retain ability of moisture. When the trail pit where dug at three (3) deferent locations round the building, it was observed to have a depth of about 500mm. After the 500mm depth is a platform of rocks which looks impermeable. One particular building with (24%) moisture content is fenced without weep holes, thereby causing the moisture to be retained which is socked up by the building causing dampness.

This is also evident in the fact that the plastered wall of this building has a moisture content of thirty-two point nine (32.9%) as shown in table 4.5.

The laboratory result reveals moisture content of twenty-five point three percent (25.3%), seventeen point nine percent (17.9%) and twenty-six point five percent (26.5%) in the first, second and third stratum respectively for the soil samples taken from Railway line. There was an encounter of rock at a depth of 700mm. The first stratum is loamy soil which looks quit dark in colour whiles the second stratum is quit starchy and brownish in colour which makes it clay soil. As a result of the characteristics of clay, moisture is retained more in the first stratum as compared to the second stratum.

Now when we take a look at the result for presby junction and school junction (Fig. 4.4), we will notice that the deeper the pit the more moisture content we encounter. These two areas have an average water table of 3,500mm, thereby making it easy to encounter more moisture when you move deeper.

**Tab. 4.4 Moisture Content Result for Soil Samples.**

| Location of Trial pit | Railway Line | | | Dzowulu central | | | North Dzowulu | | | Presby Junction | | | School Junction | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Layer Number | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| Weight of Container (g) | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 |
| Wgt of Con + Wet Soil (g) | 142 | 161 | 152 | 155 | 133 | 151 | 173 | 163 | 155 | 140 | 151 | 150 | 146 | 145 | 143 |
| Wgt of Wet Soil (g) | 119 | 138 | 129 | 132 | 110 | 128 | 150 | 140 | 132 | 117 | 128 | 127 | 123 | 122 | 120 |
| Wgt of Con + Dry Soil (g) | 118 | 140 | 125 | 134 | 110 | 125 | 144 | 138 | 140 | 114 | 123 | 121 | 121 | 117 | 114 |
| Wgt of Dry Soil (g) | 95 | 117 | 102 | 111 | 87 | 102 | 121 | 115 | 117 | 91 | 100 | 98 | 98 | 94 | 91 |
| Moisture content (%) | 25.3 | 17.9 | 26.5 | 18.9 | 26.4 | 25.5 | 24 | 21.7 | 12.8 | 28.6 | 28 | 29.6 | 25.5 | 29.8 | 31.9 |

**Tab. 4.5 Moisture Content Result for Material Samples.**

| Location of material | Railway Line | | | Dzowulu Central | | | North Dzowulu | | | Presby Junction | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Material** | Plst | Blk | Con | Plst | Blk | Con | Plst | Blk | Con | Plst | Blk | Con |
| **Weight of Container (g)** | 23 | | 23 | 23 | 23 | 23 | 23 | | | 23 | 23 | 23 |
| **Wgt of Con + Wet Soil (g)** | 130 | | 136 | 125 | 133 | 145 | 132 | | | 140 | 151 | 150 |
| **Wgt of Wet Soil (g)** | 107 | | 113 | 102 | 110 | 122 | 109 | | | 117 | 128 | 127 |
| **Wgt of Con + Dry Soil (g)** | 106 | | 114 | 104 | 110 | 125 | 105 | | | 112 | 121 | 119 |
| **Wgt of Dry Soil (g)** | 83 | | 91 | 81 | 87 | 102 | 82 | | | 89 | 98 | 96 |
| **Moisture content (%)** | 28.9 | | 24.2 | 25.9 | 26.4 | 19.6 | 32.9 | | | 31.5 | 30.6 | 32.3 |

**Fig. 4.6 The oven that was used at the Lab with samples of materials.**

# CHAPTER FIVE

## 5.0 SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

### 5.1 Introduction

This chapter presents the summary, conclusion and recommendations of the study. The first section presents the summary of the study; the second section presents the conclusion of the study based on the study's findings followed by sections that present the recommendations.

### 5.2 Summary of Findings

The following are the summary of findings:

- The study have revealed that most of the dampness in the Dzowulu area was due to inadequate investigation or information of the site before the construction works were undertaken.
- From the study, it was also identified that the dampness situation was due to design decision which did not provide solutions to address the dampness condition of the building in the Dzowulu locality.
- The study also revealed that major cause of dampness in the buildings was due to the fact the desirable ration for the mixture of mortar for block which is 1:6 was not

used, but rather a ratio of 1:8 to 1:12 was used to mould the blocks which rendered them porous and promoted high rate of dampness in the buildings.

- The study show that the dampness is as a result of non-provision of barrier such as damp proof course, damp proof membrane and oversite concrete in the building pave way for moisture to travel above the floor.
- The study also discovered that, the intensity of dampness on the building was as a result of lack of maintenance at eh initial stage of deterioration of the building components in the Dzowulu locality.
- According to the study, the sources of dampness in the Dzowulu area are revealed to be rising damp, rain or moisture penetration, faulty plumbing works, moisture entrapped during construction or maintenance and accidental flooding
- The findings of the study show that damp patches, peeling off of paints, efflorescence, chalking of walls, stains and patches of mold and disintegration of building components are the defects which were mostly found on rendered walls, block walls which were not rendered and concrete.

## 5.3 Conclusion

The study has confirmed that deepness at the lower parts of building usually have effect in the buildings Much of the documentation and evaluation is based on understanding of building materials, construction technology, and the basics of moisture movement. The effect of dampness can be evaluated step by step and situations creating direct or secondary moisture damage can generally be corrected. The majority of moisture problems can be mitigated with maintenance, repair, control of ground moisture, and improved ventilation. For more complex situations, however, a thorough diagnosis and an understanding of how the building handles moisture at present, can lead to a treatment that solves the problem without damaging the building.

It is usually advantageous to eliminate one potential source of moisture at a time. Simultaneous treatments may set up a new dynamism in the building with its own set of moisture problems. Implementing changes sequentially will allow one to track the success of each treatment.

Holding the line on unwanted moisture in buildings will be successful if there is constant concern for signs of problems, and there is ongoing physical care provided by those who understand the building, the site, and previous efforts to deal with moisture. For properties with major or difficult-to-diagnose problems, a team approach is often most effective. The owner working with properly trained contractors and consultants can monitor, select, and implement treatments within a preservation context in order to manage moisture and to protect the building.

## 5.4 Recommendation

. The following are the recommendation made to address the findings:

- It is important to gather all the necessary information on a project prior to the designing of the building. It is therefore the responsibility of the design team to acquire all the necessary information or investigation about the location prior to designing.
- The design team should analyze the design thoroughly to ensure that all aspect of the design address the dampness issues before finalizing for implementation.

- It is important for the various professional such as the clerk of works, engineers and contractors to ensure that right rations, are used when mixing mortar for the construction of buildings.
- It is also important to ensure the use or provision of barrier such as damp proof course, damp proof membrane and oversite concrete in the building during construction so as to prevent the up rise of moisture.
- Maintenance should be a constant practice to ensure that the issues of dampness are worked on so as increase the lifespan of the various building components. .
- Sub-soil drainage system should be installed in the soil that are found to be wet so as to drain the moisture in the ground away from the building. This system will arrest the rise of moisture from the ground and that of the surrounding.
- It is recommended that affected surfaces of walls of building that has the effect of dampness should be scraped and re-plastered with mortar mixed with waterproofing chemical.

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# APPENDIX 1

## INTERVIEW SCHEDULE

UNIVERSITY OF EDUCATION WINNEBA-KUMASI CAMPUS

DEPARTMENT OF CONSTRUCTION AND WOOD TECHNOLOGY

I am Akpalu-Boating Edinam from University of Education Winneba-Kumasi Campus, pursuing M-Tech in Construction. Am undertaking a research on the topic "**ASSESSING THE EFFECT OF DAMPNESS IN THE LOWER PARTS OF BUILDINGS IN THE DZOWULU LOCALITY".**

Please kindly note that this is only for academic purpose and the information provided will be kept confidential and will not expose your views to the public.

1. How familiar are you with the subject of dampness at the lower parts of buildings in Dzowulu.?
2. Please based on experience, what could be the causes of dampness at the lower parts of buildings?
3. What are the sources of moisture at the lower parts of buildings?
4. What in your view can be the solution in rectifying an already existing dampness at the lower parts of building in Dzowulu.?
5. In your opinion what precautions should be taken in preventing dampness at the lower parts of buildings for newly proposed buildings in the Dzowulu locality?

Thank you