AFRICA DEVELOPMENT AND RESOURCES RESEARCH INSTITUTE (ADRRI) JOURNAL

*ADRRI JOURNAL (**www.adrri.org**)*

***pISSN***: 2343-6662 ***ISSN-L***: 2343-6662 VOL. 7,No.7(2), pp 19-36, April, 2014

# Dampness in Walls of Residential Buildings: The Views of Building Construction Professionals in Ghana.

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**Received**: 4th March, 2014 **Revised**: 24th April, 2014 **Published Online:** 30th April, 2014

***URL***: http://www.journals.adrri.org/

[**Cite as**: Agyekum, K. and Ayarkwa, J. (2014). Dampness in Walls of Residential Buildings: The Views of Building Construction Professionals in Ghana. Africa Development and Resources Research Institute Journal, Ghana: Vol. 7, No. 7(2), Pp. 19-36.]

**Abstract**

Dampness is a very common problem in both public and private buildings in Ghana. Dampness has existed in residential buildings in Ghana for many years and a lot concerns have been raised on the problem. This study presents the results of a questionnaire survey of 247 construction professionals (Architects, Quantity Surveyors and Site Engineers) to assess their perceptions on causes and symptoms of dampness in residential buildings in Ghana. The results showed that most of the respondents were experienced on the issues of dampness and they demonstrated in-depth knowledge of the problem of dampness in residential buildings. The results also showed that rising dampness, flooding, leakages, water penetration and construction water are the five major causes of dampness in residential buildings in Ghana. Furthermore, the results showed that surface efflorescence just above skirting/floor, stains especially in horizontal band, dampness at the base of walls up to 1.5m in horizontal band, softening and deterioration of plaster' and 'blistering and flaking of paint are the five main symptoms associated with dampness. The study recommends actual laboratory tests and further analysis on samples from affected buildings to have a better understanding of how to remedy the problem of dampness.

**Keywords:** architects, building construction, dampness, quantity surveyors, site engineers

## INTRODUCTION

Water plays a major role in the deterioration of masonry materials and often has a negative and devastating influence on buildings. The penetration of water is one of the most damaging defects that can occur in both old and modern constructions (Hetreed, 2008; Burkinshaw and Parrett, 2004). Accumulation of moisture or dampness in buildings or components of a building leads to physical, biological or chemical deterioration of the building or its materials (Haverinen-Shaughnessy, 2007). Damage to buildings caused by dampness pose serious risks to the performance of the building (Oliver, 1997). Dampness in buildings is moisture that should not be present in that building (Burkinshaw and Parrett, 2004). A building is described as having a dampness problem when the materials in that building become sufficiently damp to cause material damage and visible mould growth (Burkinshaw and Parrett, 2004). In Ghana, there have been a sharp increase in the demand for new residential buildings, and these demands are being satisfied by various building firms and individual construction professionals. However, many of the houses are of poor quality and are not often built in accordance with good building practices. There are also reported cases of poor quality workmanship, design deficiencies, poor quality workmanship, non-inclusion of professionals during construction, etc. (Agyekum et al., 2014). These issues have led to severe problems such as rising dampness in many buildings in Ghana (Agyekum et al., 2013).

## LITERATURE REVIEW

Dampness is the wetting of structural elements through moisture rise by capillary action (Seeley, 1994). Dampness, an indication of the moisture content of the air present in a space, is an important factor which determines the quality of the air in relation to human health and comfort and more importantly, its effects on the structural integrity of materials in buildings (Hyvarinen et al., 2002; Canadian Wood Council, CWC, 2000; King et al., 2000). Dampness in buildings can cause a number of problems, including the destruction of timber, blocks, bricks, ineffective insulation due to cold bridging and the increased risk of mold growth (Hyvarinen et al., 2002; CWC, 2000; King et al., 2000). Dampness in buildings can arise from a number of different sources and can cause a variety of effects, such as wall staining, mold growth, impairment of air quality and respiratory problems in humans (Ahmed and Rahman, 2010; Trotman et al., 2004; Riley and Cotgrave, 2005; CWC, 2000).

Studies have shown that in 2004, about 20% of buildings in several European countries, Canada and the United States had one or more signs of dampness (WHO, 2009). This estimate agreed with those of a study of 16,190 people in Denmark, Estonia, Iceland, Norway and Sweden, which gave an overall prevalence of indoor dampness of 18% (Gunnbjornsdottir et al., 2006). In the study undertaken by Gunnbjornsdottir et al. (2006), dampness was defined on the basis of self-reported indicators, such as water leakage or damage, bubbles or discoloration of floor coverings, and visible mold growth indoors on walls, floors or ceilings. A study of 4,164 children in rural Taiwan and China showed that 12% of the parents or guardians considered their dwellings to be damp, 30% reported the presence of visible mold inside their houses, 43% reported the appearance of standing water, water damage or leaks and 60% reported at least one of these occurrences (WHO, 2009; Yang et al., 1997). In Singapore, of 4,759 children studied, the prevalence of dampness in each child's bedroom was estimated to be 5% and that of mold was 3% (WHO, 2009; Tham et al., 2007). In Ghana, a study has shown that the problem of dampness in buildings is on the rise Agyekum et al., 2013a; Asamoah et al., 2012).

Dampness in the elements of a structure can arise from rainwater penetration in exterior walls, ground water intrusion into basements and crawl spaces, condensation and indoor moisture sources (Ahmed and Rahman, 2010; Riley and Cotgrave, 2005; Trotman et al., 2004).

## METHODOLOGY

The study involved a questionnaire survey of 247 construction professionals from different disciplines (Architects, Quantity Surveyors and D1 and D2 building construction firms). The aim of the questionnaire survey was to assess the perceptions of these professionals on the causes and symptoms of dampness in residential buildings in Ghana. The survey targeted professionals working in Architectural, Quantity Surveying and Building Construction firms located in the Ashanti and Greater Accra regions of Ghana. The questionnaire was divided into three main sections. The first section of the questionnaire sought information on the designations of the respondents. The second section sought information on the experience of the respondents on the issue of dampness. Among the issues raised were how frequent dampness was experienced in buildings in recent years. The third part of the questionnaire required respondents to score on the Likert scale of 1-5 the significant causes of dampness identified in literature and modified to suit conditions in Ghana (Agyekum et al., 2013; Ahmed and Abdul Rahman, 2010; Burns, 2010; Trotman, 2004; Nicol, 2006; Riley and Cotgrave, 2005; CWC, 2000), where 1= 'Highly insignificant' and 5 = 'Highly significant'. Respondents were also asked to score on the Likert scale of 1-5, the level of severity of symptoms (identified from literature) associated with dampness in walls (Agyekum et al., 2013; Ahmed and Rahman, 2010; Burns, 2010; Trotman, 2004; Nicol, 2006; Riley and Cotgrave, 2005; CWC, 2000).

Site Engineers of D1 and D2 building construction firms were involved in this study. Individual consultants working in Quantity Surveying firms fully registered with the Ghana Institution of Surveyors (GhIS) and in Architectural firms fully registered with the Architects Registration Council of Ghana (ARCG) were also targeted. Records from the Ministry of Water Resource, Works and Housing, MWRWH, showed that there were 519 D1 and D2 building construction firms in Ghana as at the year 2011 (Ayarkwa et al., 2012). Records of the Architects Registration Council, ARCG showed that there are 114 fully registered Architectural firms in the two regions (ARCG, 2013) whilst, the Ghana Institution of Surveyors, GhIS, also had 49 fully registered Quantity Surveying firms (GhIS, 2013).

A sample size of 84 site Engineers of D1 and D2 building construction firms was determined using the formular (Israel, 2009):

$$n = \frac{N}{1+N(e)^2} \qquad (1)$$

Where n is the sample size, N is the population size and e is the desired level of precision (±10%). Questionnaires were also distributed to all the 114 architectural firms and 49 quantity surveying firms. A census approach was used to select the

pISSN: 2343-6662 ISSN-L: 2343-6662 VOL. 7,No.7(2), pp 19-36, April, 2014

Architectural and Quantity Surveying firms in the Ashanti and Greater Accra Regions. A census approach was used because it is attractive for small populations of 200 or less as it eliminates sampling error and provides data on all individuals in the population (Israel, 2009). Out of the total of 247 questionnaires sent to the professionals, 208 were returned complete representing a response rate of 84%.

A quantitative approach to data analysis was employed. Statistical Package for Social Scientists Version 20 (SPSS V 20) was used to analyze the data by means of frequencies and severity index. The severity index analysis (Idrus *et al.*, 2011) uses weighted percentage scores to compare the relative importance of the criteria under study. The frequency analysis was first carried out to determine the frequency of responses which were then used to calculate severity indices (Idrus et al., 2011):

$$\text{Severity Index (SI)} = \frac{[\sum ai.xi]}{[5\sum xi]} \times 100 \qquad (2)$$

*Xi*= Variable expressing the frequency of the response for *i*; *i* = 1, 2, 3, 4 and 5; X1= Frequency of the 'not severe' response and corresponding to a1= 1; X2= Frequency of the 'less severe' response and corresponding to a2=2; X3= Frequency of the 'neither severe nor very severe' response and corresponding to a3=3; X4=Frequency of the 'severe' response and corresponding to a4=4; X5=Frequency of the 'very severe' response and corresponding to a5=5.

## RESULTS AND DISCUSSIONS

### *Demography of respondents*

Architects constituted 43% of the respondents, Site Engineers constituted 38% and Quantity Surveyors constituted 19%. The average number of years of experience for these professionals were between 6 to 10 years. Three percent (3%) of the respondents were holders of Doctorate degrees, 25% held Master of Science degrees, 50% Bachelor of Science degrees and the remaining 22% were holders of Higher National Diploma certificates. Fifty percent of the firms have had experiences in the construction of public residential buildings, 45% both public and private residential buildings and 5% private residential buildings. This means that all the firms interviewed have had an experience in the construction of a residential building and hence their views would be of significance to this study.

***Issues on dampness***

*Frequency of occurrence of dampness*

Respondents were asked to indicate their opinions on frequency of the problem of dampness in Ghana. Sixty eight percent (68%) of the respondents agreed to the fact that dampness has been occurring frequently in most residential buildings in Ghana. This findings corroborates the results of a nationwide survey carried out which revealed that dampness is on the rise in most residential buildings in Ghana (Agyekum et al., 2013). In many European countries dampness occur often and it is the most frequently reported building defect (World Health Organization, WHO, 2009; Mudarri and Fisk, 2007; Gunnbjornsdottir, 2006). The respondents further stated that they received reported cases on dampness from building occupants in the rainy seasons. Young (2007) reported that in the city of Aberdeen, UK, experts in damp issues were of the opinion that there was a little change in the problem of dampness over the years. However, those with low level of experience in the problem of dampness did not know whether there had been a change in the frequency of damp problems or not. This trend differ among professionals in Ghana because about 68% of the respondents agreed to the frequent occurrence of dampness in buildings. Neither of the respondents were unsure of the occurrence of the problem and 32% responded that the frequency of occurrence of dampness was less often.

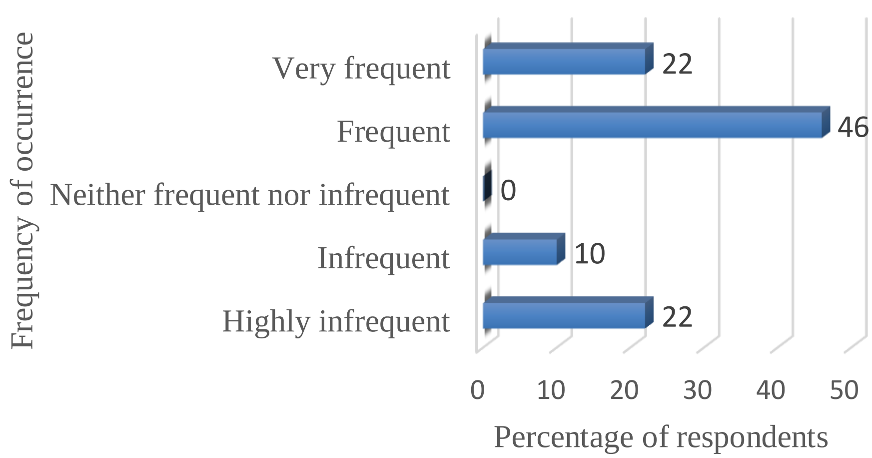


**Figure 1. Frequency of occurrence of dampness in buildings**

*Level of experience in dealing with the problem of dampness*

The level of experiences of the respondents in the issues of dampness were assessed based on the number of buildings with damp problems they have attended to. Practitioners who reported dealing with more than 10 properties in the last five years were considered to have a relatively high level of experience and vice-versa (Young, 2007). From the results obtained, 81% of the respondents were experienced in dampness issues, because they have had experiences in more than 10 buildings in the last five years (Young, 2007). This was very important for the study because their experiences in dealing with the issues of dampness means their perceptions reflected what was happening on the actual grounds in Ghana. Only 23% of the respondents were not experienced in dampness issues because they had been involved in less than 10 buildings with dampness issues over the last five years.

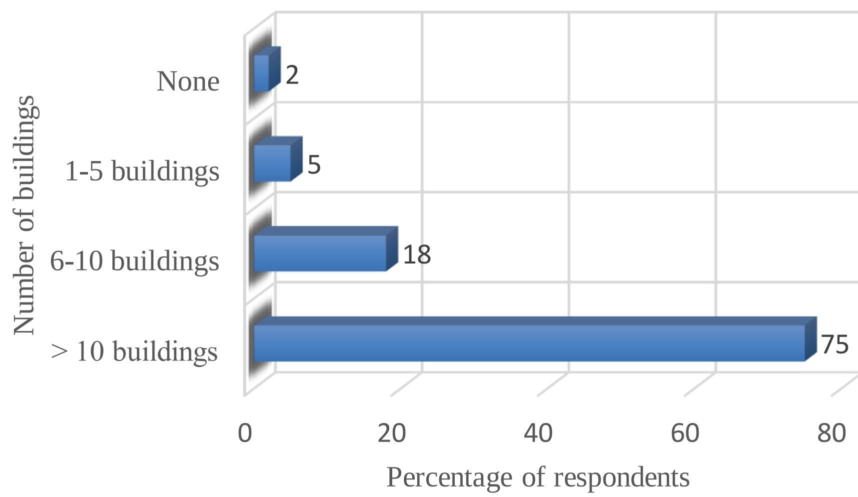


**Figure 2. Experience of respondents in dealing with damp issues**

*Significant causes of dampness in buildings*

Respondents were further asked to score the factors which cause the most cases of dampness in buildings. These causes were identified in literature and modified to suit conditions in Ghana (Agyekum et al., 2013a; 2013b; Ahmed and Abdul Rahman, 2010;

pISSN: 2343-6662 ISSN-L: 2343-6662 VOL. 7,No.7(2), pp 19-36, April, 2014

Burns, 2010; Trotman, 2004; Nicol, 2006; Riley and Cotgrave, 2005; CWC, 2000). The evaluation of the various causes were based on their mean scores. Comparison of the mean scores of the causes of dampness in buildings showed no significant differences between the responses of the Architects, Quantity Surveyors and Site Engineers at 5% significance level. The responses of the three groups of professionals were pooled together and presented in Table 1.

**Table 1. Causes of dampness in buildings**

| Causes of dampness | Mean scores | SD | Ranking |
|---|---|---|---|
| Rising dampness | 4.022 | 0.867 | 1 |
| Flooding | 3.800 | 1.160 | 2 |
| Leakages (plumbing, etc.) | 3.664 | 0.816 | 3 |
| Water penetration (water splash back, etc.) | 3.582 | 0.953 | 4 |
| Construction water | 3.577 | 1.200 | 5 |
| Condensation | 3.506 | 1.165 | 6 |
| Defective rain water guttering | 3.220 | 1.028 | 7 |

***SD-standard Deviation***

Table 1 shows that the mean scores of all the seven factors evaluated by the respondents are greater than the mean value of 2.5 (Field, 2005). This indicates that in the opinion of all the three groups of respondents all the seven factors are considered significant causes of dampness. The results further show that rising dampness, flooding, leakages, water penetration and construction water are the five major causes of dampness in residential buildings. Other factors such as condensation and defective rain water guttering systems were also considered significant causes of dampness.

Professionals in the building industry have reported that among all defects in buildings the most frequent and dangerous which contributes more than 50% of all known building failures is dampness (Halim et al., 2012; Watts et al., 2001). Accumulation of moisture or dampness in buildings or components of a building leads to physical, biological or chemical deterioration of the building or its materials (Haverinen-Shaughnessy, 2007). The findings from this study confirms literature as researchers in the past have identified the causes of dampness in buildings to include rising dampness, plumbing leakages, rain water penetration and condensation (Ahmed and Abdul Rahman, 2010; Halim and Halim, 2010; Riley and Cotgrave, 2005; Burkinshaw and Parrett, 2004; Mbachu, 1999). Of all the causes of dampness, rising damp is considered the most challenging (Ahmad and Abdul Rahman, 2010). Flooding was also evaluated as one of the major causes of dampness because most of the respondents had reported that many building owners and occupants frequently reported issues of dampness to them in the rainy seasons when flooding is on the rise. Also, majority of the respondents hailed from the Greater Accra Region in Ghana, an area very prone to frequent flooding and which has many reported cases of dampness problems. Ghafar (2004) reported that buildings located near water sources can have serious dampness penetration problems.

*Directions of buildings severely exposed to dampness*

Practitioners from their experiences were asked to evaluate the directions of buildings severely exposed to dampness. The evaluation of the various directions of the buildings exposed to dampness was based on mean scores. Comparison of the mean scores of the directions showed no significant differences between the responses of the three professionals at 5% significance level. The responses of the three groups of professionals were pooled together and presented in Table 2.

**Table 2. Directions of buildings severely exposed to dampness**

| Direction | Mean score | Standard deviation | Ranking |
|---|---|---|---|
| South | 3.885 | 1.204 | 1st |
| West | 3.753 | 1.230 | 2nd |
| East | 3.637 | 1.118 | 3rd |
| North | 3.291 | 1.260 | 4th |

Table 2 shows that the mean scores of all the four factors evaluated by the respondents are greater than the mean value of 2.5 (Field, 2005). This indicates that in the opinion of all the respondents all four directions of buildings are susceptible to dampness attacks. However these attacks differ from one geographical location to the other (Agyekum et al., 2013). In the views of professionals the southern orientation of buildings are in most cases susceptible to severe dampness attacks. This is followed by the Western, Eastern and Northern directions of buildings. This results is in contrast to that identified in

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Aberdeen, UK. According to Young (2007), practitioners in UK mainly felt that northerly facing walls, especially those located in the north and north-east directions were most commonly associated with dampness.

Orientation, a key issue in sustainable architecture has not been given much attention in environmental design (Koranteng and Abaitey, 2009). Most buildings in Ghana now are oriented anyhow and there is the need to orient the buildings in directions where they are less susceptible to the attacks from the weather.

*Symptoms associated with dampness in buildings*

Table 3 shows the relative severity indices of the symptoms associated with dampness. Figure 3 is a graphical representation of the symptoms and their severity indices. The results from Table 3 and Figure 3 show that 'surface efflorescence just above skirting/floor', 'stains especially in horizontal band', 'dampness at the base of walls up to 1.5m in horizontal band', 'softening and deterioration of plaster' and 'blistering and flaking of paint' are the five most severe symptoms which are associated with damp buildings in the opinions of the practitioners. Other symptoms such as 'dampness around edges of solid floors', 'mould growth' and 'decayed skirting' were also identified by the practitioners to be severe in buildings. This finding corroborates that of literature. Studies undertaken by practitioners worldwide have identified surface efflorescence, blistering of paints, mould growth, among others to be the factors associated with dampness in buildings (Hetreed, 2008; Burkinshaw and Parrett, 2004; Trotman et al., 2004; Mbachu, 1999).

The results further show that the interviewed practitioners identified 'free surface water, water run marks, etc.' and 'dampness on first floor and above' to be less severe among buildings in Ghana. The severity of these symptoms were identified to be low because they are associated with surface condensation (Burns, 2010), a problem which is not very prevalent in Ghana.

Studies have also shown that 'surface efflorescence just above skirting/floor', 'stains especially in horizontal band', 'dampness at the base of walls up to 1.5m in horizontal band', 'softening and deterioration of plaster' and 'blistering and flaking of paint' are

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symptoms which are highly associated with rising dampness in buildings (Ahmed and Abdul Rahman, 2010; Trotman et al., 2007; Burkinshaw and Parrett, 2004).

**Table 3 Severity indices of symptoms associated with dampness**

| SYMPTOM | RSI | Ranking |
|---|---|---|
| Decayed skirting | 60.151% | 8th |
| Dampness around edges of solid floors | 71.648% | 6th |
| Surface efflorescence just above skirting/floor | 80.988% | 1st |
| Dampness at the base of walls up to 1.5m in horizontal band | 77.032% | 3rd |
| Stains especially in horizontal band | 78.899% | 2nd |
| Mould growth | 70.549% | 7th |
| Free surface water, water run marks, etc. | 42.637% | 9th |
| Blistering and flaking of paint | 75.935% | 5th |
| Softening and deterioration of plaster | 76.593% | 4th |
| Dampness on first floor and above | 36.264% | 10th |

$$\boldsymbol{RSI} = \frac{[\sum \boldsymbol{ai.xi}]}{[\boldsymbol{5}\sum \boldsymbol{xi}]} \times \boldsymbol{100}$$

This justifies the reason why the practitioners being surveyed in this study identified rising dampness to be the major cause of dampness in residential buildings in Ghana. This finding also corroborate that identified in a study by Agyekum et al. (2013a) where building occupants interviewed identified rising dampness to be the lead source of dampness in their buildings. This means both practitioners and building occupants in Ghana are of the view that rising dampness dominates buildings in Ghana.

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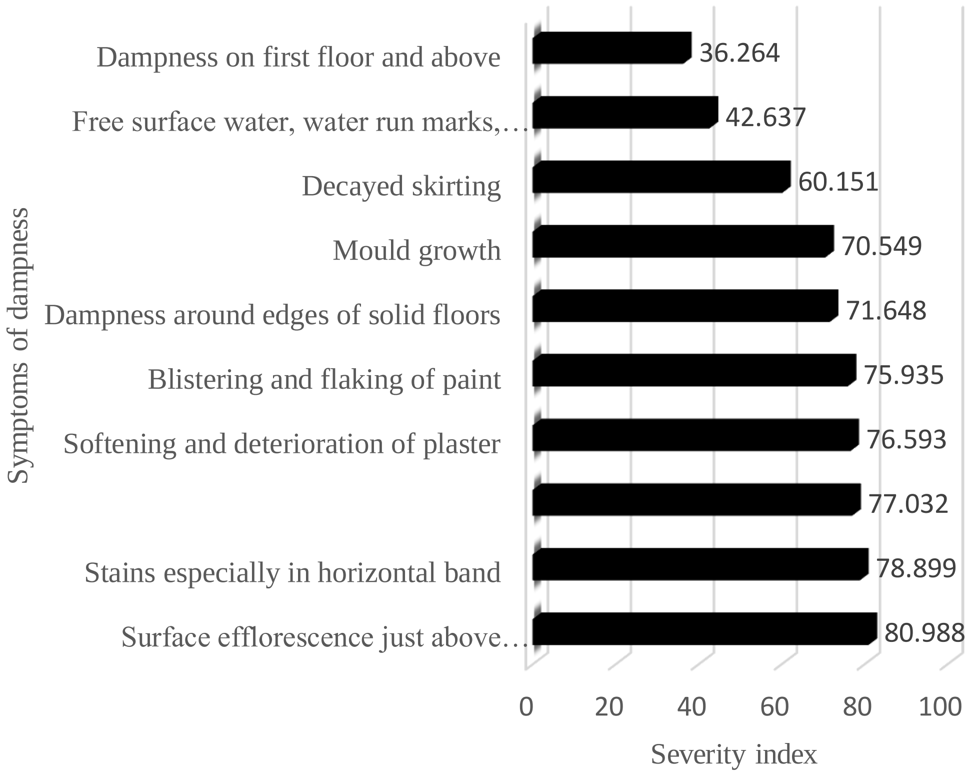


**Figure 3. Severity indices of symptoms associated with dampness**

## CONCLUSION

Damage to buildings caused by dampness pose serious risks to the performance of the building. If buildings affected by dampness are not treated such buildings will deteriorate with time and pose serious health risks to occupants. This study sought to assess the perceptions of building construction professionals on the causes and symptoms of dampness in residential buildings in Ghana. The results showed that most of the respondents were experienced on the issues of dampness and they demonstrated in-depth knowledge of the problem of dampness in residential buildings. The results also showed that rising dampness, flooding, leakages, water penetration and construction water are the five major causes of dampness in residential buildings in Ghana. Furthermore, the results showed that surface efflorescence just above skirting/floor, stains especially in horizontal band, dampness at the base of walls up to

1.5m in horizontal band, softening and deterioration of plaster' and 'blistering and flaking of paint are the five main symptoms associated with dampness. The study recommends to stakeholders involved in the construction industry to come together and find a common solution to this problem through more in-depth studies into buildings suffering from such problems. Laboratory tests coupled with scientific analyses should be conducted and proper technical reports on results obtained from such analyses should be well documented to have a better understanding of how to handle the problem of dampness.

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pISSN: 2343-6662 ISSN-L: 2343-6662 VOL. 7,No.7(2), pp 19-36, April, 2014

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