***Sustainable Solutions to Dampness in Building: A Case Study of Selected Period Properties in England***

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**Abstract**

**Purpose:** Dampness is a problem in predominantly period properties due to lack of insulation, heating, ventilation and untreated building defects. Associated problems of dampness in buildings transcend physical deterioration in buildings. There are serious and varied health hazards and environmental problems, particularly concerning the chosen methods of remediation. The aim of this study is to examine other eco-friendly and sustainable alternatives to Chemical treatment of dampness, which is disruptive to occupants and intrusive to the building.

**Design/methodology/approach:** Case study methodology was employed for this study as a deep understanding of dampness and the effectiveness of the electro-osmosis and magneto-physical methods. Nine properties treated using electro-osmosis and magneto-physical methods are presented as exploratory case studies to demonstrate their effectiveness in comparison to the conventional dampness treatment method.

**Findings:** In 3, 4, 6, representing (33%) of the cases, significant improvements to rising dampness was achieved. However, it was found in few of the cases; 1, 2, 5, 7 and 8 representing (56%), that the dampness returned after treatment. It was not successful in case 9 which represent (11%) due to other source of dampness that was not detected initially. On further investigation, it was found in these cases that the sources of dampness had not been exhausted at the beginning of the experimentation, necessitating the strong recommendations that thorough investigations of sources of dampness in buildings must be undertaken before treatment is applied.

**Practical implications:** Electro-osmosis and Magneto-physical method are chemical-free, simpler and cheaper to apply. In other to eliminate the negative imprints of the 70s and 80s, educating building professionals through continuous professional development (CPDs) is paramount to their revival, as effective measures for arresting rising dampness in buildings.

**Originality/value:** The study argues for increased preference for the eco-friendly and sustainable alternative methods to conventional chemical based methods of treating rising dampness.

**Keywords:** Building, Dampness, Defects, Safety, Electro-Osmosis and Sustainable.

***Introduction***

Dampness in buildings is unwanted moisture and researches have shown it contributes to half of all building defects in the UK (Burkinshaw, 2004 and 2009). In some European countries, more than 30% of population lives in damp dwellings making them 40% more likely to have asthma or other respiratory diseases (Kilpeläinena et al., 2011). As we spend more than 90% of our time indoors, respiratory infections becomes more frequent with damped buildings, and this involves huge social and economic costs to businesses and households, resulting to absenteeism from work. As a strong correlation exists between dampness and respiratory infections (Kilpeläinena et al., 2011). The annual total cost to European governments is estimated at 82 billion euros, 51% for treatment and 49% indirect cost for loss of productivity (Fraunhofer, 2016). The most common source of dampness is penetration from the outside due to rain or water pooling by the external wall (Rose, 2005). Air moisture known as condensation is most likely to occur in accommodations lacking inadequate insulation, ventilation and heating, especially where cooking, showering and drying clothes are daily activities. Other sources include plumbing defects, and flooding. Dampness from either source above normal level of relative humidity (45-65%), presents health hazard to the occupants while precipitating defects in building structure and the interior (Burkinshaw and Parrett, 2010) and (Hollis, 2013). Dampness exerts different effects on building materials, and as Oliver (1997), clearly indicates frost damages leaves physical damages while salt deposition and fungal attacks are damages respectively causing chemical and biological effect.

Rising dampness is mostly associated with period properties where damp proof course had been applied. This is also the case with new properties where damp proof course may have failed. Where this is the case, ground water travel upwards owing to capillary action. In hotter climates e. g Australia, rising dampness is associated with salt attack (Young 2008). Generally, construction industry practitioners tends to underplay the extent of rising dampness (Howell, 2008), due to lack of experience or wrong application. Thus, the need to search for effective solutions, apart from the adverse physical effects on buildings, the impact on the health of occupants makes it overwhelming.

A critical review of existing method is necessary in order to ascertain the source of the problems with dampness. According to the British Research Establishment Digest 245 (2007), the most effective way of treating damp is to introduce an effective damp-proof course into the wall of an existing building, forming a new physical membrane. However, this is expensive, labour intensive, time consuming, disruptive and inconveniencing. The mainstream remedy nowadays where new physical membrane is not possible, is chemical injection in conjunction with plastering which conceals damp. Although ineffective and not suitable for all building types, particularly if use in heritage buildings, it is recognized as the only alternative to physical membrane by British Standard Institution, Building Research Establishment and British Board of Agreement.

Alternatives to existing damp-proofing measures include evaporative damp-proof courses, electro-osmosis and magneto-physical methods. These methods, are largely unrecognised in the United Kingdom and hardly used. This paper therefore discusses the problems associated with rising dampness prior and post installation, results and experiences of occupiers, building owners and professionals, captured in an interview and presented as case studies.

***Theoretical Review.***

Dampness within buildings affects health of occupants and accelerates decay of the building structure. There are three main reasons dampness occur in buildings: air moisture shown as condensation, penetration, and rising dampness. The latter is the rarest, but surely the most mystical and wrongly diagnosed (Burkinshaw, 2004 and 2009). While condensation and penetration dampness are widely recognised, rising dampness divides opinions regarding its causes and remedial solutions. According to Boniface (2009), rising dampness is a myth and chemical injection is a waste of money. Similarly, Blockett-Ord (2009), also seem to be in support that rising dampness is extremely rare, while in a similar vein, Howell (2008), argues that rising dampness is a myth. However, evidence abounds indicating concerns for rising dampness (Hall and Hoff, 2007) and used concepts and methods of unsaturated flow theory to produce sharp front model in explaining rising dampness

Effects of damp on historic buildings, including rising damp, is probably the greatest cause of damage to historic building fabric (Ashurst, 1990). It causes unsuitable micro-climatic conditions (temperature, humidity) susceptible to mould and condensation. Wet walls increase thermal conductivity which invariably invites high heating bills. In addition, wet walls loose mechanical strength, but the choice of treatment is questionable (Franzoni, 2014). For instance, in Belgium and other Europeans countries, half of the renovation interventions are linked to rising dampness and hygroscopic salts and in contrast, only 10% of dampness problems in the UK are attributed to rising damp (Franzoni, 2014). In Australia, the climate is hotter and drier causing rapid drying and higher rates of transportation of moisture and in combination with saltier soils, the building decay is much greater than in the UK (Young, 2008).

***Mechanism of Damp Proofing Course***

In the UK there are building regulations, standards and procedures to prevent rising dampness in new builds. Remedial damp-proofing methods for older properties include physical Damp proofing course by inserting new physical membrane which needs to be feasible and justifiable (BRE, 2007). This method is disruptive, very expensive, time and labour intensive resulting in ineffectiveness. It can be damaging and causing structural problems (SPAB, 2007), besides inserting new physical membrane and/or chemical injection. It is widely recognized by both manufacturers and professionals, that chemical treatment does not stop rising damp, but only controls it and relies on dense cement/sand waterproof rendering for concealment. Chemical treatments will be less effective in non-uniformed (flint and rubble-filled) and wet walls, and is mostly effective when applied during summer as water table will be at their lowest and walls will be relatively dry. However, it is time consuming and is mainly performed as mortgage condition to attain guarantee against damp (Emerisda, 2014).

Electro-osmosis was discovered by physicist Reus in1800, using a process where water was forced through permeable membrane by application of external direct current electric field. This principle was used in soil moisture control and decontamination from 1930s. In 1980s in Switzerland, Hungary and Yugoslavia commercial units for drying walls were developed. Mechanism of drying is different in buildings; therefore, some authors acknowledge lack of evidence to sway either way (Burkinshaw, 2009). There are some successful applications in the US and Europe (Morefield et al., 2003, TBA Periti, 2014, DPA, 2014), but surprisingly not many conclusive results were obtained (Young, 2008, Franzoni, 2014). Beside the UK, the method was tested in Australia in the 1960s and 1970s, and became notorious for its failures (Young, 2008). Significant improvements were made that saw the Electro-osmosis receive the Commonwealth Scientific and Industrial Research Organisation Appraisal in Australia in 2003 and renewed 2006 as an effective measure for counteracting rising dampness. Also in the US electro-osmotic pulses up to ±40V DC was patented in the 1990s as means of eliminating rising dampness in masonry, and has since been constantly improved. The US Army successfully tested this technology in concrete basements in several locations, including tunnels and military bunkers, to show how moisture in masonry can be eliminated by use of asymmetric dual polarity electro-osmotic pulses and innovative electrode materials (Morefield et al., 2003 and Marshal et al, 2007).

Similar research was carried out in Denmark using electrodes and direct current up to 50V was conducted, and similar results were obtained. They used iron anode embedded in clay to buffer acidification from H⁺ ions and could demonstrate water flow from anode to cathode (Ottosen and Rorig-Dalgard, 2007). Building previously used as stable was affected by increase of hygroscopic moisture from these organic salts, structure decay due to crystallization and paint peeling from lower adhesion, confirming removal of most common salts (sulphates, chlorides and nitrates) from brick masonry by electro-osmosis (Ottosen et al., 2007). Additional to its use in treating rising dampness, electro-osmosis has been found useful in preventing radon gas penetrating into dwellings (Nam and Renken, 1998).



Figure 1 – Water Seepage into the structure Figure 2 – Electro-osmosis process

Source: Orange et al., (2007) Source: Orange et al., (2007)

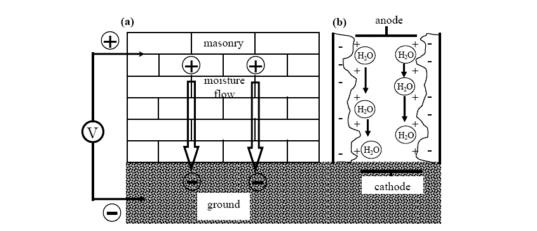


Figure 3 – Electro Osmosis setup used on a Masonry Wall

Sources: Massari and Massari (1998)

In Europe, there are two versions of active electro-osmosis: wired and wireless. The passive wireless version is not in use. Only the active wired electro-osmosis such as Drytech and Drytronic are in use, and this involves using interconnected electrodes inserted into the walls and connected to the earth pole, see fig. 1, 2 & 3. Small charge is applied to electrodes reversing the polarity of the wall and forcing water molecules downwards, hence it is green and chemical free but involves a lot of internal disruption to insert wires (Drytech, 2017; Drytronic, 2017). The last 20 years have seen newer active electro-osmosis systems developed – Drymat Ombrello and Prosystem that utilises wireless technology without any building work involved. There is usually only one unit connected to the mains sited in the middle of the treated property to reach all the external walls. It emits low energy electro-magnetic waves charging walls and floors. Drymat is a German device for drying all kinds of dampness and suitable for all buildings. Ombrello on the other hand is a Swiss product that operates on electro-magnetic principles. Prosystem is a Croatian product that works on the same electromagnetic principle that produces pulsating waves to eliminate capillary actions to drive moisture downwards.

The most recent dampness control method is the magneto-physical method, it harnesses Earth’s magnetic field, filters out and emits to the walls certain frequency which forces hydrogen to resonate (Mohorn, 2015). In theory this effect overcomes adhesion forces and water molecule is gradually drawn down by gravity. There is no other external power supply. There are two devices of this kind available: Murtronic used in France, which is based on the use of electromagnetic energy produced by underground water streams, lakes or geological faults. In this area electromagnetic fields are stronger than elsewhere and electrically charge walls up to 500 mV. Suitable for all buildings, no maintenance, no power consumption, no harm to occupants and ecological (Tellurica, 2017). The other is Aquapol in Austria, this device was first developed in 1985 on principle of harnessing Earth’s geo-magnetic field. It will also take radio-frequency energy from other sources: radio, radar, mobiles, Wi-Fi etc. There are three main parts: receiver, amplifier and transmission units. It does not require any additional power supply. The frequency of hydrogen atom is 1420MHz, which is received from Earth’s magnetic field by the device, amplified and sent to surroundings causing hydrogen atoms to vibrate until they are shaken off and drained away due to gravity. Once installed, the unit stays permanently, and has expected life of over 50 years. For effectiveness, other moisture sources need to be addressed separately. As part of installation, comprehensive moisture survey is performed, while electro-smog pollution is checked together and wall core moisture measured by gravimetric method. This method was successfully used in Hungarian Parliament in Budapest, and in the UK there are more than 200 installations mostly in Scotland (Aquapol, 2017).

Evaporation Improvement method has been in use since the 1930s but fell out of fashion in 1970s with the introduction of chemical treatment (UK Damp, 2015). Ceramic (Knappen) tubes or Ventilation (Schrijver) tubes (modified version of ceramic tubes) are inserted externally within the wall at low level which attract and absorb moisture in surrounding wall. Porous material of tubes draws moisture from surrounding brickwork, which evaporates at inner surface and vents to the atmosphere. Critics say that these tubes can be blocked with salt, which is proof that they work and can be easily removed with compressed air (UK Damp, 2015). The wall drying quickly depends on local weather conditions. Physical damp-proofing was introduced in 1870s as public health measure. Overlapping slates were laid horizontally at the wall base to form a continuous water barrier. In 1930s bitumen was introduced which nowadays gave way to plastic membranes. Slate damp course is still effective and inserting new damp course should be the last resort, most common problems being penetrating dampness and bridging. Introducing additional airbricks will help cross-ventilation and reduce moisture levels (UK Damp, 2015).

***Research methodology***

This research employ a quasi-experimental case study to establish what is happening in remedial damp-proofing industry and gain insight into current state of applicable remedies for rising dampness across building professionals and building owners in South of England, (Yin, 2014 and Saunder et al., 2016). A quasi-experimental case study is practice based approach which was carried out in an actual house affected by rising damp.

The Case study is chosen to understand dynamics of the rising dampness phenomenon in the real world. This study is to provide the context in which electro-osmosis and magneto-physical method is deemed successful or failed (Yin, 2014 and Saunder et al., 2016). The essence of a case study is to illuminate a decision or set of decisions; why they were taken, how they were implemented, and with what result. It follows the logic of multiple experiments or replication design (Yin, 2014). Cases should be selected in a way that few (2-3) produce similar results (literal replication, and some other (4-6) pursue different outcomes for predicted reasons (theoretical replication).

***Case studies***

There are nine case studies, were alternative methods for eliminating rising dampness were adopted; two with Aquapol and seven with Prosystem, this are the available cases at the time of this study, since it is not widely known in the UK. Aquapol reports made available were used while in Prosystem, visual and non-destructive methods were collected (Zhang, 2010).

***Case Study 1 - Lambeth***

Ground floor terraced flat constructed in 1900s with brick in city plain.Aquapol was installed in October 2016 and the flat was refurbished and sold 2 years later. The buyer noticed low level damp spots, but surveyor diagnosed them as drying plaster and sale went through. The damp was getting worse and owner had to look for clues herself as there was no help coming from anywhere (builders or freeholder would not talk to her or admit fault). The salt analysis from the wall detected chlorides in addition to nitrates and sulphates, which indicated water main leak combined with the ground source water. After leak was fixed, the owner decided to introduce Aquapol system as recommended. Survey done at that time found defects on external walls around corners and windows, which allowed rain to penetrate inside. After fixing external defects, there was reduction in wall dampness, measured by gravimetric method, though plasterboard showed more water damage. The affected plaster was replaced and the floor lifted to inspect void below ensuring adequate ventilation. After drying the walls new plasterboard is put in place with metal stud to prevent salt migration. Though the walls were nearly dry and measured by gravimetric, there was still damp smell in the air from wet plasterboards, hence piece of the plasterboard was cut out to allow access to the wall and take samples. Owner was encouraged with device performance, hence was satisfied.

***Case Study 2 - Exeter.***

A two storey 1870s rural stone house with a garage. It was previously utilised as mill factory and latter converted into dwelling in the 1950s.The cottage was suffering from some damp patches in the main house ground, first floor and in the garage. House dampness can be related to faulty pointing and rising dampness from the shared garage wall. Garage is used as storage and there was previous attempt to damp-proof it by tanking the walls but not the floor. The rear and side walls are partially underground, and roof is insulated to prevent condensation. The owner decided to take a trial with Aquapol to eradicate dampness in the garage. Before installation, monitoring equipment was set up to record data in real time over whole period of drying of internal wall to exclude side penetration. Aquapol was installed in September 2016 and both temperature and humidity were measured in the wall, room and externally. Data logger was gathering continuous measurements since installation and showed moisture reduction in the wall within 4 months and this was confirmed by gravimetric measurements. The system works on walls only, so the smell of dampness was still in the room because of floor dampness. Although the dehumidifier was left working in the garage continuously, the floor remained damp. The wall affected by rising dampness were almost dried. However, floors and other sources of dampness needs to be addressed separately hence, the owner were encouraged by the results.

***Case Study 3 – Brighton***

Ground floor and basement architectural office in an end of terrace two storey 1800s solid masonry building built on sloped land. This was previously utilised as a shop and was renovated 20yrs ago. It suffered from penetrating damp around windows and down pipe, as well as dampness on internal walls at the basement level due to ageing. The owners are aware of the Prosystem technology, and being risk averse, installed Prosystem in February 2016. There was steady decline in moisture readings on the walls, except around the window head due to rain and neighbouring soaking hence it was confirmed to be effective. Comparison of infrared pictures before and after 20 months shows even temperature across the wall, in line with moisture readings confirming dryness. The owner was contented with the system performance and would therefore recommend it in the future. However, they are aware of system limitations in dealing with rain penetration, which must be addressed separately.

***Case Study 4 – Kensington.***

Basement flat in four storey terraced building, sloping city land.Prosystem was installed in April 2017. The flat was refurbished 2 years ago and used as bed and breakfast. After few months, damp smell was noted and pealing of paint and blistering of wallpaper appeared. As it was becoming worse, and the owners were not in mood to do building work again, they were looking for an alternative. By recommendation, they took trial from Prosystem. After 4 months, smell is gone and there is visible drying of walls and woodwork, when measured by moisture meter and in line with infrared survey. The owners find this successful and would recommend system in future.

***Case Study 5 – Balham.***

Two storey semi-detached pre1900s brick house, city level ground. Property has low cellar which was tanked at floor level while the rest of the house was restored 15yrs ago. There was damp smell and visible dampness marks on the ground floor walls. Owners found advert in the magazine after hearing personal recommendations, installed the system. Prosystem installed in October 2014, and improvement was noted and the ground floor walls appeared dry when measured by moisture meter. Three years after, there is not much change in appearance of landing and stairs leading to cellar, suggesting constant supply of moisture from the soil, as ground floor bathroom adjacent to stairs is not in use. It is interesting that the house dried out over the first winter. The owner can see an improvement initially and smell disappearing.

***Case Study 6 – Oxford.***

End of terrace, 1850s brick two storey city house. The house was built on clay soil without foundations, timber flooring in the front and concrete at the back of the house, which make the building prone to flooding with water reaching the house foundation during heavy rain. The house was chemically injected 35yrs ago, dampness returned with smell and walls were visibly damp, confirmed by moisture meter and thermography imaging**.** Prosystem was installed February, 2015 and removed in May 2016. There was an immediate improvement as the walls dried out and the smell disappeared. Temperature difference between wall and floor on the back-room wall fell from 4.2 to 1.1°C for the same time of the year with visible drying, and lower moisture meter readings. The device was removed a year later, smell and dampness in the back room returned, confirmed by higher moisture meter readings and increase of temperature difference, which is now 3°C at the same spot. The house owner endorses the used of electro-osmosis and would recommend it but unexplained dampness in the front room walls next to the chimney forced her to cancel trial.

***Case Study 7 – Birmingham.***

A four storey 1880s City Hotel with basement on sloping land. The Hotel was suffering from rising dampness, recognised by bad smell, visible damage to internal basement walls and tidal marks on the outside walls. Prosystem was installed in June 2014, taken away November in 2016.The building manager accepted 2-year trial of the technology before actual treatment, Damp proofing moisture readings taken from various basement locations which were classed as wet, a year after the reading was taken it was confirmed that the building was now dry. A different surveyor also reconfirmed it in November 2016. However, the unit was removed on request from hotel building manager. Recent survey after 1 year when the device was removed, smell and dampness are slowly returning in places: there are more visible damages to interior plaster and paint and higher readings on moisture meter. Comparison of horizontal temperature distribution on a lower part of the wall affected by rising dampness shows initially difference of 0.6°C and months later increase to 0.3°C a year after system was removed. The hotel maintenance manager fully endorses Prosystem as a result of disappearing of dampness after treatment. Treating building of large size by chemical injection would require vacating the rooms during application while the results could not be guaranteed.

***Case Study 8 - Sunbury-on-Thames****.*

18th century Church by river Thames. Prosystem installed in August 2014 and removed in August 2015. The Church has an acute dampness with visible damp patches, flaking paint, salt deposits and crumbling plaster. Initially, there was smell of damp and moisture readings in the wall between 11-26%. Previous priest and church warden have been to Malta where they saw Prosystem installed. They opted for a one year trial before committing to buy. Damp proofing association was monitoring and taking measurement before and after treatment, within 3 months the measurements showed reduction of moisture in walls between 2-6%, accompanied by smell disappearing, visible drying of surfaces and more salt deposits. The same outcome was confirmed by another independent measurement with Speedy meter. In spring 2015, most affected plaster was removed and replaced by most likely cement based one up to the visible line of damage, salts just above joint reacted with newly introduced water into the wall and flaked the paint, the system was not working and its removal was requested by church committee in August 2015. In repairing dampness damage to historic buildings, there are two important conditions: The use of lime plaster and remover of old plaster 500mm above visible line of rising dampness.

***Case 9 Study - Letcombe Regis.***

Rural solid wall 1850s residential dwelling cottage, sloping land by stream. Prosysteminstalled, January 2015. The Cottage was bought 15yrs ago and partially refurbished 7yrs ago after flash flooding. There has been problem with dampness since purchase. They have been rather sceptical about it as being too simple to solve their problem. After nearly 2 years walls got worse and remain visibly damp with very little signs of drying. There is possibility that the walls is dry and only the surface is wet due to salt contamination. The owners are aware of the health implications, though their opinion about the system remains rather sceptical.

**Discussions and Findings**

***The use of other methods for eliminating rising dampness***

The common remedy for rising dampness is insertion of physical membrane (Howell, 2008). This process is labour intensive, disruptive and expensive, it should be used as a last option Emerisda (2014). In the UK, chemical injection is more popular than physical membrane, which has not been successful (Sellers, 2017) and Howell (2008) as illustrated in these case studies. Electro-osmosis and Magneto-osmosis is a sustainable way of reducing dampness although it’s used as declined from its peak in 1970s due to bad reputation of thousands of these installations from 1960s, it is now affecting its rebirth. Better approach by Aquapol for their professional survey and Prosystem team relying on sensory receptors as help in proving their effectiveness and installation which has increased to over 200 across the country.

***Effectiveness of sustainable methods in eliminating rising dampness***

Remedial damp proofing by electro-osmosis and magneto-physical method was used in nine case studies with detailed result summaries below:

* Drying of the walls confirmed by gravimetric method, but damp smell remains as other sources of dampness need to be dealt with and wet plasterboard replaced; owners seen improvements.
* In (Case 3 and 4), Drying of the walls confirmed both visually and by moisture meters with some other sources to be dealt with; owners satisfied with results and would recommend it for other user.
* Property initially dried out and smell disappeared in (Case 5), but dampness returned 6 months later for known reason (flooding) and could not dry out again; owner was initially satisfied with results but could not be sure about the system after the flooding.
* Case 6 property was initially dried out and smell disappeared, the owner saw the improvements and would recommend system.
* The Building dried out and smell disappeared in Case 7 and 8 as confirmed by surveyor’s measurements with moisture meter and initial direct users’ observations. Due to change of users and lack of material evidence before and after, the subsequent users would not recognise there were improvement.
* System installed by users without prior inspection in case 9. Building never visibly dried out and walls remained wet since installation, even getting worse. Owners did not see any improvements and would not recommend the system. Detailed survey is needed to combat any health hazard.

***Conclusion and recommendations***

***Conclusion***

Treatment of rising dampness is controversial. Mainstream treatment in the UK is chemical injection but its success in controlling and concealing dampness is low. Other methods, such as electro-osmosis and magneto-physical method are not considered in the UK as viable alternatives. There is slow uptake of these alternative methods and application is completely new in solving the problem of dampness. In the UK, no technology advances and introduction of wireless active electro-osmosis were considered in the past, whereas it is being widely used in Europe and the US.

The architects and builders have seen growth in their business with the use of this practice in eliminating dampness in building. It is proven both theoretically and in practice, that rising dampness will reoccur over newly introduced rendering even if with chemical injection. If the evaporation surface is reduced by tanking or impermeable treatment, moisture will go higher up.

The case studies show that, there is potential for electro-magneto-physical methods in eliminating rising dampness in historic buildings as it is non-invasive and eco-friendly solution without the use of chemicals. The power used is very small and therefore complete drying is a lengthy process (expected in 1-3 years) depending on many factors: wall porosity, salinity and thickness, micro-climatic conditions, previous treatments, other sources of water beside rising dampness etc. Signs of improvement may be visible within days in walls becoming brighter, increased air humidity or even water trickling out of the walls. Faulty building fixtures, like flashing, gutters, downpipes, drainage and pointing need to be repaired as it will provide constant supply of moisture. Users of the alternative methods of dampness prevention have used the chemical injection method unsuccessfully.

Excess of building dampness will usually come from more sources and thorough professional survey is needed. Although the Electro-osmosis and magneto-physical methods will deal with rising dampness in walls, other sources such as floor dampness must be dealt with separately. Education of both building professionals and clients on the alternative methods of dampness is also desirable, but without due care and knowledge about dampness issues and available methods of treatment, success is not attainable. Unexplained dampness (Cases 6 and 9) should be examined, as was done in Cases 1 and 2 as this is the only way wall sample analysis by gravimetric method would give unambiguous results.

***Recommendations***

Research and Education, excessive dampness in buildings results in increased heating bills, damage to surfaces and structural walls, or even renders the buildings unusable or uninhabitable. The most adverse effects can be found with the impact on occupants’ health. Sources of dampness can be from various source, usually there are more than one-combined sources. Treatments can also be a combination of good and responsible management. Once eliminating other sources, rising dampness can be addressed by electro-osmosis or magneto-physical method which are chemical-free and simpler and cheaper to apply. There is need for modern research and review on the latest technological approach on electro-osmosis and magneto-physical method to reveal or analyse its effectiveness. Therefore, education of building professionals through continuous professional development is paramount to give them knowledge on how and when to deal with rising dampness. For environmental and sustainability reasons, in addition to cost savings, electro-magneto-physical methods should be given the desired recognition as effective solutions to problems of rising dampness? Problem of rising dampness is not as common, but damages caused to historic buildings and heritage homes are enormous. Continuous research on this process is necessary to be able to convince the stakeholders about its effectiveness and the result from such research should put into public domain.

Creating an Awareness or enlightenment campaign, Jeff Howell (2010) was right to conclude that rising dampness is a strange beast, it cannot often be seen but can be smelt. There is an awareness on the impact and health implication of dampness within the community by various environmental health officer or building inspector, the various building users and stakeholders need to be enlighten on various sustainable approach of reducing dampness.

Building Professionals,Manufacturers offering alternative remedial damp proofing could form their own association, as in the case of chemical damp-proofers. Their voice and case would be heard loud and wide. The way Aquapol approach gather its data for proving effectiveness of their product is highly technical and professional. There is a need for professional body to offer independent survey to homeowners and police all damp-proofers against false claims.

Innovative Technological Ideas,building owners and users should be open to any technology or innovative ideas, anylatest eco-friendly technologies should not be judged on past performance before innovation and advancement in the devices. What the users should be interesting in is the current performance and alternative solution from chemical injection which is not sustainable.

Sustainable Approach,Stale and damp air and mould are all hazardous to health, we need to be cautious of our environment and the kind of chemical used around us. The use of chemical injection in treating dampness has proved unsuccessful and households are exposed to dangerous chemical. It is necessary to change the dynamics of dealing with dampness by exploring alternative eco-friendly and more environmentally sustainable solutions. We should be conversant with innovative ways of doing things, which can improve future generations’ wellbeing by sourcing a sustainable way of eliminating dampness.

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